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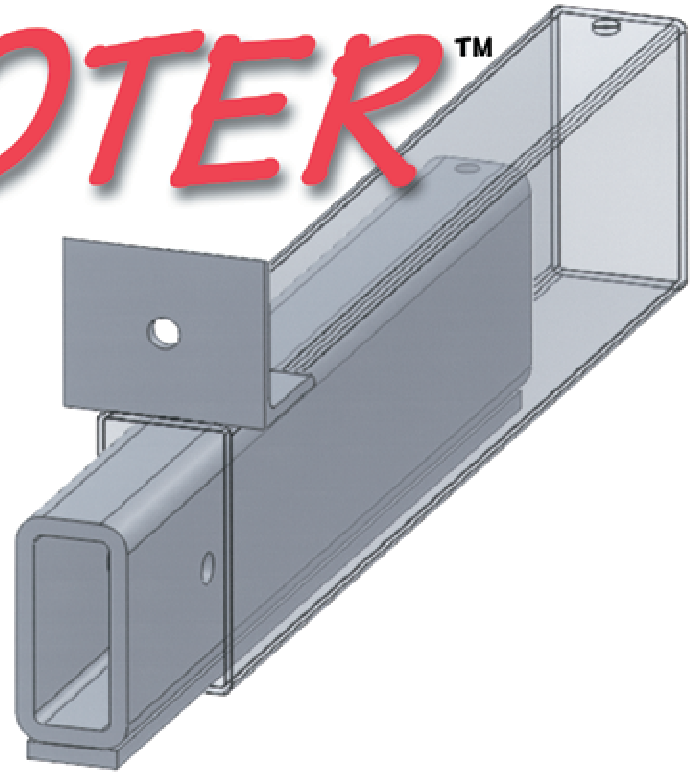

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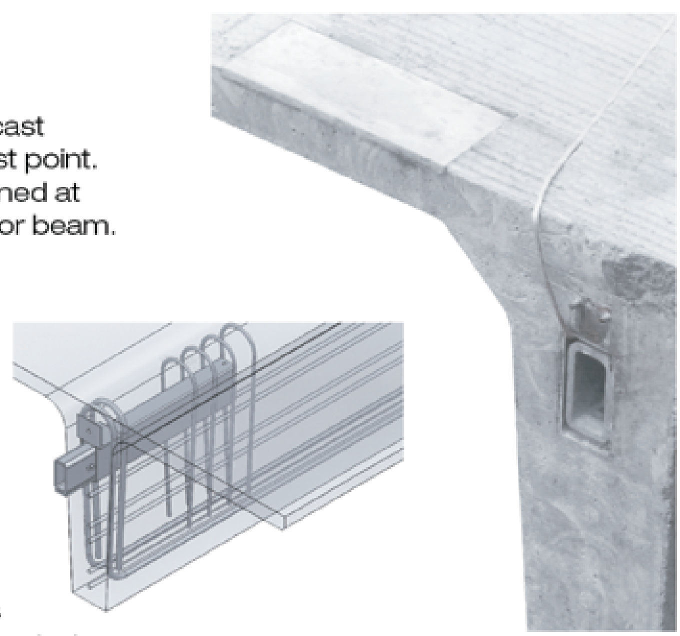

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GOLDEN, COLORADO

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Features

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Departments

On Call For You

PCI Headquarters
phone: (312) 786-0300 fax: (312) 621-1114
email: info@pci.org www.pci.org

Central Atlantic Bridge Associates — Heinrich O. Bonstedt
phone: (610) 395-2338
email: info@caba-bridges.org
www.caba-bridges.org

Colorado Prestressers Assn. — J. D. Schafer
phone: (303) 880-3843
email: jdschafer@stresscon.com

Florida Prestressed Concrete Association (FPCA) — Joseph Lord
phone: (813) 579-7232 fax: (813) 315-6026
email: info@fpcaweb.org www.fpcaweb.org

Georgia/Carolinas PCI (GCPCI) — Peter Finsen
phone: (678) 638-6220 fax: (678) 638-6221
email: peter.finsen@gcpci.org www.gcpci.org

Mid-Atlantic Precast Association (MAPA) — Greg Winkler, AIA
phone: (856) 761-8885
email: gwinkler@mapaprecast.org www.mapaprecast.org

PCI Midwest — Mike Johnsrud
phone: (952) 806-9997 fax: (952) 806-9998
email: mike@pcimidwest.org
www.midwestprecast.com

PCI Central Region — Phil Wiedemann
phone: (937) 833-3900 fax: (937) 833-3700
email: phil@pci-central.org www.pci-central.org

PCI Northeast — Rita L. Seraderian, P.E., LEED AP
phone: (888) 700-5670 fax: (617) 489-5810
email: contact@pcine.org www.pcine.org

PCI of Illinois & Wisconsin (PCI-IW) — Dawn Parker
phone: (312) 505-1858
email: d.parker@pci-iw.org www.pci-iw.org

Precast Concrete Manufacturers Assn. of Texas (PCMA of Texas) — Chris Lechner
phone: (210) 633-6743
email: lechner@pcmatexas.org
www.pcmatexas.org

PCI West (formerly) Precast/Prestressed Concrete Manufacturers Assn. of California (PCMAC) — Doug Mooradian, AIA
phone: (818) 247-6177 fax: (818) 240-3041
email: doug@precastconcrete.org
www.precastconcrete.org

Brian Miller, P.E., LEED AP Executive Editor bmiller@pci.org

Precast—A Better Way To Build.

Construction is coming back. Projections for this year show total construction at around $568 billion dollars. This is a 32% increase since 2010, which was the low point in the recession for construction. The reviving market gives owners, architects, and contractors an opportunity to review their methods and materials and to update their choices to match the high-performance needs of building users.

Nearly half of the expected rebound in construction is expected on the residential side. Of the $568 billion in total construction, $246 billion will be residential. This represents an 18% increase over last year, and residential building is projected to grow at double-digit rates for a while. This is good news for the commercial market too. Residential construction serves as a general indicator for the overall economy and is fundamental to all segments of construction. Along with new residences, both single-family and multifamily, come support services: shopping centers, schools, roads, parking, healthcare facilities, etc.

Since the recession, many factors involving residential construction have changed. These include the average size of residences, types of rooms and spaces needed, amenities, and even the building codes, especially related to energy efficiency.

However, the general materials used to construct homes have not changed to match these evolving needs. Many areas of the country continue to use outdated construction methods and materials to build residences even while new codes drive us towards increased energy efficiency, less water vapor intrusion, and reductions in air infiltration/exfiltration. Also, common sense tells us to build more safe and resilient housing, especially in areas of storms, high winds, fires, etc.—and these areas are expanding. We have better options and technology at our disposal.

High-performance precast concrete offers a better way to build. It provides an optimal solution not just for large-scale projects, but for mid- and small-scale projects as well. Precast offers the aesthetic versatility to include or emulate brick, stone, siding, stucco, or any other finish desired by an owner. It also offers the structural versatility to serve as the primary structural system at the same time.

Precast concrete is extremely durable and requires little maintenance. Precast concrete wall systems can also provide superior energy efficiency, by combining continuous insulation, a continuous air barrier, and a vapor barrier in one system. This type of wall system also reduces the potential of mold and other water intrusion issues.

But wait, there's more! Precast concrete inherently provides passive fire protection, because its inorganic composition does not combust. It is also resilient, protecting against storms, high winds, flying debris, and other natural and manmade hazards. This benefit is the most significant, as we cannot put a price on human life. In addition, the cost of rebuilding after catastrophic events is high financially, emotionally, and socially. The opportunity to take steps to minimize this is now.

You can learn more about residential construction and the benefits of precast concrete in this issue of *Ascent*. Whether you are building a multistory condo or a single-family residence, precast concrete offers a better way to build.

ASCENT

On the cover: 2550 North Lakeview Drive, Chicago, Illinois (see page 24). Photo: High Concrete Group, LLC

- **Executive Editor:** Brian Miller, P.E., LEED AP
- **Managing Editor:** Craig Shutt
- **Editorial Staff:** Thomas Irvin
- **Editorial Administration:** Jennifer Peters
- **Art Director:** Paul Grigonis
- **Graphic Design:** Ed Derwent
- **Graphic Design:** Tressa A. Park
- **Ad Sales:** Kirstin Osgood Manager, Sales and Member Development kosgood@pci.org (312) 360-3206
- **Reprint Sales:** Paul Grigonis, Art Director (312) 360-3217 pgrigonis@pci.org
- **Precast/Prestressed Concrete Institute:** James G. Toscas, President
- **Industry Technical Review Team:** Jane Martin, Elizabeth Burns, Jay Cariveau, Peter Finsen, Sidney Freedman, Corey Greika, Thomas Ketron, Mark McKeny, Brian Miller and Greg Winkler
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Eighty precast concrete components, including architectural panels and planter wall curbs, helped the two-story, 25,000-square-foot addition to Gillette Stadium match the existing structure and complete construction faster.

Gillette Stadium Expands

FOXBORO, MASSACHUSETTS

To expand administrative space at Gillette Stadium, home to the NFL New England Patriots, owners are creating a two-story, 25,000-square-foot addition to the east side of the stadium. In an effort to match the existing façade and fast-track the project, designers chose precast concrete architectural wall panels and other decorative elements for the façade.

The addition will consolidate football operations into one unified area, bringing them together from a variety of current locations. The fast-track design schedule was easily met by precast concrete's ability to cast components while the site was prepared and steel structural framing was erected.

"The precast panels were being cast as the footings were being poured, so they were ready when the site was ready," says Gerald K. Grassby, sales associate at Strescon Limited, the Burlington, Mass.-based precaster. Strescon's key challenge came in finding a close aesthetic match to the existing precast concrete panels on the stadium, which were fabricated by another supplier when the stadium was originally built. A variety of mock-ups and prototypes were created to find the ideal match. Planter wall curbs also were fabricated in the same finish to complement the addition.

Two sizes of panels were cast, consisting of 36 14-inch base panels, encompassing 1,517 square feet, for use on larger areas, and 11 8-inch base panels, covering 1,851 square feet, for use around curtain wall. The panels were erected in early May 2014, with occupancy expected in July. J.K. Scanlan Co. LLC in East Falmouth, Mass., served as general contractor.

Oldcastle Precast Casts Unique Elements

LITTLETON, COLORADO

Oldcastle Precast has produced unique precast concrete elements for three recent projects with novel applications.

Specially designed precast concrete rings were cast to create artificial reef structures for OysterBreak, which uses strategically placed artificial reef structures to encourage oysters' inherent nature to cluster and fill in gaps.

The system uses stacks of precast concrete rings similar in size, shape, and weight to space rings used on manhole risers only with anchor lugs and wave openings. Each ring was wet-cast using an OysterKrete mix design, a harsh mixture that results in a hardened concrete similar to pervious concrete.

Placed in rows two to three deep, the structures serve as protection against shoreline erosion, allowing tidal water to move through while disrupting wave action.

Oldcastle's Auburn, Maine, plant products multiple sizes of L-Wall agricultural panels, the largest being 10'10" high by 5 feet wide, to create a manure-storage facility for R.E. Hemond Farms in Minot, Maine. The design and location of the facility qualified for reimbursement by the Federal Natural Resources Conservation Service program. The L-Walls also are used for recycling bins and security walls.

Lightweight precast concrete dive platforms were cast for the University of Southern California's Transformed Aquatics Center in Los Angeles. Oldcastle's Perris, Calif., plant produced the pieces that created the towers. The Uytengsu Aquatics Center's new design features a new stadium entry, diving and dry-land training areas, new locker rooms, offices, meeting rooms, and other amenities.

The first phases of the $500-million University Station project features 550,000 square feet of retail space and a 350-luxury residential development. The residences will wrap about a central precast concrete parking structure.

University Station Features 'Texas Wrap' Design

WESTWOOD, MASSACHUSETTS

Developers of the new 2 million-square-foot University Station multi-use project near the Route 128 MBTA commuter rail line have begun construction on the first phases, which will include an apartment complex with a total-precast concrete parking structure at its core.

When completed, the $500-million project will include 750,000 square feet of retail space, a 350,000-square-foot Class A office building, 650 residential units, up to 160 hotel units, and an assisted-living and memory-care facility with 100 units, according to the *Boston Business Journal*.

The first phase, to open in the spring of 2015, will feature 550,000 square feet of retail space. That will be followed by the Gables at University Station, a 350-unit luxury residential development planned to open that summer, *BBJ* reported. Later phases will add the offices, hotel and additional residences and retail.

The residences are being designed by Wallace Garcia Wilson of Houston using the "Texas wrap" format the developer used on other projects. In this design, a parking structure is constructed at the center and residential spaces are wrapped around that core, leaving some façades of the parking structure open. The precaster on the project is Blakeslee Prestress, which has worked with the general contractor on a total-precast concrete parking structure in the past.

The 457 components comprise double tees, girders, columns, shear walls, lite walls, spandrels, wall panels, stairs and slabs. The erection took about six weeks, after which construction on the apartments began. The Hanover Co. in Boston, Mass., is serving as general contractor on the project.

On the two sides where the parking walls are exposed, designers specified an architectural finish of a gray concrete with a light sandblast. Some panels on the west façade had thin brick inset into them to provide depth and contrast. Panels were designed so that only one finish was required on each piece, simplifying the casting process.

Students from local high schools participating in the ACE (Architecture-Construction-Engineering) Mentoring program learn how precast concrete is cast and finished during a tour of the Blakeslee Prestress plant in April.

Blakeslee Hosts ACE High-School Program

BRANFORD, CONNECTICUT

This spring, Blakeslee Prestress Inc. hosted local high-school students who participate in a school program that exposes them to various professions and activities within the construction industry.

The nationwide ACE (Architecture-Construction-Engineering) Mentor program, founded in 1994, coordinates programs for high-school students interested in construction fields. It teams them with mentors who are professionals in those industries to provide presentations and tours. The New Haven Chapter consists of students from 17 area high schools who are taking courses in engineering or drafting or have summer construction experience.

The visit was coordinated through Blakeslee's Al Ignoto, senior project coordinator, and ACE's Sara Pettit with Pickard Chilton Architects. Blakeslee's Jim Fitzgerald, quality control manager, led a tour of the facility and yard. The students saw precast concrete components being cast, stripped, and finished. They also were given a demonstration of the company's Tekla 3-D modeling software during their half-day visit.

"The students were really engaged learning about Blakeslee's projects, processes, and technology, and the tour really blew them away," Pettit said later.

Stresscon Project Earns ACI Award

GOLDEN, COLORADO

The U.S. Department of Energy's National Renewable Energy Laboratory's (NREL) Energy Systems Integration Facility (ESIF) has earned an Award of Excellence for Precast Concrete. The project was submitted to the 46th ACI Awards Program to highlight the use of high-performance precast insulated wall panel systems to accommodate high energy efficiency requirements.

The ACI Awards Program recognizes creative, innovative, aesthetic, and imaginative uses of precast concrete. Stresscon provided 876 precast concrete pieces, including the high-performance, thermally efficient precast concrete wall panels.

The high-performance insulated wall panel systems consisted of a 14-inch-thick Thermomass panel system consisting of a 3-inch exterior wythe of gray concrete, 3 inches of polyisocyanurate insulation, and an 8-inch interior structural concrete wythe. With edge-to-edge insulation, the wall panels achieve an R-value of 20.55, helping achieve 40% greater performance efficiency than the ASHRAE 90.1 building standards.

M. Lee Marsh Named BergerABAM President and CEO

FEDERAL WAY, WASHINGTON

BergerABAM has named Dr. M. Lee Marsh as president and chief executive officer. He succeeds Arnfinn Rusten, who has retired. Since joining the firm in 1994, Dr. Marsh has spearheaded many of the firm's seismic design and assessment projects.

During his tenure as senior project manager and principal, his work has included design, assessment, project management, and business development for bridges, transit guideways, marine structures, buildings, and specialized projects, such as cranes for nuclear power plants. In addition to his operational and project duties, Dr. Marsh has served on the firm's Board of Directors since 2006.

Lafarge Sponsors 'Designing for Disaster' Exhibition

CHICAGO, ILLINOIS

Lafarge North America has become the lead sponsor of the exhibition, "*Designing for Disaster*" at the National Building Museum in Washington, D.C. The program discusses disaster mitigation as an evolving science and highlights tools and strategies for building safer, stronger and more disaster-resilient communities that are functional, pragmatic, and beautiful.

The multimedia exhibition will explore new solutions for, and historical responses to, a range of natural hazards as they impact a variety of residential, commercial, and institutional facilities.

The exhibition opened May 11 and will remain on view through August 2, 2015. To complement the exhibition, the National Building Museum and its partners have planned a slate of public programming.

Elliott New Spancrete Rep for Southeast

WAUKESHA, WISCONSIN

– Daniel Elliott

Spancrete has named Daniel Elliott regional sales representative to assist in the sales growth for its Southeast territory. Elliott has more than a decade of precast, prestressed concrete experience. He also has an associate degree in drafting from Southern Crescent Technical College in Griffin, Ga. He will work from Spancrete's Newnan, Ga., office.

Duncan Joins Gate Precast

JACKSONVILLE, FLORIDA

– Jerry Duncan

Jerry Duncan, a 23-year veteran in precast concrete construction, has joined Gate Precast's Southwest division. Duncan will cover markets in Dallas, Fort Worth, and North Texas. He will work with designers and contractors in the earliest conceptual stages of design through completion.

PCI to Hold a Special Afternoon of Continuing Education For Architects at the PCI Convention on September 9!

NATIONAL HARBOR, MARYLAND

This FREE session will be held on the afternoon of Tuesday, September 9. Visit www.pci.org/archsday for more info. Celebrate 60 years of success at the 60th Anniversary PCI Convention and National Bridge Conference, September 6-9 at the Gaylord National Resort and Convention Center in National Harbor, Md. If you register before August 1, 2014, you will receive the Early Bird rates. Visit www.pci.org register, view education courses, see the exhibitors, and more!

Submit your headline news for consideration in a future issue of *Ascent* to Stephanie Corrigan at scorrigan@pci.org.

LCA Shows that Precast Concrete Does Not Impose Any More Environmental Burden than Other Materials

(This is part three of a four-part series)

— Emily Lorenz, PE, LEED AP BD+C

In previous parts of this series, the benefits of using life-cycle assessment (LCA) to predict environmental-impact potential of products, processes, or services were highlighted. When LCA is used to compare complex systems using a full set of environmental impacts over the full service life, designers can better assess the sustainability of their design choices and make fair comparisons between materials or systems. And because LCA can show different results depending on the system boundary chosen, the quality of the data, and the timeframe selected for comparisons, the best way to evaluate the full environmental impact of a product is through a cradle-to-grave, ISO-compliant LCA.

It is with that background knowledge that the precast concrete industry began a cradle-to-grave, ISO-compliant, comparative assertion LCA in 2009. This article will highlight some of the results of that study.

Background

In 2009, the Precast/Prestressed Concrete Institute (PCI), Canadian Precast/Prestressed Concrete Institute (CPCI), and the National Precast Concrete Association (NPCA), began a research program to better understand precast concrete's environmental life-cycle performance.

– Emily Lorenz is an independent consultant in the areas of life-cycle assessment; environmental product declarations; product category rules; and sustainability rating systems, standards, and codes.

Overall, the research objectives were to:

1. foster a better understanding of the environmental impacts of precast/prestressed concrete components and their use in high-performance structures;
2. better understand precast concrete's environmental life-cycle performance in mid-rise precast concrete buildings compared to alternative structural and envelope systems;
3. benchmark the industry's performance in order to track its improvements;
4. increase transparency in the marketplace.

Scope

This LCA study used the U.S. EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) impact assessment method, which output the following midpoint indicators:

- Global Warming Potential
- Acidification Potential
- Potential Respiratory Effects
- Eutrophication Potential
- Photochemical Smog Creation Potential
- Ozone Depletion Potential

In addition, the following inventory items were tracked:

- Total Primary Energy
- Solid Waste
- Water Use
- Abiotic Resource Depletion

The methodology employed in this study complied with international standards ISO 14040:2006[1] and ISO 14044:2006[2] for conducting life-cycle assessments. The research was conducted by a team comprised of Morrison Hershfield, the Athena Institute, and Venta, Glaser & Associates.

Baseline Building

The basis of comparison chosen for the study was a five-story commercial office building that provides space for 130 people and meets minimum building and energy code requirements. The service life of the building was assumed to be 73 years, the median life for large commercial buildings according to published literature.

The study evaluated 15 design cases consisting of five different building envelope systems combined with three different structural systems (Table 1). To consider different climate conditions, the 15 cases were modeled in four U.S. locations (Denver, Memphis, Miami, and Phoenix). The case using precast concrete for both the envelope and structural systems (designated "P-P") was defined as the baseline for comparison.

Results

Ten specific environmental impact and life-cycle inventory categories were evaluated for each of the 15 cases, in each of the four cities. To provide a simplified characterization for the purpose of this article, the discussion below focuses on the coefficient of variation (COV) of the results for the

Table 1. Summary of the 15 Building Types / Assemblies.

Building envelope type and abbreviation	Structure type and abbreviation		
	Steel (S)	Cast-in-place concrete (C)	Precast concrete (P)
Curtain wall (CW)	CW-S	CW-C	CW-P
Brick and steel stud (S)	S-S	S-C	S-P
Precast concrete (P)	P-S	P-C	P-P
Insulated precast concrete (Pi)	Pi-S	Pi-C	Pi-P
Insulated precast concrete and thin-brick veneer (Pib)*	Pib-S	Pib-C	Pib-P

**Thin-brick veneer is bricks that are 13 to 16 mm (1/2 to 5/8 in.) thick, cast into the precast concrete panels.*

15 building cases for each environmental impact and life-cycle inventory category. Refer to **Table 1** for a summary of the 15 building assemblies.

In many categories, the 15 different building cases had a COV of 2% or less, which shows that there is not much difference between the buildings within a given city. These categories include Global Warming Potential, Total Primary Energy, Acidification Potential, Potential Respiratory Effects, Eutrophication Potential, Photochemical Smog Creation Potential, and Solid Waste.

As an example, let's look at Global Warming Potential. Global Warming Potential (GWP) is mainly a function of the energy use of the building and the type (source) of electricity in the particular city. The GWP of electricity from the electricity grid in Denver is more than the GWP of electricity in the other cities because it has much less contribution from nuclear (which is a low CO2-intensive source of electricity). Therefore, even though the buildings in Denver use the least amount of electricity, they have the highest GWP. Further, the relative difference between the wall U-factors within a city are different among cities because energy code requirements are different for each city. For example, the code requires more insulation in curtain walls in Phoenix than in Miami. Therefore, when comparing the GWP of concrete curtain wall buildings, Miami is lower (better) than their counterparts in Phoenix. **Figure 1** data show:

- In Denver, GWP varies from 58 to 62 million kg CO_2 eq. and the coefficient of variation (COV) is 2%.
- In Memphis, GWP varies from 45 to 46 million kg CO_2 eq. and the COV is 1%.
- In Miami, GWP varies from 50 to 51 million kg CO_2 eq. and the COV is less than 1%.
- In Phoenix, GWP varies from 44 to 46 million kg CO_2 eq. and the COV is 1%.

These small COVs indicate that there is not much relative difference in GWP between the buildings within a given city.

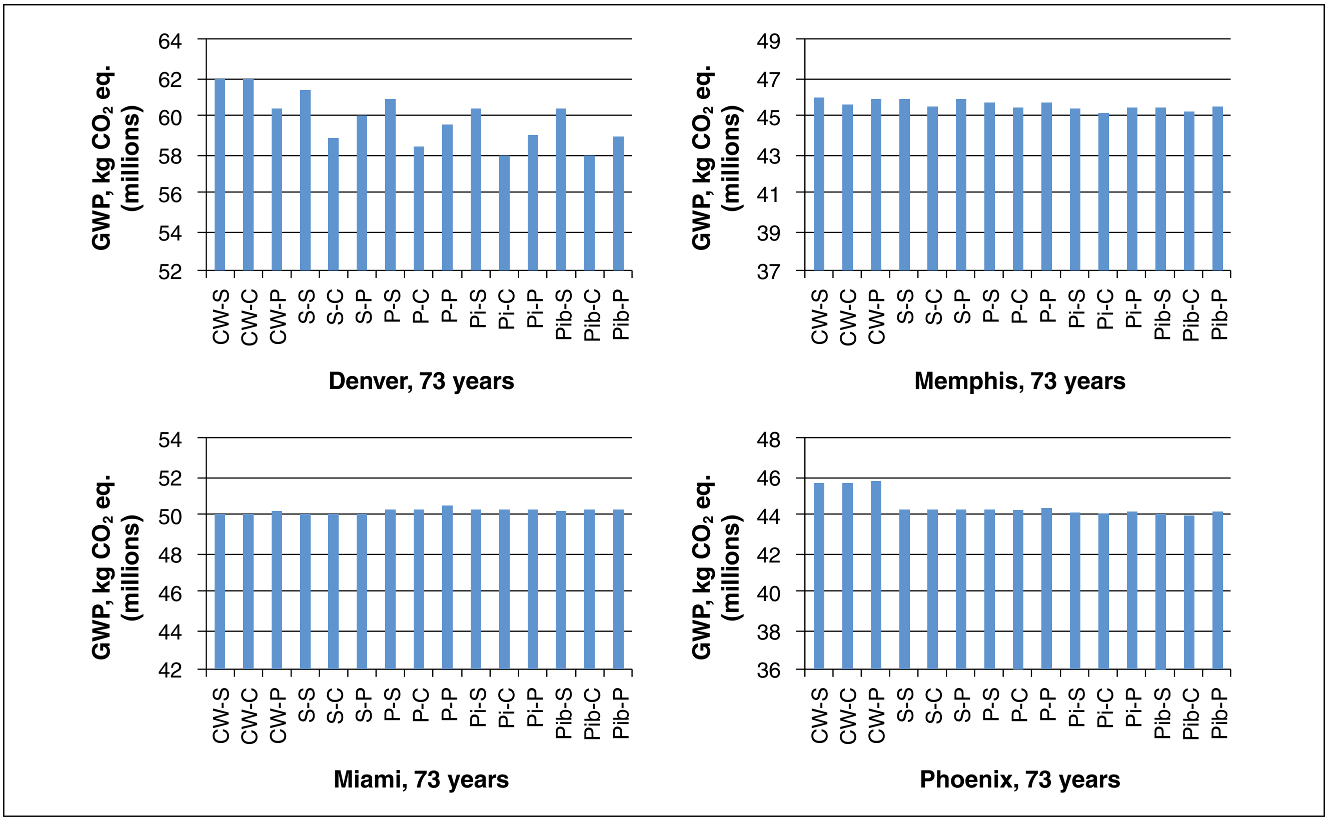

Figure 1. Global Warming Potential (GWP) of the 15 buildings for each of the four cities; coefficient of variation for the data varies from 0 to 2%. Note that the scale of the vertical axis is different for each city.*

**These small COVs indicate that there is not much relative difference in GWP between the buildings within a given city.*

For the following three categories, some slight variances were observed.

Water Use

For the 15 different building cases:

- Within a given city, the COV of Water Use is 14%, which shows that there is some difference between the buildings within a given city.
- In all cities, regardless of envelope, the buildings with steel structures have the highest potential water use.
- The reason for the similarity is that most of the water use is during the operating energy stage, and is the same in all buildings regardless of building or location (23,984 m^3).
- The reason for the difference is that in the buildings with steel structures, the elevator and stairwell walls—which are concrete masonry—embody more water use (9882 m^3) than all the water embodied in the buildings with cast-in-place or precast concrete structures (3104 m3 to 4916 m^3). The elevator and stairwell walls in the buildings with cast-in-place or precast concrete structures are cast-in-place concrete and embody 175 m^3).

Abiotic Resource Depletion

For the 15 different building cases:

- Within a given city, the COV of Abiotic Resource Depletion is 36%, which shows that there is a large difference between the buildings within a given city.
- The majority of the abiotic resource depletion is embodied in the manufacturing stage.
- Regardless of city, the buildings with largest potential for abiotic resource depletion are the buildings with steel structures. Looking deeper into the data, in the buildings with steel structure the majority of the abiotic resource depletion is embodied in the steel decking of the floors and roof (2.40 kg Sb eq. for the steel floors and roof out of 3.62 kg Sb eq. for the total manufacturing stage).

In comparison, the total abiotic resource depletion embodied in the manufacturing stage of buildings with cast-in-place concrete or precast concrete structures (1.66 to 2.02 kg Sb eq.) is less than that embodied in just the floors and roof of the buildings with steel structures.

Ozone Depletion Potential

For the 15 different building cases:

- Within a given city, the COV of Ozone Depletion Potential varies from 0 to 15%, depending on the city, which shows that there are some regional differences between the buildings within some cities and none in others.
- Most of the ozone depletion potential is embodied in the extruded polystyrene (XPS) insulation; therefore, the ozone depletion potential is directly proportional to the amount of XPS insulation in the buildings over their life cycle.
- All the buildings have XPS insulation in the roof, and during the maintenance stage, when the roof is replaced every 20 years, the insulation is also replaced. Over the life of the building, more XPS insulation is used in the roofs of all buildings than is used in the walls of the buildings with cast-in-place or precast concrete envelopes. Therefore the main driver of ozone depletion potential is the XPS insulation in the roof.
- All of the XPS insulation in the buildings in Miami is in the roof and it is the same amount in all buildings; therefore, the ozone depletion potential is essentially the same for all buildings (COV is close to 0%).
- In the walls of the study, XPS insulation is only used in the cast-in-place and the precast concrete walls in Phoenix, Memphis, and Denver. So the buildings with cast-in-place and precast concrete walls have a greater ozone depletion potential than the building with curtain wall and brick on steel stud walls.

Similar Overall Life-Cycle Environmental Impact

This study confirmed a basic conclusion of most balanced LCA studies of commercial buildings, such as the MIT Research: Life Cycle Assessment of Commercial Buildings[3] namely, that there is presently not a significant difference in life-cycle impacts between steel, cast-in-place concrete, and precast concrete structural systems. Although concrete is sometimes perceived to have a higher environmental impact due to energy use and carbon dioxide emissions associated with manufacturing portland cement. The fact is, as shown by this research, precast concrete does not impose additional environmental burden than other materials.

Hence, material and system selection can be based on the inherent attributes and benefits of the material or system. Precast concrete inherently offers many high-performance attributes, and is being used to help projects meet and exceed their high-performance goals during design, construction, and operation. Therefore, the benefits of precast concrete can be utilized to meet high-performance goals without any more environmental burden relative to other materials and systems.

Furthermore, since the use phase has the most impact on the life cycle of a building, selecting materials and systems that provide energy reducing benefits, such as precast concrete envelope systems, are very important to reducing overall environmental impact.

Next Steps

Through its LCA research, the precast concrete industry is increasing transparency and developing a more-thorough picture of the environmental impact of its products or processes. The last article in this series will focus on the steps some precasters are taking in their manufacturing facilities to reduce environmental impacts and increase transparency.

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For more information on these or other projects, visit www.pci.org/ascent.

Precast Concrete Creates High-Performance Homes

Whether designers are creating high-rise condominium complexes or single-family residences, precast concrete structural and architectural systems can meet challenges that arise

— Craig A. Shutt

Following the collapse of the housing market in 2008, families began evaluating their best residential options for the long term. That has led to a return to urban centers, as well as more interest in condominium and rental properties that offer amenities and less maintenance. To meet these needs while providing a striking appearance and structural benefits, designers are using precast concrete in a variety of ways.

Precast concrete's aesthetic versatility ensures that any residential property can fit into its neighborhood, whether it consists of historic homes or contemporary high-rises. It can match or create virtually any color, texture, or shape required while integrating with other materials. Its structural versatility provides for long open spans, flexible floor plates, and the ability to integrate the structural system with the envelope saving time and money, while creating more usable space.

Precast concrete's inherent efficiency allows for rapid construction and hence, earlier occupancy. Its thermal mass, ability to serve as a continuous air barrier, and option to incorporate continuous insulation provides a complete energy efficient envelope system that will help reduce long-term costs. Also, precast concrete's inherent resiliency provides multihazard protection and passive fire resistance.

The range of options can be seen in these projects, which cover a wide geographic and residential mix. The benefits provided by precast concrete vary with the needs of the project, ensuring an economical, aesthetically pleasing, and easily constructed design.

The Century

At the high (literally) end of the market, curved architectural precast concrete panels were used to clad The Century, a 42-story residential tower in Los Angeles, Calif. The developers' goal was to "create a condominium complex that offered timeless West Coast elegance and contemporary green-living experience that redefined estate living," explains Daniel Lobitz, project manager at Robert A.M. Stern, the architectural firm on the project. The building is located on the former Twentieth Century-Fox Studios production lot along the Avenue of the Stars in Century City.

The goal with the building's appearance and layout was to create a "contemporary yet classic design that provides a modern-day approach to sustainable building and luxury high-rise urban living, which is rare amid the sprawling valleys and car culture of Los Angeles," he says.

The site was developed with a variety of "L.A. tropes," Lobitz says, that invoke the glamour of an exclusive hotel. These include sunken gardens, outdoor entertaining areas, and a pool with cabanas. High-end stone, such a marble, granite, and limestone, were used widely throughout the building, totaling more than 1,300 tons in all. Among the amenities are floor-to-ceiling windows, private elevators, wine storage, and a fitness center with pool and spa. Each residence has a private elevator vestibule, fireplaces, and large balconies. A restaurant, conference room, catering kitchen, library, and screening room also are included.

Precast concrete was specified for the cladding on the design-build project because it could create the intricate details required, as well as serving as a backing for the travertine veneer while also replicating that look on upper floors. "The precast concrete used on The Century supported the design goals of the project to bring a high-quality finish to the building," Lobitz says. "It provided a durable and sustainable solution."

The panels feature a light-cream finish with reveals throughout that break up the panels' mass and convey the look of the stone motif throughout the façade. Due to the tower's elliptical shape, all but 82 of the 1,147 precast concrete panels were cast on convex or concave forms, creating challenges for achieving the high-quality appearance that was required while using difficult forming designs.

"The radiused shapes of the panels contributed to the function of the building, with the curved forms allowing for optimum natural lighting," Lobitz explains. "The diagonal siting of the radiused panels provides open vistas between neighboring towers to the south toward the ocean, to Beverly Hills to the west, and to the surround cityscape." The tower's detailing, with fluted columns, pilasters, and protruding eyebrow lintels, pays homage to the residential architecture in nearby Beverly Hills and Bel Air. "The quality

Architectural precast concrete panels clad The Century, a 42-story residential tower in Los Angeles , Calif. Designers wanted to project a contemporary yet classic appearance that combined modern touches with sustainable design.

Photos: Paul Turang

PROJECT SPOTLIGHT

The Century

Location: *Los Angeles, Calif.*

Project Type: *Condominium complex*

Size: *207,000 square feet*

Designer: *Robert A.M. Stern, New York, N.Y.*

Owner: *The Related Companies LP, Los Angeles, Calif.*

Structural Engineer: *Magnusson Klemencic & Associates, Seattle, Wash.*

Contractor: *Webcor Builders, Los Angeles, Calif.*

PCI-Certified Precaster: *Clark Pacific, Fontana, Calif.*

Precast Components: *1,147 curved architectural panels, curved spandrel panels, and column covers.*

and craftsmanship of the precast lent itself nicely to the overall elegance intended for the structure."

The panels were cast in custom-made curved molds designed to create the proper shape for each piece. "There were many radii involved due to the building's egg-shaped footprint," says Sam Argentine, senior project manager with Clark Pacific, the precaster. Some of the panels even have two distinct curves in them to meet the unique geometry of the building's curved ends. Many panels feature deep reveals and contain blockouts for punched windows and other details. In some cases, panels contained two large punched windows, creating thin members that had to be stripped carefully. "Stripping and handling the two-window pieces were very challenging," says Argentine.

To provide support during transport and maneuvering the pieces into a vertical-lift position at the site, the precaster welded a number of strongbacks into the backside of the panels. These back-to-back channels provided support frames that secured the panels during delivery and allowed positioning as they were lifted from the trucks. The strongbacks were disconnected once the panel was secured to the crane hoist. There were approximately 12 different versions were used to secure all of the different radiused panels.

Travertine granite was hand-set into the building's base, but veneer pieces were set into the precast concrete panels on the north tower, where the granite continues up the building's face. Details on the panels vary every five or six floors, creating a segmented look that helped reduce the building's scale. Each section featured its own balcony style to further set it apart.

Typical panels were 11 by 25 feet, with balcony spandrel panels measuring 4 by 25 feet. Column covers of about 8 feet wide and 8 feet tall also were created. The panels were lifted from the delivery trucks and moved into position via a tower crane that could reach to the top of the 42-story building. Dentil spandrels with deep reveals were used to clad the balconies, providing depth and added finish to the façade.

The Century incorporates a variety of sustainable-design features, which allowed it to be awarded LEED Silver Certification by the U.S. Green Building Council. These features address energy efficiency, sustainable building materials, water conservation, and indoor environment quality.

Precast concrete aided the LEED certification by being manufactured within 500 miles of the site and for using local materials in their manufacture, including recycled materials. The panels also reduced site congestion and construction waste and consist of material that can be recycled for other uses if the building is torn down.

"The project's sheer size and scope was a great challenge on many fronts," says Clark Pacific's Argentine. "The incorporation of the Italian travertine as well as the elliptical shapes necessitated a significant investment of additional time to design and successfully produce the precast architectural panels." Overall the aesthetic versatility of high-performance precast concrete met challenges head-on, and helped the designers meet and exceed the project's goals.

Myers Place

On the other end of the scale, a total-precast concrete structural system provided the ideal solution for a four-story residential building designed for those with disabilities in Mount Prospect, Ill. The 32,000-square-foot facility features four finishes in the load-bearing wall panels used, including three colors of thin brick that were cast into the panels.

"The architecture of Myers Place uses a lively blend of cast stone and thin brick, a variety of brick colors, and details that emphasize the different interior uses of the building to create a 'sense of place,'" says Therese Thompson, project manager at Cordogan, Clark & Associates, the architecture firm on the project. "The design intent is to reinforce the developer's mission to provide access to high-quality affordable housing for people with mental or physical disabilities as they move towards recovery or self-sufficiency."

The structural system used on Myers Place consists of columns, beams, wall panels, and hollow-core planks. The planks rest on wall panels and serve as both ceiling and flooring in one piece. This approach reduces the number of subcontractors and scheduling issues required by combining the structural and envelope systems to create the building's shell.

"The general contractor was very familiar with the precast concrete structural system, often referred to as total precast, so they were comfortable with that approach," says Thompson. Masonry alternatives were priced, she notes, "but we found that the precast concrete option was more economical than any other option."

> Masonry alternatives were priced, but we found that the precast concrete option was more economical than any other option.

The speed of construction also was a benefit, she adds. "The precast concrete structure was erected quickly, allowing us to get the shell enclosed rapidly and get the floors into place so we could start on interior work. It definitely helped expedite the construction process."

Construction speed was enhanced by the designers taking advantage of precast concrete's speed in casting repetitious panels one after another. "By using repetition in the panels, we kept the design very economical and also sped up fabrication of the pieces. But we still were able to achieve a variety of aesthetic appearances while maintaining that speed."

To create visual interest, the exterior features modules with dark brown brick and punched windows that alternate with red and tan brick units. The bottom floor and accent frames around the windows have a buff-colored, sand-blasted appearance that replicates the look of limestone. End units feature projecting bays that add dimension to the rectangular, four-story building. These were created by projecting steel-framed sections out from the precast concrete and cladding them with fiber-cement siding to lessen the load.

"The architect understood the benefits of precast concrete and how to maximize its efficiencies," says Auggy Chung, regional sales manager with Spancrete, the precaster. For instance, to eliminate the need for complicated thin-brick returns at corners, designers created vertical precast concrete bands that eliminate brick at the edges. The bands project out from the brick line, creating additional depth and visual interest.

The architect had created other precast concrete projects, but typically uses it for taller buildings, Thompson notes. "This is the lowest-rise building we've done with a total precast concrete system," she says. "We were surprised that precast was so competitive with other building systems for a four-story building. We found that it lent itself well to the mid-rise type, where we were able exploit the repetition of producing many similar panels and columns. Repetition is a major help to minimizing the budget."

Designers provided standard accessible amenities, such as elevators and toilet rooms, for the project, funded in part by a grant from the Illinois Housing Development Authority. Four units are fully accessible and eight units can be easily adapted to be fully accessible. "It's designed to provide independent living, but it does have on-site social service caseworkers, which meant creating office space for those services," she explains. The building's first floor also features a laundry, community room, and computer room.

Erection of the panels moved smoothly, as the site's former use as a parking lot provided unobstructed space. The hollow-core panels, using the precaster's proprietary design, were 8 feet wide and 10 inches thick, allowing for faster erection than narrower profiles provide. Exterior panels were 9 inches thick and varying sizes, while interior demising walls to create corridors were 8 inches thick. A thermal break was provided between the planks and panels to create continuous insulation. In all, 95 exterior wall panels, 50 interior wall panels, and 193 pieces of hollow-core plank were installed in only 20 days.

'The architect understood the benefits of precast concrete and how to maximize its efficiencies.'

The hollow-core plank had a leveling topping applied to the top side to create even floors and had a textured paint sprayed onto the underside to create an acoustical ceiling. "Hollow-core inherently has high acoustical control due to the material's mass and the voids at the center, so we

Photos: Cordogan, Clark and Associates

The 32,000-square-foot Myers Place residential building in Mount Prospect, Ill., combines four finishes in its load-bearing precast concrete wall panels. The facility offers affordable housing for people with mental or physical disabilities as they move towards recovery or self-sufficiency.

PROJECT SPOTLIGHT

Myers Place

Location: *Mount Prospect, Ill.*

Project Type: *Affordable-housing residences*

Size: *31,500 square feet*

Designer/Engineer: *Cordogan, Clark & Associates, Aurora, Ill.*

Owner: *Daveri Development Group LLC, Chicago, and the Kenneth Young Center, Elk Grove Village, Ill.*

Contractor: *McShane Construction Co. LLC, Rosemont, Ill.*

PCI-Certified Precaster: *Spancrete, Waukesha, Wis.*

Precast Components: *Columns, beams, wall panels with a sandblast finish and three colors of inset thin brick, and hollow-core planks.*

PROJECT SPOTLIGHT

Huixquilucan Home

Location: *Puerto Vallarta, Mexico*

Project Type: *Single-family home*

Size: *107,640 square feet*

Cost: *$5 million*

Designer/Engineer/Contractor: *Zyman & Zyman, Huixquilucan, Estado de Mexico*

PCI-Certified Precaster: *Pretecsa, Altizapan de Zaragoza, Estado de Mexico*

Precast Components: *1,600 acid-etched architectural panels*

Images by Karen Weber ©Fotosenconcreto.com

This 107,640-square-foot, single-family residence in Huixquilucan, Estado de Mexico in Mexico used architectural precast concrete panels to create a personalized look that continues inside with additional precast panels.

didn't have to add any extra acoustical materials to dampen noise," says Thompson.

The project is in the process of being LEED certified, offering such sustainable features as geothermal vertical heat pumps. The precast concrete system contributed to the sustainable goals by being produced within 500 miles of the site, using local materials in the manufacturing process, incorporating recycled materials, reducing site congestion, limiting construction waste, and providing a recyclable material.

The result is a dynamic, attractive housing option that provides sustainable, affordable housing that was quick to construct, allowing tenants faster access to their new homes. The total precast concrete system also inherently provides passive fire protection and resiliency, such as protection from storms.

Single-Family Home

Precast concrete also can be used for single-family homes, creating distinctive looks and providing benefits that other materials can't offer. An example can be seen in a large residence built Puerto Vallarta, Mexico. The expansive, 107,640-square-foot mansion used architectural precast concrete panels to create a personalized look for the home that continues inside with additional use of precast panels.

"The construction of this great house demanded challenging architecture and precise execution, such that the architectural precast concrete wall panels presented an ideal solution to solve both requirements," says Erick Ginard, communications manager for Pretecsa, the precast manufacturer on the project.

Built in one of the most exclusive developments, the three-story residence features an exterior of architectural precast concrete panels created with precise lines of reveals that continue from one panel to another in varying widths in different locations. "The detailed walls, both indoors and outdoors, were designed to resemble infinite roads, which serve as a metaphor for journeys taken around the world," he explains. The designer, Jack Zyman of Zyman & Zyman, was inspired in his design by a quote from 1800s Irish writer George Moore, who wrote, "A man travels the world in search of what he needs and returns home to find it."

"The precast concrete architectural panels allowed the design team to play with colors and finishes during the creative stage, imagining different patterns and maintaining a simple yet still attractive design point," Ginard explains. "They worked with Pretecsa to gain economies through repetitive patterning and used a natural scale to keep the building from being too overwhelming."

Maintaining the fluid reveal pattern in different sizes across all panels required close coordination of plan and craftsmanship. The precaster created molds from glass-fiber reinforced concrete to cast the panels, allowing for the largest possible number of pieces to be cast from the same mold. "This approach made it possible to create perfectly straight grooves in all the panels, ensuring a perfect continuity of the installed smaller pieces," he says.

> 'The precast concrete architectural panels allowed the design team to play with colors and finishes during the creative stage.'

More than 1,600 elegantly acid-etched pieces were fabricated with straight grooves, using beige aggregates and white cement. They were designed to complement and interface with a variety of other materials on the home's exterior, including wood and steel. "The goal was to combine materials in a perfect combination of elegance and modernity," Ginard says.

A key challenge came in creating a panelization system that kept panel sizes and weights small enough to be erected without requiring a crane. "This necessity complicated the manufacturing and installation of the precast concrete elements, which required keeping the panels horizontally aligned with the maximum degree of accuracy," he explains. Each panel covered no more than eight square feet.

"The precast concrete panels and installation process provided a clean working environment at the site," Ginard notes. "In a very short time, the house looked sharp, clean, and finished, which allowed the owners to adapt the interiors to their specific decorative needs."

The panels were erected onto a light steel frame anchored to the building structure. This provides a framework that allowed the panels to be erected and adjusted as needed. In all, the panels, covering 12,500 square feet, were erected in only four weeks. Panels also were used for interior walls in some locations, providing continuity as visitors arrive.

The result of the attention to detail is a large home that provides a welcoming atmosphere with a highly contemporary appearance. "Precast concrete elements provided a great solution for this single-family home," says Ginard. "It adds a touch of distinction and modernity to the project, a pictorial composition with precise lines in a visually homogeneous construction. The result is truly spectacular."

Ritz Carlton Residences

The Ritz Carlton Residences along the Baltimore harbor front contains 192 luxury condominiums with expansive views of the inner harbor. That amenity was articulated by the six-story, finger-like segments connected by four-story, interstitial sections between them, creating a series of view corridors along the length of the building. Architectural precast concrete panels on the lower floors of the 793,000-square-foot building combine with brick masonry on the upper floors to reduce the scale of the large building and create a distinguished façade.

"We looked at a variety of materials to find the best blend of options," says Michael Blake, principal and partner in Marks, Thomas Architects, the architectural firm on the project. "Precast concrete was very economical, especially with the large size of panels we could produce. As designers, we like precast concrete and like to see it being used because of its combination of aesthetics, economy, and speed."

Its aesthetics was as important as the other factors, he notes. "This is a large and prominent project on the waterfront, and we wanted to invoke a quality of permanence for this substantial building. The large-panel precast concrete assembly was a good fit." Gate Precast Co. fabricated the precast concrete components for the project.

The owners wanted the building's

PROJECT SPOTLIGHT

Ritz Carlton Residences

Location: *Baltimore, Md.*

Project Type: *Condominium complex*

Size: *793,000 square feet*

Cost: *$155 million*

Designer: *Marks, Thomas Architects, Baltimore, Md.*

Owner: *Midtown Baltimore LLC, Baltimore, Md.*

Structural Engineer: *SK&A Structural Engineers, Potomac, MD.*

Contractor: *Bovis Lend Lease, Bethesda, Md.*

PCI-Certified Precaster: *Gate Precast Co., Winchester, Ky.*

Precast Specialty Engineer: *Engineering Techniques, Front Royal, Va.*

Precast Components: *88,474 square feet (1,264 pieces) of architectural components, 129 with punched windows, column covers, cornice panels, and quoin panels.*

Photo: Commercial Photographics: Photography by Jeffrey Sauers

Designers considered a variety of cladding options for the 793,000-square-foot Ritz Carlton Residences along the Baltimore harbor front before deciding on using architectural precast concrete panels on the lower floors and brick masonry on the upper floors.

Photo: Paul Burk Photography

Photo: Paul Burk Photography

Photo: Commercial Photographics: Photography by Jeffrey Sauers

Photo: Commercial Photographics: Photography by Jeffrey Sauers

Photo: Commercial Photographics: Photography by Jeffrey Sauers presence to suggest a "classical elegance," Blake says, which led to the combination of precast concrete, brick masonry, and cast-stone accents. The brick consists of traditional flashed red "molded" units, a style rooted in Maryland's history. "Its textural quality lends itself to a residential scale and feel, which was important for a large structure like this," he says.

The architect visited the precaster's plant to view operations and discuss options, working with the company on a design-assist basis. "We had terrific meetings," Blake says. "We worked out the aesthetics we could achieve and discussed ways to design and fabricate the panels as cost-efficient as possible. We looked at ways to create the primary panel types to aid repetition and reduce costs. We worked really closely with them to make it all happen." Panel sizes were maximized to limit the number of lateral tie-backs that were needed reducing the number of let-outs in the back-up wall assembly and subsequent patching required after the panels were in place.

The design incorporated vertical relief panels and projecting pilasters, adding detail, depth, and articulation. "Double soldier-course banding and window lintels, in concert with the integration of cast-stone surround detailing at windows, contributes to the richness and quality of the building's classical architecture," he says.

A key element was the use of deep reveals to create shadow lines that change as the sun moves overhead. "Achieving those deep shadows was important to us, and we couldn't have gotten them with any other material."

The building features a variety of balconies to take advantage of the views, and to provide depth and interest. These were clad with precast concrete spandrel panels. "The utility of the precast concrete allowed the construction criteria to be satisfied and was essential to the balcony feature's success," he says.

Scheduling also was critical on a project of this size. The site was constrained by a busy highway on one side and the harbor on the other. "Access was really very minimal, so we had to coordinate delivery of our loads closely," says Mark Pedron, vice president of operations at Gate Precast. Multiple tower cranes were used, but they had to be coordinated closely, as they were used continually and had to often be repositioned to reach the appropriate locations on the huge site around the restrictions.

Ledges were cast into the tops of the precast concrete panels, which were attached to a cast-in-place frame, to provide support from the precast for the brick levels. But the design also allowed the option of developing independent support for the upper floors of brick. This allowed the precast panels to be erected after the upper levels of brick had been laid if needed, as well as allowing the brick to be in-filled after the panels were erected. This option eliminated the need for extra steel to support the brick. In some areas, the brick was installed before the precast panels below them had been erected.

'The utility of the precast concrete allowed the construction criteria to be satisfied and was essential to the balcony feature's success.'

"Baltimore and the mid-Atlantic region is very competitive for masonry and has a long history with it," Blake explains. "We wanted to combine precast concrete and brick while tying the two together and provide more dimension to the project." The panels were designed so they wouldn't impose gravity loads on the second- and third-floor slabs, allowing minimal slab depth.

"Each part was choreographed for each crane, so we could tell our trucks exactly where they had to go and in what order they had to be there," Pedron explains. "It was highly coordinated because of all the detail on the panels. They had to be in the right order." Breaking the building into sections allowed each portion to be completed before moving onto the next one, allowing pieces to be cast to fit that portion.

"Meeting each milestone of completion was a key focus," he notes. "With so many trades on site and cranes being scheduled tightly, we knew it would either look like a ballet or a car crash." The coordination proved worth it, he adds. "We completed the elevations in about one-third of the time as could have been done with conventional masonry. We worked to get trades up to install windows quickly and let interior trades start work and get everyone else off-site." Many of the panels were delivered at night to avoid traffic congestion and ensure they were ready for erection in the morning.

Working with the precaster early in the project on a design-assist basis ensured the design was simplified to the extent that it maximized the repetitive nature of the panels while maintaining the design intent. "This approach reduced the lead time required for delivery," Blake explains. "It allowed for efficient production and erection of the precast concrete in what would have been a complicated logistical challenge. The project schedule really benefitted from it."

A finishing touch was supplied in a precast concrete arch that marks the entry and frames the water view from the boulevard. "It helps to successfully integrate this large, new building into its context," Blake says. Even that design created challenges, as it had to be delivered under an arched bridge to the interior courtyard once exterior pieces already were in place.

The result of this close coordination is a monumental building that belies its immense size by creating a homey, residential feel with dramatic views. "Everyone was committed to maintaining the design intent and working efficiently," says Blake. "Flexibility in precast concrete design, finish, and construction allowed for a quick enclosure while adding seamless design integration with other conventional construction materials on the project."

These examples show some of the range of precast concrete's capabilities in creating residential projects of any size, architectural style, and location. Taking full advantage of the versatility, efficiency, and resiliency of high-performance precast concrete helps ensure that architectural and marketing goals can be achieved to create aesthetically pleasing, quickly constructed, and cost-efficient residential buildings.

For more information on these or other projects, visit www.pci.org/ascent.


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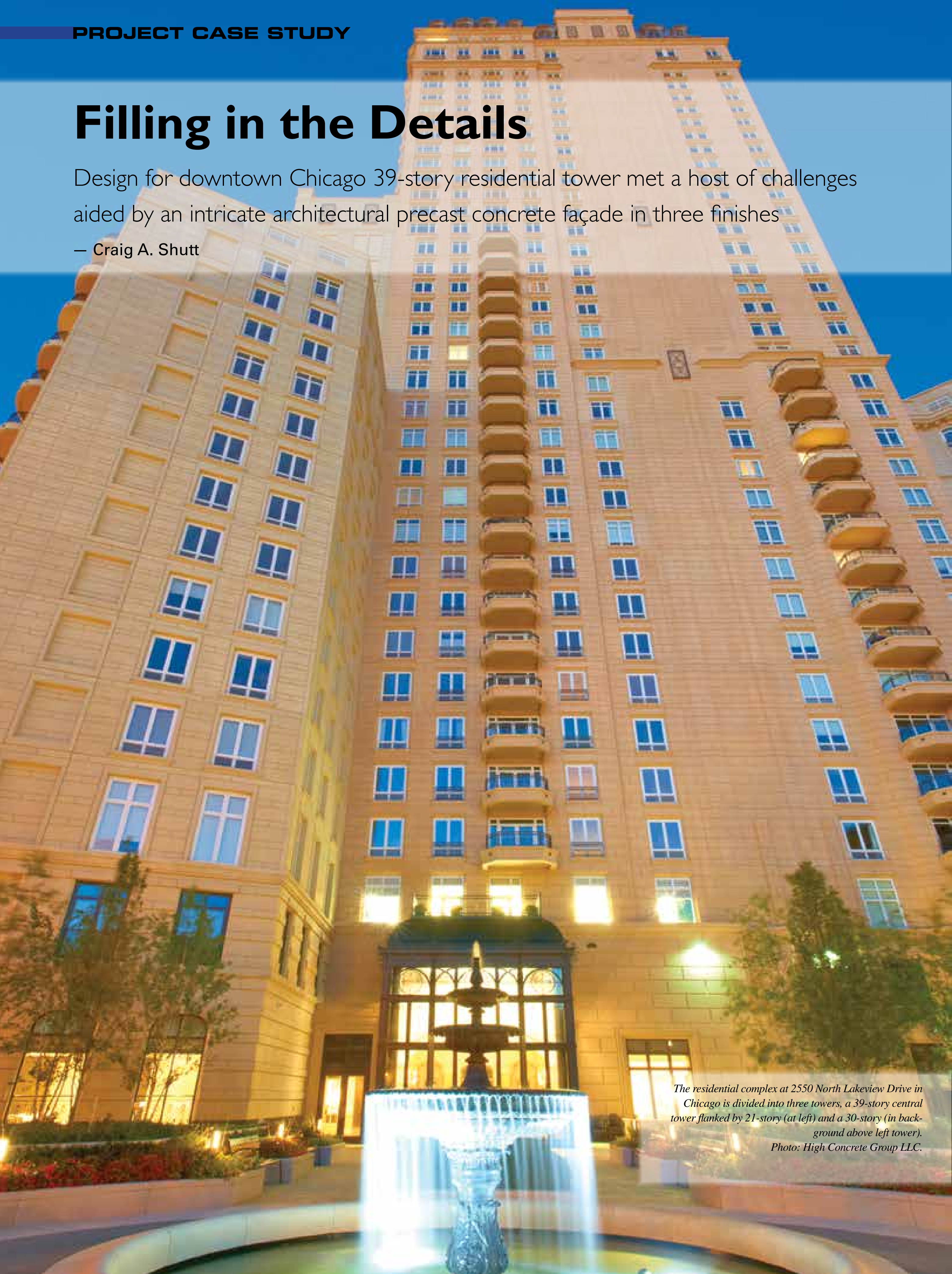
Filling in the Details

Design for downtown Chicago 39-story residential tower met a host of challenges aided by an intricate architectural precast concrete façade in three finishes

— Craig A. Shutt



The residential complex at 2550 North Lakeview Drive in Chicago is divided into three towers, a 39-story central tower flanked by 21-story (at left) and a 30-story (in background above left tower). Photo: High Concrete Group LLC.

Soaring above Chicago's north-side lakefront, the 39-story residential tower at 2550 North Lakeview Drive has been called "the Vertical Gold Coast," an allusion to its high-end accommodations that reflect the opulence of the nearby affluent historic district. The architectural precast concrete panels that were used to clad the structure were designed to invoke that atmosphere with their intricate, highly detailed appearance. Achieving that goal required overcoming a variety of obstacles, including construction on a busy urban street and filling in details when the design architect filed for bankruptcy early in the construction process.

The 318-residence building was designed by the architectural firm of Lucien Lagrange, a prominent Chicago firm known for its use of precast concrete panels on tall, residential downtown structures. The firm designed thousands of residential units, including those at the Ritz-Carlton Residences on the Magnificent Mile, The Catalyst, the Ten East Delaware condominium tower, and the Elysian Hotel & Private Residences in the Gold Coast. But in 2008, Lagrange filed for bankruptcy (for more on the company, see the profile in the Summer 2008 issue of *Ascent*).

"This building was probably the most ornate of all of the Lucien Lagrange buildings," says Kellen Decoursey, assistant project manager at Walsh Construction Co., the project's general contractor. "The uniqueness of the design was a key point in its planning and for its marketing. But it also created challenges."

The 39-story tower features residential units that range in size from 900 to 5,000 square feet and range in price between $465,560 to $11.4 million

PROJECT SPOTLIGHT

2550 North Lakeview Drive

Location: Chicago, Ill.

Project Type: Condominium

Size: 39 stories, 1.2 million square feet

Designer: Lucien Lagrange & Associates and Solomon Cordwell Buenz, Chicago, Ill.

Owner: Ricker-Murphy Development LLC, Chicago, Ill.

Structural Engineer: CS Associates Inc., Oak Lawn, Ill.

Contractor: Walsh Construction Co., Chicago, Ill.

PCI-Certified Precaster (architectural panels): High Concrete Group LLC, Springboro, Ohio

PCI-Certified Precaster (balconies): Precast Specialties Inc., Monroeville, Ind.

PCI-Certified Precaster (base panels): Lombard Architectural Precast Products Co., Alsip, Ill.

Precast Components: 2,000-plus architectural precast concrete panels and column covers

Reveals, ledges, and balcony designs unique to each tower created depth and interest to the building's façade. A second precaster provided the balcony components, requiring added coordination. Photo: High Concrete Group LLC.

Soaring above Chicago's north-side lakefront, ornate architectural precast concrete panels on the 39-story residential tower at 2550 North Lakeview Drive, seen here from Lincoln Park, helped to give the building its nickname of "the Vertical Gold Coast." Photo: High Concrete Group LLC.

(for a penthouse). It sits on a three-acre site north of downtown that overlooks Lincoln Park and offers expansive views of Lake Michigan to its east and downtown Chicago to the south.

Three Joined Towers

The building's design creates the illusion of three towers of varying heights (a 39-story central tower flanked by 21- and 30-story towers) joined into one complex. Each of the towers includes unique intricate detailing and finishes. A distinctive set-back, zinc-clad, mansard roof provides a skyline focal point. Dimensional balcony fascias and elaborate railings, again unique to each tower, create depth while ensuring the towers complement each other. A dramatic two-story entrance announces the building's presence at street level, where limestone and granite veneer were used to clad the bottom two floors.

The challenges for designing the individual precast concrete panels began after the architectural firm filed for bankruptcy about six months into the design process, explains Cliff Broyles, project manager at High Concrete Group LLC. "We didn't have any specific direction or plans for developing the details that were desired," he explains. "That created immense challenges for us in achieving the architectural intent. We took on the role of understanding the plan and supplying the engineering input to ensure the details coordinated." The architectural firm of Solomon Cordwell Buenz was brought on to oversee completion of the architectural documents.

The precaster worked out details of the reveals relevant to the architectural documents to ensure the original intent was achieved. "The architects had not completed all of the details, so we spent a lot of time trying to make everything fit together dimensionally and geometrically to get the appearance that was intended," says Broyles.

The three towers' unique appearances reduced the amount of repetitive formwork that could be provided for the precast concrete panels, notes Decoursey. "Each had different coursing patterns, with different widths of reveals and designs, and all were very ornate. In some cases, details varied from one floor to another, so we couldn't reuse forms as much as we would have otherwise." Broyles agrees. "There were different geometries involved with each tower that required changes in the reveal patterns. That meant we had to use new forms for each portion."

Curved precast concrete spandrels frame the large expanses of glass used at the towers' corners to create a welcoming street presence. The precasters interpreted the original architectural drawings to create details in the precast concrete panels to achieve the intended goals. Photo: High Concrete Group LLC.

Three Finish Colors

The concrete mix was specified to match a nearby structure, with a medium sandblast finish. Each of the towers used a different color mix, with the north tower featuring a gray-green look, the central, tallest tower using a tan color, and the south tower, the second highest, having a whiter finish..

Black-granite and limestone veneer pieces were field-applied to the lower three levels of the building, providing visual interest at pedestrian level. The

Penthouse residences feature extensive balconies with decorative architectural precast concrete components, including detailed cornices. Photo: High Concrete Group LLC.

precast concrete backing panels were cast with anchors to supply connections for the stone. The limestone was then reflected in the precast concrete finish on the upper floors.

Balcony fascia panels were cast with deep insets at the center, creating a framing pattern for these three-sided enclosures. Balconies on another tower were cast as semi-circles, and these were clad with curved fascia panels. "There was a unique design for the balconies in each building, and each required a different design to the precast concrete fascia panels," says Decoursey.

The balconies also had scuppers cast into them to direct rainwater. The balconies sloped away from the building, he notes, but the panels on both sides were designed to retain their horizontal reveal pattern in line with the pattern on the building. A special jig apparatus was used by the precaster to ensure these pieces were erected to maintain the flow of the reveals from one dimension to another. Curved spandrel panels also were used at corners to support large, curved windows that provide softened edges for the building. Erecting and maintaining the reveal patterns from one panel to the next required close coordination with the contractor and precaster.

Erection Challenges Arose

The site provided several significant challenges, notes Decoursey. "This was a busy street in downtown Chicago right along the lakefront, so it had limited access and often had high winds." Construction was slowed due to working through the winter, when a number of days had wind speeds that were too high to erect steel framing or the large concrete panels with the two tower cranes. In addition, because of the building's location in a residential neighborhood, delivery times were limited during the day.

'It's a gem for the North Side of Chicago.'

The tower cranes were unable to rotate the panels once they were lifted off the trucks as they were delivered. To overcome this challenge and deliver the panels so they could be lifted into position with minimal handling, High Concrete developed a rotating carrier frame for the trucks. The panels were delivered, rotated into the proper alignment, and then lifted from the truck for positioning.

The precast concrete panels were delivered from two plants, while precast concrete balconies were cast in a third. This arrangement sped up casting but required coordinated scheduling to ensure the proper pieces were available for erection when they were needed. A staging area was established on the south side of the city due to the limited site access, with panels shuttled to the site as needed for erection.

The intricacies of the panels' detailing limited the way the erection could proceed, Decoursey notes. "With little repetition between different portions of the building, we erected all of one type of panel before moving onto the next type so similar panels could be cast in batches," he explains. "Typically, we would wrap each floor horizontally before moving upward, but it was easier in this case to erect all of the similar vertical panels up the face of the building before moving onto another area and creating new forms with the details that area required."

There were also two subcontracting precasters. Precast Specialties Inc. in Monroeville, Ind., fabricated the balcony bases, while Lombard Architectural Precast Products Co. in Alsip, Ill., provided the precast concrete base panels onto which the stone veneer was attached.

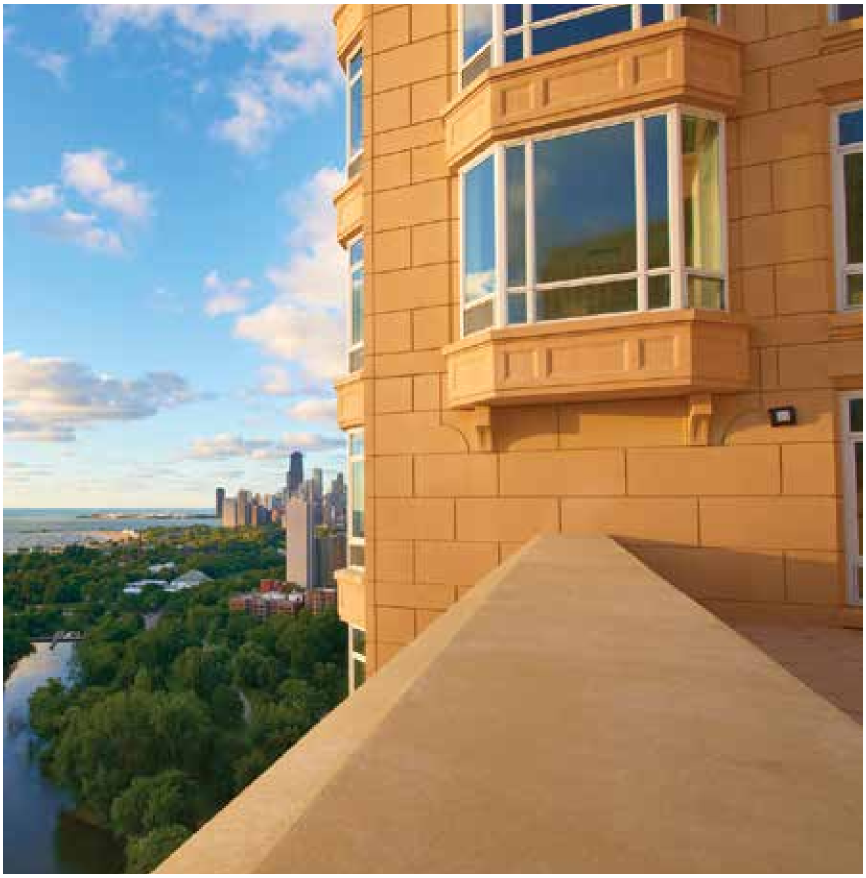
"There was a lot of coordination needed, but everything moved smoothly," Broyles reports. In all, more than 2,000 pieces covering more than 200,400 square feet of architectural precast concrete panels and column covers were fabricated.

Cabrini Shrine Preserved

An interesting feature of the project resulted from another obstacle concerning a historic church on the site. St. Frances Xavier (Mother) Cabrini, who had ministered to immigrants in the area back at the turn of the twentieth century, died in the hospital located on the site in 1917. She became the first U.S. citizen canonized by the Roman Catholic Church, according to *Chicago* magazine. To mark her impact, the Cabrini Chapel national shrine was built on the hospital's grounds. The Missionary Sisters of the Sacred Heart of Jesus, who owned the property, agreed to sell it as long as the chapel remained intact.

To ensure it was unharmed during construction, Walsh erected protective scaffolding around the chapel. "The building construction sometimes came within inches of the church, but it wasn't damaged," says Broyles. As a result, the chapel is still located at its original location, now sitting behind galleries and other retail spaces inside the ground-level southeast entry, which is marked by classical columns to direct visitors to the chapel.

Such attention to detail and respect for the neighborhood ensured the project achieved its goals despite the variety of challenges. "The project was a big success for everybody," Decoursey says. "It's a gem for the North Side of Chicago. It's also the most complex architectural precast concrete project I've been involved with or have seen in the city. High Concrete was able to handle this complex and challenging project with close coordination among engineering, plant staff, and field management. The result is a project everyone in the city can enjoy."



Bay windows framed with precast concrete spandrels add visual depth and enhance scenic views from every floor. Photo: High Concrete Group LLC.

Black-granite and limestone veneer pieces were field-applied to the lower three levels of the building, providing visual interest at pedestrian level. Photo: High Concrete Group LLC.

Indeed, despite the many challenges it faced, 2550 North Lakeview Drive today stands in harmony with Chicago's grandest lakefront buildings, offering an impressive appearance, high-quality amenities, and a little bit of the Windy City's history as well.

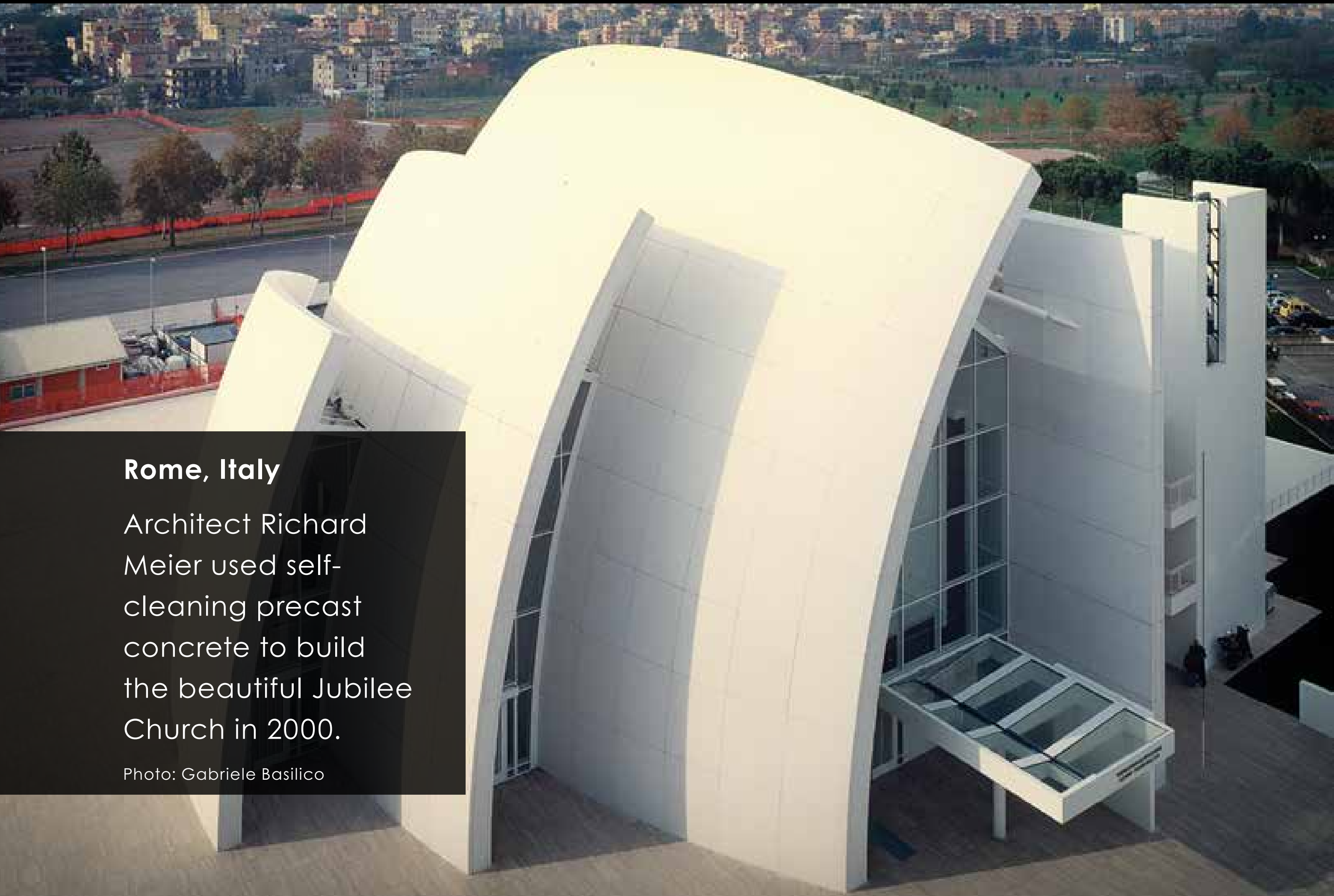
For more information on these or other projects, visit www.pci.org/ascent.

Wilmette, IL

Completed in 1953, the Baha'i House of Worship showcases the intricate details that can be achieved with precast concrete.

Photo: This file is licensed under the Creative Commons

WHAT DO THESE BUILDINGS HAVE IN COMMON?



Rome, Italy

Architect Richard Meier used self-cleaning precast concrete to build the beautiful Jubilee Church in 2000.

Photo: Gabriele Basilico

Trends and Opportunities for Precast Concrete in Residential Design

— Richard Garber, AIA

It should come as no surprise that with an uptick in sustainable and high-performance housing projects, there has been increased interest in the use of precast concrete for residential design. Some virtues of precast concrete construction are well known, such as rapid assembly and minimal site impact. Others such as high thermal efficiency and aesthetic versatility can provide incredible benefits as designers learn how to optimize projects. The application of precast concrete construction once thought best for larger scale developments has found increasing relevance in residential projects of small to mid-size scales.

Single-Family Residential Design Trends

With sustainability remaining of keen interest in building design, a simple way to ensure energy efficiency is to utilize a highly insulative material, such as a precast concrete system, to minimize the escape of conditioned air. In residential design, we are seeing a move from traditional solid precast walls, sometimes used

– Richard Garber, AIA, is an Associate Professor at NJIT's New Jersey School of Architecture. His work uses computer simulation and computer numerically controlled (CNC) hardware to generate innovative design, construction, and assembly solutions.

Figure 1: PREttyFAB, Jersey City, N.J., GRO Architects PLLC, 2009. Credit: Fabian Birgfeld/photoTECTONICS.

for foundations and basements, to sandwich panels for walls, floors, and roofs. A sandwich panel is comprised of two layers, interior and exterior wythes of precast concrete, as well as a layer of rigid insulation between. Sandwich panels can also address thermal bridging by using a non-ferrous connection through the insulation to tie the wythes together. Additionally precast concrete can theoretically be made in any shape. This lends itself to novel solutions in which the architect or designer can specifically form the panels to respond to environmental factors such as prevalent winds, solar exposure, and day-lighting. It should also be stated that precast concrete is increasingly valued as a recycled material, adding to its sustainable benefits.

PREttyFAB, a precast concrete, single-family house, was originally conceived as a prototype for urban infill housing in residential districts. The house was designed and built in 2008-2009 in Jersey City, N.J., for a total construction cost of $250,000 or just over $150/square foot. The private client acquired a small piece of vacant land—ultimately classified

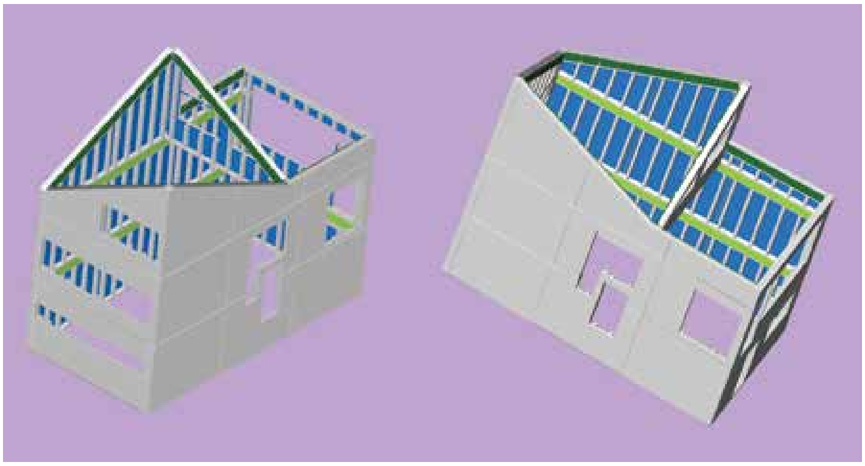


Figure 2: Three-dimensional views of PREttyFAB's panel system as extracted from GRO Architect's digital design model and transmitted to the concrete fabricator in a popular 3D format for the production of shop drawings. Note the precast wall system and insulation are simulated in the model, including ledger boards for the framing of floors. Credit: Notheast Precast.

Figure 3: eNJoy! House—New Jersey Institute of Technology and Rutgers University, 2011, U.S. Department of Energy Solar Decathlon competition. Credit: Solar Team NJ.

as a nonconforming undersized lot—and wished to build a 1,600-square-foot house. The house had to produce its own energy and have minimal to no maintenance costs. The owner was originally interested in concrete for this purpose, but as the design commenced, our firm became increasingly interested in how concrete, and specifically highly insulated precast panels, could be integrated into a total passive and active sustainable solution. The final design also contained a small photovoltaic array, a green roof for additional insulation, low-emissivity glazing, and radiant heating. The house's high insulative value is aided by the building's split level reverse living design—the bedrooms are in the lower level, which is at 5′-0″ below grade, ensuring they remain cool during the warmest times of the year.

In a second single-family house, the eNJoy House, a sandwich panel system was used with fiberglass trusses joining the inside and outside wythes of the panels. This project was the New Jersey Institute of Technology's (NJIT , where I am a faculty member) entry to the 2011 U.S. Department of Energy Solar Decathlon. The low thermal conductivity of the fiberglass trusses would maintain temperature differences on the interior and exterior sides of the wall. We also used a special graphite impregnated expanded polystyrene in the sandwich panels. The graphite both reflects and absorbs energy, further decreasing thermal conductivity while increasing the wall's insulative value. The graphite also slows the flow of heat through the insulation layer, giving the wall a higher level of performance.

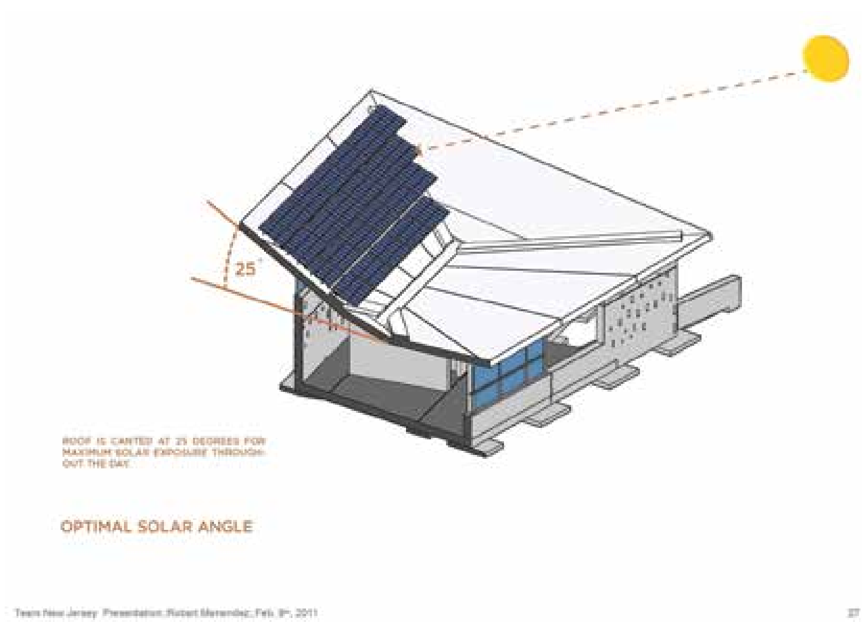


Figure 4: Passive Optimization—Optimal Solar Angle. The eNJoy House utilized an inverted-hip roof with two south-facing panels canted at 25 degrees for maximum solar exposure throughout the day on the panels facing due south. Credit: Solar Team NJ.

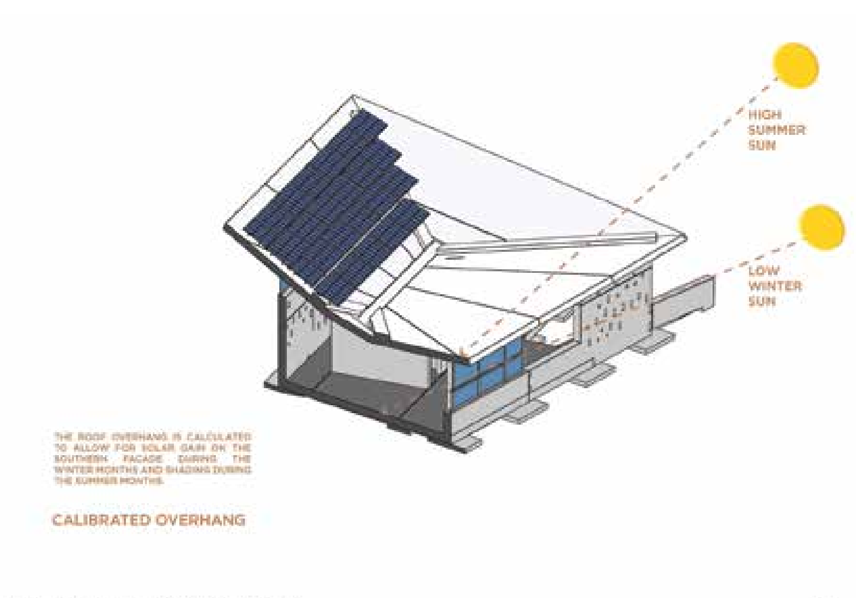


Figure 5: Passive Optimization—Calibrated Overhangs. The roof overhang on the south side of the eNJoy House is calculated to allow for solar gain on the southern façade during the winter months and shading during the southern months working passively to prevent excess cooling and heating respectively. Credit: Solar Team NJ.

High Performance and Resiliency in Multifamily Design

Resiliency, especially in the greater New York/New Jersey area, has become a very hot topic. New rules for setbacks, base flood elevations, and insurance requirements have made the post-Sandy world a difficult one for architects to navigate. The Federal Emergency Management Administration (FEMA) guidelines for revised base flood elevations (BFE) affect many areas and many construction projects, both urban and less dense. Focusing on the urban implications of FEMA's requirements are of utmost importance currently, especially in multifamily residential design. To effectively ensure an urban project in a Special Flood Hazard Area (SFHA), a Letter of Map Amendment (LOMA) must be obtained to officially remove a property from flood hazard on a National Floor Insurance Program map. For sites below the base flood elevation, an effective strategy has been to elevate the site to the BFE + 1′-0″ with fill held by retaining walls. Again, a precast concrete panel system—in this case used as a site foundation—can be used to hold the fill within the raised site and form the foundational "plinth" upon which the structure above sits.

In this case, the site is raised at its extents, and then a second foundation wall is inset 3′-0″ which becomes the wall that supports the building. It is possible to cantilever the building above the first floor to the edge of the lot lines to regain the offset of space at the "new ground" level. While this is an accepted strategy for map amendment, it does raise questions for architects and planners. First, what becomes of the "right-of-way?" The sidewalk, especially the urban sidewalk, is a place of vibrancy and the relationship of the vertical building wall to the horizontal sidewalk is an important one. By raising the ground plane to meet the BFE, accessibility challenges are created, magnified by low lying urban areas where the new BFE can be 6'-0" or more above actual grade. Next, by setting the building back to accommodate the fill area, the idea of "zero-lot line" building, which is an at-grade characteristic of many urban areas, is no longer possible. These are all important aspects of design to contend with, and although a precast concrete panel system is an excellent way to achieve the map amendment described, these questions are larger than a single site and solution.

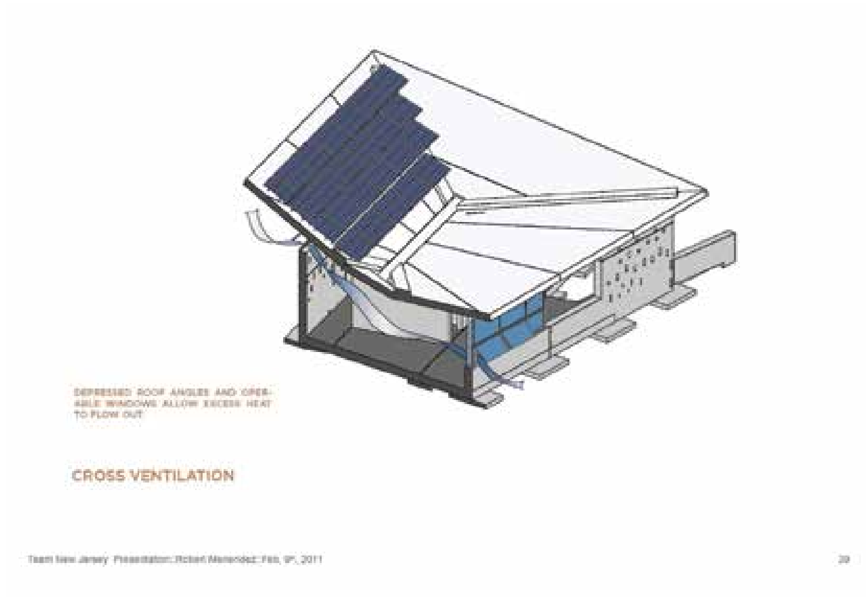


Figure 6: Passive Optimization—Cross Ventilation. The depressed roof angles of eNJoy House made possible by the inverted-hip roof and operable windows (low on the south façade and high on the north façade) allow excess heat to flow out of the house. Credit: Solar Team NJ.

New Challenges and Opportunities

Precast solutions allow for sustainable buildings that require minimal maintenance of a structure or façades. These should be seen as very desirable attributes for affordable multifamily housing projects. This is an area where we are interested in seeing an expanded use of precast concrete in residential design as affordable housing projects continue to be constructed in many cities. In New York City, Mayor De Blasio has called for the preservation or creation of 200,000 affordable homes for half a million New Yorkers over the next 10 years. We have seen precast solutions priced out of the market due to the low budget of construction for many of these projects. When thinking about the life-cycle use costs of such projects, however, precast concrete certainly has a role to play. In addition to fast assembly times and less site mobilization costs, as a monolithic structural system, precast concrete is less prone to issues and problems that framing and other smaller component structural and cladding systems are susceptible to. This means lower costs over the life cycle of a project, and signals that new financial strategies that amortize cost over the life of a building might be called for in such projects.

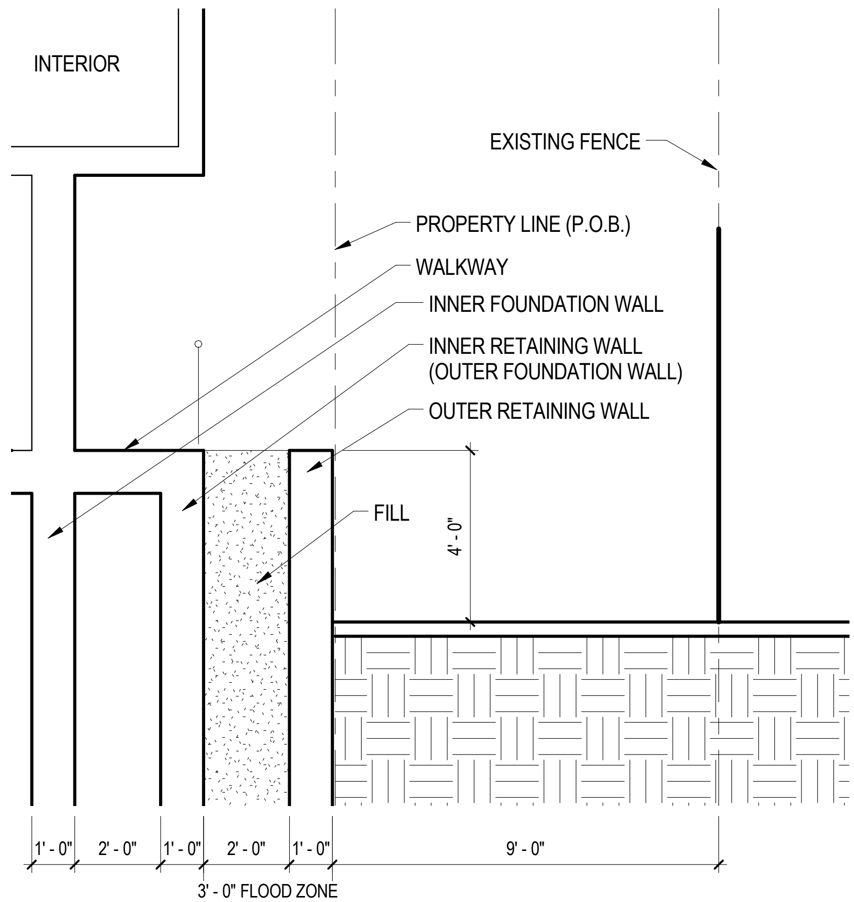


Figure 7: Section of a precast plinth foundation system required for a Letter of Map Amendment in Flood Zones. Credit: GRO Architects.

Conclusions: Engaging Our Students

At the NJIT College of Architecture and Design, we have been working with the PCI Foundation and the Mid-Atlantic Precast Association (MAPA) for the last few years on bringing precast concrete into the Special Topics upper level design studios. The studios introduce precast concrete as a plastic material that is inherently formable, and students initially work geometrically in three-dimensional space to find solutions to the design problems given. Key to this experience is the interaction with precast concrete manufacturers and the forming processes they utilize. Students visit precast plants, and many times fabricators will come to our university to review student work. The need for more sustainable and resilient housing, especially in the wake of natural disasters, has made students and design faculty very aware of the applicability of precast for these problems. To this end, the university has created the Center for Resilient Design, in which architects and engineers from NJIT engage students in the very real problems of housing and sustainable infrastructure in flood-prone areas. Precast concrete figures prominently into this equation, and I suspect the professional and academic opportunities that have presented themselves in our current context allow us to expand our use of precast in both sustainable and resilient design solutions for our cities and towns.

For more information on these or other projects, visit www.pci.org/ascent.

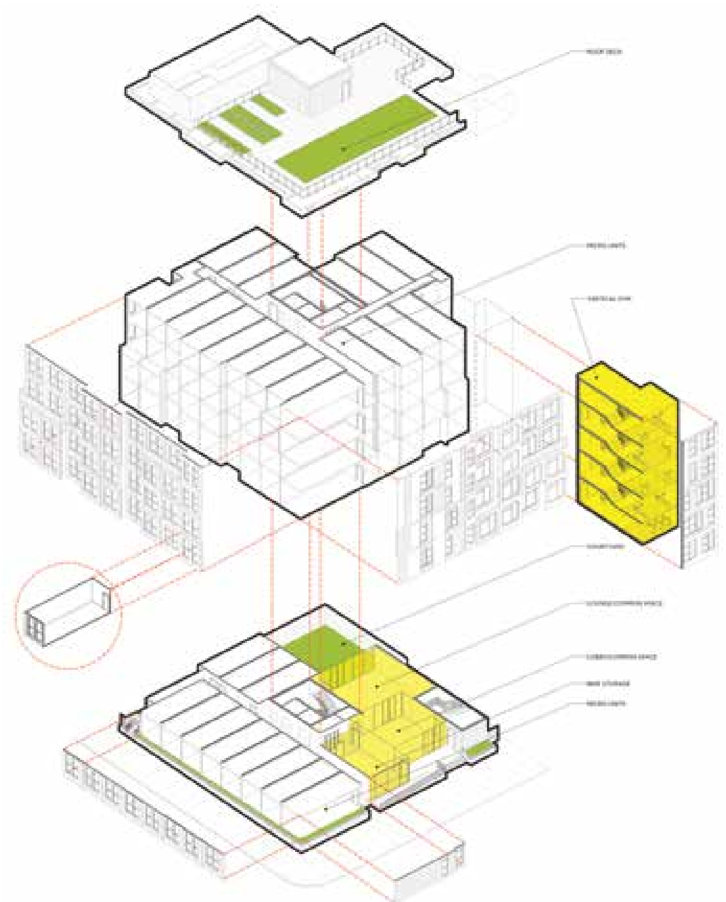


Figure 8: GRO Architects is currently designing a microhousing project in Jersey City, N.J., that is imagined as a 4 over 1 building. Credit: GRO Architects.

Figure 9: GRO Architects has proposed an eight-unit affordable housing project in the Oliver section of Baltimore, Md., utilizing precast concrete for the foundation, wall, and floor and roof systems. Credit: GRO Architects.

Optimizing Value in Comparing Materials and Systems

Thorough evaluation of alternate materials and systems can lead to incredible value for all stakeholders.

— Brian Miller, PE, LEED AP

It is common in the construction industry to compare different or alternate options of construction methods. Even after a design is completed, there may be alternates submitted to change one system, or material, for another. There are many benefits to this such as finding materials that perform better, look better, reduce life-cycle costs, increase the overall value, and in some cases, even reduce first costs. However, the difficult part is performing a complete and fair evaluation between options. Often this is rushed or made to be too simplistic, leaving a lot of value, including money, on the table. This article discusses several of the interrelationships and approaches to conducting a thorough evaluation.

The Simple Substitution Approach

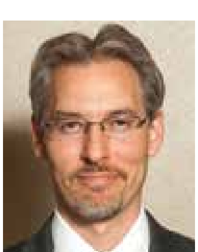
The easiest and unfortunately most common approach is to simply substitute one specific material for another. For example, if we were building a single-family, traditional stick-framed home that was to be finished with brick veneer, and the owner requested an evaluation to change to stone veneer instead. In the simple substitution approach we would look at the material and labor costs associated with the brick veneer compared to stone veneer. Hypothetically, if the stone veneer was $15 per square foot and the brick veneer was $12 per square foot, we could determine that the stone veneer costs $3 per square foot more and submit a change order for the cost difference increase. However, this is only part of the evaluation. For example, what about the foundation that no longer needs to include a 4-inch brick ledge? The stone veneer will transfer its load into the stick-framed wall, whereas the brick would have gravity loaded onto the foundation walls. The smaller foundation requires less concrete, as well as smaller footers, etc.; this would result in a cost savings which should be taken into account as well.

The decision to switch one material for another rarely impacts only one system or component of the project. To truly understand the impact, one must evaluate the interrelation between systems, as well as schedule, effect on revenue generation (for commercial projects), operational costs (e.g., energy to heat and cool), maintenance costs, etc. While this may require more time, it is the only way to truly optimize a structure and its performance.

High-Performance Approach

Buildings are a compilation of complex and integrated systems. Designers and contractors must understand how these systems interrelate in order to achieve project optimization and deliver high-performance structures. This includes a high-performance approach to evaluating one material to another. Here are some suggestions on how to truly compare and evaluate different materials and systems.

First, start by creating a list of systems and project components to investigate. Table 1 contains a sample list that is rooted in the definition of high-performance structures. This definition challenges us to optimize all relevant attributes for a structure. Hence, we must consider the impact on these systems with a material change. Realizing however that each project is unique, the list could be modified for your project's specifics. The main idea here is to think "out of the line item box" and more holistically about the project and its operations. We should also keep in mind that high-performance structures challenge us to evaluate structures and costs from a long-term, life-cycle perspective, not just a first-cost approach.



– Brian Miller has more than 25 years of experience in the construction industry. Prior to joining PCI, Miller has served in the capacity of president of a design-build construction company, as well as in the roles of director of technical services, project manager, project engineer, and field manager

Table 1—Sample List of Items to Consider when comparing materials or systems.

Project Schedule	**Speed up or delay?**
Foundation Systems	**Design changes required? Does it make it smaller or bigger?**
Site Impact (storage, staging, waste, etc.)	**More or less?**
HVAC Systems & Other MEP	**Does it change heating & cooling loads? System(s) installation?**
Operational Costs (e.g. energy consumption)	**How does the change affect the projected energy consumption?**
Maintenance	**More or less? Costs increase or decrease?**
Structural Systems	**Change in loads, connections, etc.**
Envelope Systems	**Does it affect the envelope? Air barrier? Vapor barrier? Thermal bridging?**
Elevator Systems	**Does it affect the elevators or transit systems?**
Use Adaptability	**Does it make it easier to change use, or harder?**
Project Aesthetics	**Does is accomplish the aesthetic goal(s)?**
Environmental Impacts	**More or less?**
Indoor Environmental Quality	**Does it improve or reduce IEQ?**
Revenue Generation	**Linked to schedule, does the project complete faster? If so, what is the revenue/per week for the owner? Does is decrease the construction loan amount or period?**
Design and Construction Complexity	**Does it make it easier to design and construct? Is the change adding trades, detailing, connections, and maintenance concerns?**
Risk Management	**Increasing or reducing risks? Liability for designer, contractor, owner, public, occupants?**
Durability and Resiliency	**Is the change improving durability? Is it improving resiliency? Does it increase service life?**

Next, determine if the material change has any affect or interaction with the items in Table 1. If yes, then try to quantify, or at least qualify the effect. Most of these can be translated into dollars, but assumptions should be stated and maintained for all comparisons.

Let's look at an actual project as an example to apply. Table 2 contains a comparison for a 120,000 square-foot, eight-story, dormitory project. High-performance insulated precast wall panels with embedded thin-brick were compared as an alternate to traditional field-laid brick veneer and block CMU. The structural system was cast-in-place concrete for both envelope options.

The precast envelope system option saved 60 days, and $1,200,000 of first costs.

Table 2—Insulated, Embedded Thin-brick Precast Compared to Field-laid Brick Veneer.

Project Schedule — Speed up or delay?	Precast saved 40 days from the project schedule. Reduced cost of general conditions.
Foundation Systems — Design changes required? Does it make it smaller or bigger?	Foundation size increased 2%.
Site Impact (storage, staging, waste, etc.) — More or less?	The site impact was significantly reduced, e.g., no scaffolding was needed. There was a reduction in site clean-up after project completion as well.
HVAC Systems & Other MEP — Does it change heating & cooling loads?	HVAC contractors used the performance R-value of R-26, which reduced the size of the HVAC equipment by 30% = $500,000 in first-cost savings.
Operational Costs (e.g. energy consumption) — How does the change effect the projected energy consumption?	Energy modeling or actual data shows the annual energy costs to be reduced by 40%, relative to the baseline code. This results in an approximate annual savings of $38,000 per year based on the cost of natural gas.
Maintenance — More or less? Costs increase or decrease?	Precast system reduced total number of joints, flashing, etc. The project was completed four years ago, and has required no maintenance. Maintenance costs are projected to be reduced by 10%, or approximately $20,000 per year.
Structural Systems — Change in loads, connections, etc.	The load-bearing precast wall system eliminated the need for redundant exterior columns saving about $650,000 in construction costs, and adding 1.2% more usable floor space.
Envelope Systems — Does it affect the envelope? Air barrier? Vapor barrier? Thermal bridging?	Improved energy performance by providing continuous insulation (ci), eliminated thermal bridging, provided vapor barrier, and thermal mass—resulted in material R-value of R-14.25, performance R-value 26.
Elevator Systems — Does it affect the elevators or transit systems?	No effect.
Use Adaptability — Does it make it easier to change use, or harder?	The precast envelope eliminated exterior columns, which increased usable floor space.
Project Aesthetics — Does it accomplish the aesthetic goal(s)?	Exceeded project requirements by using embedded thin-brick and sandblasted, medium-exposure precast often in the same panel.
Environmental Impacts — More or less?	The reduction in site impact alone reduces the environmental impacts. Also there is a good opportunity to use recycled material in both the concrete and the steel used to fabricate the panels, and of course the reduction in energy use.
Indoor Environmental Quality — Does it improve or reduce IEQ?	Precast eliminates a cavity between outer and interior walls, does not provide food source for mold, no VOCs, = improved IEQ.
Revenue Generation — Linked to schedule, does the project complete faster? If so, what is the revenue/per week for the owner?	Not applicable for this project since the project had to be completed for the next school year. Missing the deadline however, would have cost the university millions of dollars.
Design and Construction Complexity — Does it make it easier to design and construct? Is the change adding trades, detailing, connections, and maintenance concerns?	Reduced trades and detailing = reduced complexity. An architect can tell you that the installation of the building envelope by one trade made our work in the field significantly easier. The system is virtually foolproof and does not require multiple site visits and reports on progress with inevitable punch list items for the contractor to correct—results in time saving of 10%.
Risk Management — Increasing or reducing risks? Liability for designer, contractor, owner, public, occupants?	Precast reduced overall risk and design complexity—reducing design, coordination and inspection time by 15%. For example: built in vapor barrier and ci, which cannot be damaged in the field by sloppy construction techniques, no weather delays, tighter tolerances, etc.
Durability and Resiliency — Is the change improving durability? Is it improving resiliency? Does increase service life?	Precast exceeded the 50-year service life requirement, at a lower life-cycle cost.

Net Results

The precast envelope system option saved 60 days, and $1,200,000 of first costs—including time spent on design, inspection, etc. The precast option is projected to save the owner about $58,000 on an annual basis over the next 50 years = $2,900,000 in today's dollars.

Often a thorough analysis will expose several factors that may not have been obvious at first glance. This can result in substantial savings for an owner, contractor, the public, and all stakeholders, as well as the environment. So the next time you have an opportunity to evaluate an alternate option, what approach will you use?

For more information on these or other projects, visit www.pci.org/ascent.

Stresscon's High-Performance Architectural Precast Plant and People

Circle Point features multi-color precast architectural panels of combined texture with deep reveals and a light acid etch finish. Photo: Fred J. Fuhrmeister/Time Frame Images

Stresscon Corporation has a longstanding history as a specialty contractor providing engineered concrete products and services to local and regional construction communities. For over 40 years, Stresscon has manufactured and installed a wide range of architectural and structural precast prestressed building solutions. Located on an approximate 70-acre production facility south of Denver, Stresscon serves Colorado and the western United States.

Stresscon's employees provide product knowledge of architectural and structural precast, including structural engineering and building codes, precast panel production and delivery processes, and structural and architectural precast form and features. Our unique material and staff bring decades of research and expertise, allowing us to offer a full range of diverse services managed from the initial design stage through building completion. As an experienced precast group with over 250 employees, Stresscon strives to provide product variation and geographical diversification, development of innovative product lines, use of certified precast products, and cutting-edge design techniques. The Stresscon team also features an in-house design and engineering team, unrestricted preconstruction design assistance, and professional sales and project management personnel to help owners and developers better understand the use of architectural precast to create unique structures with specific features and capabilities.

The amazing array of products produced in Stresscon's outdoor environment are certified by the Precast\Prestressed Concrete Institute (PCI). Stresscon has continued to grow and expand its offerings with architectural precast products that provide unlimited design possibilities and integrated structural solutions. The architectural and structural building elements include but are not limited to: CarbonCast® enclosure systems, structural framing systems of columns, beams, double tees, hollow-core, stadium risers, envelop systems including insulated walls, solid walls, cladding, and spandrels, lateral framing systems including concrete tubes, shafts for stairs, and elevator and other mechanical cores, transportation systems including deck panels, bridge members, noise walls, and miscellaneous products including ornamental items, retaining walls, and stairs. As a certified producer member of PCI, and an AltusGroup® Producer Member, Stresscon is recognized among the leading precast companies in the United States.

Architectural product diversification is a huge factor in Stresscon's success and has allowed for expansion into various market segments due to new and unique product offerings. Architectural precast concrete applications offer numerous advantages and maximize design freedom. Architectural options and features can be used in conjunction with precast structural framing and lateral systems to enhance aesthetic options and building economy, while also showcasing a wide variety of possibilities for expression and detail. Architectural precast concrete provides sculptural freedom and versatility, and it is adaptable to any building configuration.

Precast concrete design flexibility is available in a broad range of architectural styles including cornices, bullnoses, reveals, and textures. Architectural precast has unlimited design potential and can be integrated into any project type to define architectural expression. Architectural products add dramatic detail to the building with the use of colors, finishes, shapes and features, and custom elements. Stresscon's architectural products can incorporate inlays, standard and custom molds and form liners, various finish options, colors, multiple mixes, stains, textures, and custom details.

Architectural precast is efficient, durable, versatile, and requires little maintenance. Stresscon tailors architectural precast solutions to be artistically appealing and to provide required performance characteristics. Architectural pieces can also serve as structural and load bearing pieces in a project. These pieces create a wide range of design and flexibility that can be incorporated into any design environment. This allows designers to create and realize the fullest potential of precast concrete products. Because precast concrete can be used to create both structural and architectural elements, substantial cost savings can be incurred. Manufacturing techniques and cost effective approaches also help achieve the desired design budget.

Stresscon's outdoor plant allows for continual year-round manufacturing of architectural precast solutions. The plant features an efficient and open processing area providing effective production and storage space, and a team of skilled craftsmen with decades of experience in precast production, forming, pouring and finishing. With highly controlled and automated features, including heated casting beds, curing tarps, computerized curing, and specialized employee training, the plant is able to continue production even through some of the worst inclement weather. Stresscon also uses a computer controlled curing process to ensure the concrete finishing and curing process is not compromised due to the outdoor plant location.

The biggest advantage of the outdoor architectural plant is the ability to handle large or complicated pieces. Placement of the plant outdoors allows for unlimited custom mold and frame shapes and sizes for individual projects in precise dimensions in high capacity prestressing beds. These high capacity beds provide superior structural capacity and create more efficient products that can be sold more competitively.

Stresscon Corporation is a member of the EnCon United family of companies. As a full-service precaster, EnCon manufactures a wide range of architectural and structural building components throughout the United States. Corporate offices and the design group are located in Denver, Colorado. EnCon currently sells its products in over 20 states. A broad range of products and exceptional service are the cornerstones of EnCon's business philosophy. EnCon continues to expand to meet the rising demand for precast/prestressed concrete products and services through geographical and product diversification, cutting-edge design techniques, the development of innovative product lines, and a strategic corporate development program. The EnCon family of companies looks forward to increasing growth, leadership and service to the construction industry.

For more information, call 303.298.1900 or visit www.Stresscon.com.

Denver Health Center's parking structure features architectural panels of combined texture palette with thin brick cast in architectural acid-washed concrete. Photo: Fred J. Fuhrmeister/Time Frame Images

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Fire Resistance of Architectural Precast Concrete Envelopes

PCI designer's notebook

FIRE RESISTANCE OF ARCHITECTURAL PRECAST CONCRETE ENVELOPES

In the interest of life safety and property protection, building codes require that resistance to fire be considered in the design of buildings. The degree of fire resistance required depends on the type of occupancy, the size of the building, its location (proximity to property lines and within established fire zones), and in some cases, the amount and type of fire detection and extinguishing equipment available in the structure. Precast concrete members are inherently noncombustible and can be designed to meet any degree of fire resistance that may be required by building codes, insurance companies, and other authorities.

Although life safety is of paramount importance, casualty insurance companies and owners are also concerned with the damage that might be inflicted upon the building and its contents during a fire. This means that both fire resistance and containment must be considered. Insurance rates are usually substantially lower for buildings with higher fire-resistance designs incorporating containment features. Building codes commonly assign fire resistance ratings on the basis of results of standard fire tests. However, in recent years, there has been a trend toward calculating the fire endurance of building components, rather than relying entirely on fire tests. Much research work has been conducted on the behavior of materials and building components in fires. This article summarizes the available information on the behavior of architectural precast concrete under fire conditions. The article is based on the PCI "***Design for Fire Resistance of Precast/Prestressed Concrete***" 3rd Edition, (MNL-124-11). MNL-124 is referenced in the International Building Code (IBC). It can also be accepted as an alternate method to what is specified in IBC or UBC Section 703.3 based on ICC-ES Evaluation Report, ESR-1997.

Fire resistance ratings of building components are measured and specified in accordance with ASTM E119. Fire endurance is defined as the period of time elapsed before a prescribed condition of failure or end point is reached during a standard fire test. The major "end points" used to evaluate performance in a fire test include:

1. Structural End Point. Collapse of loadbearing specimens (structural end point).
2. Flame Passage End Point. Formation of holes, cracks, or fissures through which flames or gases hot enough to ignite cotton waste may pass.
3. Heat Transmission End Point. Temperature increase of the unexposed surface of floors, roofs, or walls reaching an average of 250 °F (122 °C) or a maximum of 325 °F (163 °C) at any one point.
4. Hose Stream Test. Collapse of walls and partitions during a hose-stream test or inability to support twice the super-imposed load following the hose stream test.

A fire-resistance rating (sometimes called a fire rating, a fire-resistance classification, or an hourly rating) is a legal term defined in building codes, usually based on fire endurance. Building codes specify required fire-resistance ratings depending on the construction classification, occupancy, and fire separation distance. In IBC

2012, Table 601 defines the required fire-resistance rating based on type of construction and Table 602 defines the required fire-resistance rating based on separation distance. The more restrictive would apply. Performance is defined by the authorities (regulatory and insurance) as the time for which each component would reach its controlling end point if it were subjected to a standard test.

Fire Endurance of Exterior Walls

The fire endurances of precast concrete walls, as determined by fire tests, are almost universally governed by the ASTM E119 criteria for heat transmission (temperature rise of the unexposed surface) rather than by structural behavior during fire tests. This is probably due to the low level of stresses, even in concrete bearing walls, and the fact that reinforcement generally does not perform a primary structural function. Concrete cover as specified in ACI 318 for durability will be sufficient for fire ratings up to 4-hr.

Most of the information on heat transmission was derived from fire tests of assemblies tested in a horizontal position simulating floors or roofs. The data is slightly conservative for assemblies tested vertically, such as walls. Nevertheless, it is suggested that no correction be made unless more specific data derived from fire tests of walls are used.

For concrete wall panels, the temperature rise of the unexposed surface depends mainly on the thickness and aggregate type in the concrete mixture. Other less important factors include unit weight, moisture condition, air content, and maximum aggregate size. Within the usual ranges, water-cement ratio, strength, and age have insignificant effects.

Table 1. Fire Endurances for Single-Mixture Concrete Panel.

Aggregate	Thickness for fire endurance, in.			
	1 hr	**2 hr**	**3 hr**	**4 hr**
All lightweight	2.5	3.6	4.4	5.1
Sand-lightweight	2.7	3.8	4.6	5.4
Carbonate	3.2	4.6	5.7	6.6
Siliceous	3.5	5.0	6.2	7.0

From information that has been developed from fire tests, it is possible to accurately estimate the thickness of many types of single-course and multicourse (face and backup mixtures) walls that will provide fire endurances of 1, 2, 3, or 4 hours, based on the temperature rise of the unexposed surface. Based on fire test data, the thicknesses shown in Fig. 1 and Tables 1 and 2 can be expected to provide the fire endurances indicated for single-course and two-course walls. Figure 1 shows the fire endurance (heat transmission) of concrete as influenced by aggregate type and thickness. Interpolation of varying concrete unit weights is acceptable in this figure. Table 1 provides the thickness (in inches) of solid concrete wall panels for various fire endurances, while Table 2 provides the same for two-course panels. Table 3 provides reduced required thickness when $^{5}/_{8}$ in. thick Type X gypsum wallboard covers the fire-exposed surface.

As used in this article, concrete aggregates are designated as lightweight, sand-lightweight, carbonate, or siliceous.

Table 2. Thickness of Wythes to Provide Various Fire Endurances for Panels with Facing and Backup Materials.

Fire Endurance, hr	Backup Material / Inside Wythe Material (Fire-Exposed Side)	Siliceous Aggregate Concrete, in. (Facing Material)			Sand-Lightweight Concrete, in. (Facing Material)		
		$1^1/_2$	2	3	$1^1/_2$	2	3
1	Carbonate aggregate concrete*	1.9	1.4	0.45	1.7	1.0	0
1	Siliceous aggregate concrete	2.0	1.48	0.48	1.7	1.0	0
1	Lightweight aggregate concrete	1.5	1.2	0.25	1.13	0.63	0
2	Carbonate aggregate concrete*	3.25	2.8	1.9	3.2	2.6	1.25
2	Siliceous aggregate concrete	3.5	3.0	2.0	3.3	2.7	1.3
2	Lightweight aggregate concrete	2.5	2.1	1.4	2.26	1.76	0.76
3	Carbonate aggregate concrete*	4.4	3.9	3.0	4.2	3.7	2.4
3	Siliceous aggregate concrete	4.65	4.15	3.15	4.4	3.8	2.5
3	Lightweight aggregate concrete	3.4	3.1	2.4	3.12	2.62	1.62
4	Carbonate aggregate concrete*	5.15	4.8	3.85	5.2	4.7	3.5
4	Siliceous aggregate concrete	5.55	5.05	4.05	5.5	4.9	3.7
4	Lightweight aggregate concrete	4.2	3.8	3.0	3.87	3.37	2.37

*Tabulated values for thickness of inside wythe are conservative for carbonate aggregate concrete.
Note: 1. NA = not applicable; that is, a thicker facing material is needed.
2. To obtain thickness of concrete for a specific fire endurance, read across and then up. For example, a 2 hr fire endurance for a 2 in. siliceous facing and carbonate backup requires 4.8 in. of concrete.

1. Lightweight aggregates include expanded clay, shale, slate, and sintered fly ash. These materials produce concretes having unit weights of about 90 to 105 pcf (1520 to 1680 kg/m^3) without sand replacement.
2. Lightweight concretes in which sand is used as part of or all of the fine aggregate, and unit weight of 105 to 120 pcf (1680 to 1920 kg/m^3), are designated as sand-lightweight.
3. Carbonate aggregates include limestone and dolomite (minerals consisting mainly of calcium and/or magnesium carbonate).
4. Siliceous aggregates include quartzite, granite, basalt, and most rocks other than limestone and dolomite.

Table 3. Use of $^5/_8$ in. thick type X gypsum wallboard required to provide fire endurances of 2 hr and 3 hr.

Aggregate	Thickness of concrete panel, in., for fire endurance of 2 hr and 3 hr	
	2 hr	3 hr
Sand-lightweight	2.5	3.6
Carbonate	2.8	4.0
Siliceous	2.9	4.2

Ribbed panel heat transmission is influenced by both the thinnest portion of the panel and by the panel's "equivalent thickness." Here, equivalent thickness is defined as the net cross-sectional area of the panel divided by the width of the cross-section. In calculating the net cross-sectional area of the panel, portions of ribs that project beyond twice the minimum thickness should be neglected (Fig. 2).

The fire endurance (as defined by the heat transmission end point) can be governed by either the thinnest section, the average thickness, or a combination of the two. The following rule-of-thumb expressions describe the conditions under which each set of criteria governs.

Let t = minimum thickness, in.

t_e = equivalent thickness of panel, in.

s = rib spacing, in.

If $t \leq s/4$, fire endurance, R, is governed by t and is equal to R_t.

If $t \geq s/2$, fire endurance, R, is governed by t_e and is equal to R_{te}.

If $s/2 > t > s/4$:

$R = R_t + (4t/s - 1)(R_{te} - R_t)$ (Eq. 1)

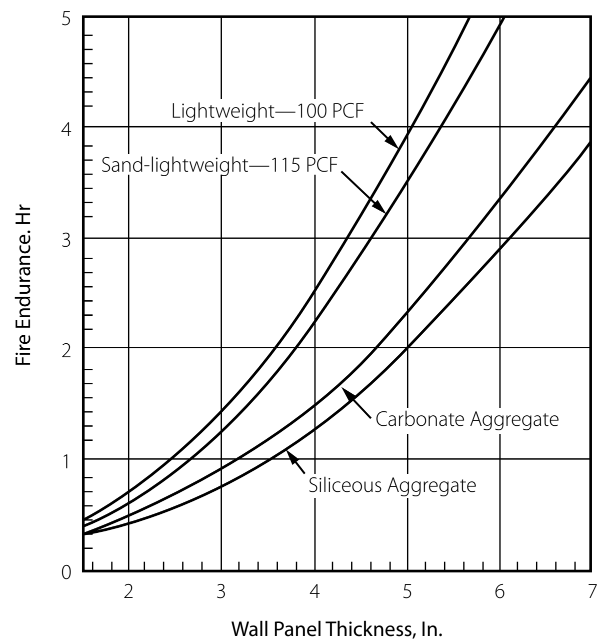


Figure 1 Fire endurance (heat transmision) as a function of panel thickness.

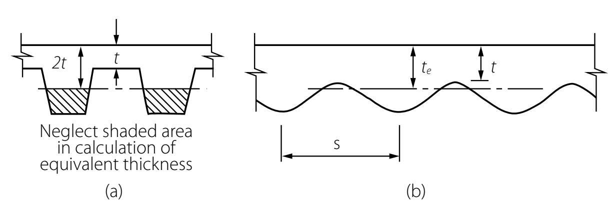


Figure 2 Cross-section of ribbed wall panels.

where R is the fire endurance of a concrete panel and subscripts t and t_e relate the corresponding R values to a concrete slab of thicknesses t and t_e, respectively.

These expressions apply to ribbed and corrugated panels, but they give excessively low results for panels with widely spaced grooves or rustications. Consequently, engineering judgment must be used when applying these expressions.

Insulated precast concrete panels have insulating materials between the two wythes of concrete. Exterior walls of buildings of Type I, II, III, or IV construction of any height must comply with IBC Sections 2603.5.1

through 2603.5.7. Insulated precast concrete panels are Type I and II. Exterior walls of cold storage buildings required to be constructed of noncombustible materials, where the building is more than one story in height, must also comply with the provisions of Sections 2603.5.1 through 2603.5.7.

The exterior wall assembly must be tested in accordance with and comply with the acceptance criteria of NFPA 285 with the following exceptions:

1. One-story buildings complying with (2012) IBC Section 2603.4.1.4.
2. The 2015 IBC in Section 2603.5.5 includes the following additional exceptions. Wall assemblies where the foam plastic insulation is covered on each face by a minimum of 1-inch (25 mm) thickness of concrete or masonry and meeting one of the following:
    a. There is no air space between the insulation and the concrete or masonry; or
    b. The insulation has a flame spread index of not more than 25 as determined in accordance with ASTM E 84 or UL 723 and the maximum air space between the insulation and the concrete or masonry is not more than 1-inch (25 mm).

It should be noted that cellular plastics melt and are consumed at about 400 to 600° F (205 to 316° C). Thus, thickness of cellular plastics greater than 1.0 in. (25 mm) or changes in composition probably have only a minor affect on the fire endurance of insulated precast concrete panels. The danger of toxic fumes caused by the burning of cellular plastics is practically eliminated when the plastics are completely encased within the two concrete withes.

It is possible to calculate the thicknesses of various materials in an insulated precast concrete panel required to achieve a given fire rating using Equation 2.

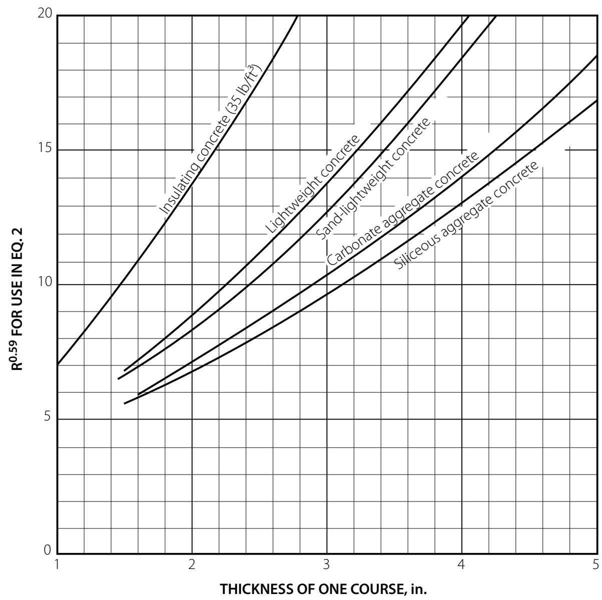
$$R^{0.59} = R_1^{\,0.59} + R_2^{\,0.59} \ldots R_n^{\,0.59} \qquad \text{(Eq. 2)}$$

where R = fire endurance of the composite assembly in minutes and R_1, R_2, and R_n = fire endurance of each of the individual courses in minutes.

A design graph for solving the equation is provided in Fig. 3.

Table 4 lists fire endurances for insulated precast concrete panels with either cellular plastic, glass fiber board used as the insulating material. The values were obtained using Eq. 2.

Walls that have windows and are required to be fire resistive have limits imposed on the area of window openings by the building code. Openings in exterior walls must comply with Section 705.8 (2012 IBC). These limits are based on the construction classification, occupancy, fire separation distance, and use of sprinklers. For example, Table 705.8 of the IBC permits no openings in exterior walls when the fire separation distance is less than 3 ft (0.9 m). Where protected openings are allowed 2012 IBC Tables 716.5 and 716.6 provide the rating required for fire doors and windows in the exterior wall. For example, exterior walls with a 1-hour rating require fire doors and window assemblies with a 45-minute rating. For 2- and 3-hour rated exterior walls, door and



R, Minutes	$R^{0.59}$
60	11.20
120	16.85
180	21.41
240	25.37
Material	**$R^{0.59}$**
Cellular plastic (i in. or thicker)	2.57
$^3/_4$ in. thick glass fiber board	4.03
$1^1/_2$ in. thick glass fiber board	8.57
Continuous air space	3.33
Two continuous air spaces	6.67

Figure 3 Design aid for use in solving Eq. 2.

window openings must have a 90-minute rating.

For buildings that are more than three stories in height, openings in exterior walls in adjacent stories are to be separated vertically to protect against fire spread on the exterior of the buildings where the openings are within 5 ft (1.5 m) of each other horizontally and the opening in the lower story is not a protected opening with not less than $^3/_4$ hr. rating. Such openings are to be separated vertically by at least 3 ft (1 m) by spandrel girders, exterior walls, or other similar assemblies that have a fire-resistance rating of at least 1 hour or by flame barriers having a fire-resistance rating of at least 1 hour that extends horizontally at least 30 in. (762 mm) beyond the exterior wall.

Requirements for various occupancies differ somewhat but generally follow the same pattern and certain exceptions often apply. The IBC code relates fire separation distance and maximum area of openings to the area of the exposed building face. Percentages of opening areas are then tabulated in the code for various percentages of area of the exterior wall per story and fire separation distance. The percentage of openings permitted increases as the fire separation distance increases.

Where the allowable area of protected openings is not limited or the allowable area of protected openings is limited and the equivalent area from Eq. 3 satisfies the limit, the heat transmission end point for the exterior wall does not apply. The equivalent opening factor is a function of the temperature on the unexposed surface of the wall and the fire rating of the wall.

Table 4. Fire Endurance of Insulated Precast Concrete Panels.

Inside Wythe, in.	Insulation, in.	Outside Wythe, in.	Fire Endurance, hr: min
$1^1/_2$ Sil	1 CP	$1^1/_2$ Sil	1:23
$1^1/_2$ Carb.	1 CP	$1^1/_2$ Carb.	1:23
$1^1/_2$ SLW	1 CP	$1^1/_2$ SLW	1:45
2 Sil	1 CP	2 Sil	1:50
2 Carb.	1 CP	2 Carb	2:00
2 SLW	1 CP	2 SLW	2:32
3 Sil	1 CP	3 Sil	3:07
$1^1/_2$ Sil	$^3/_4$ GFB	$1^1/_2$ Sil	1:39
2 Sil	$^3/_4$ GFB	2 Sil	2:07
2 SLW	$^3/_4$ GFB	2 SLW	2:52
2 Sil	$^3/_4$ GFB	3 SLW	3:10
$1^1/_2$ Sil	$1^1/_2$ GFB	$1^1/_2$ Sil	2:35
2 Sil	$1^1/_2$ GFB	2 Sil	3:08
2 SLW	$1^1/_2$ GFB	2 SLW	4:00

Note: Carb = carbonate aggregate concrete; Sil = siliceous aggregate concrete; SLW = sand-lightweight concrete (115 pcf maximum); CP = cellular plastic (polystyrene or polyurethane); GFB = glass fiber board.

$$A_c = A + A_t F_{eo} \qquad \text{(Eq. 3)}$$

where

A_c = equivalent area of protected openings.

A = actual area of protected openings

A_t = area of exterior wall surface in the story under consideration exclusive of openings, on which the temperature limitation of the standard fire test is exceeded.

Equation 3 can be rearranged to solve for F_{eo} from which a panel thickness can be determined from Figure 4.

Pockets into the thickness of a panel may be required for many reasons. The concrete thickness outside the pocket must be considered in determining the fire resistance of the wall. One approach is to consider the reduction in wall thickness the same as an opening which would occur with complete through penetration.

If the wall is close to the property line, within 5 ft (1.5 m), then openings may not be allowed. This could require restoring the pocket to its original fire rating by applying a fire-resistive spray, inserting various fire-retardant materials, or during design moving the pocket to the opposite wall or using a corbel or ledge instead of a pocket.

Detailing Precautions

If precast concrete wall panels could be designed and installed such that no space exists between the wall panel and floor, a fire below the floor could not pass through the joint between the floor and wall. However, all exterior panels are designed such that a space does exist, a space referred to as a "safe-off" area.

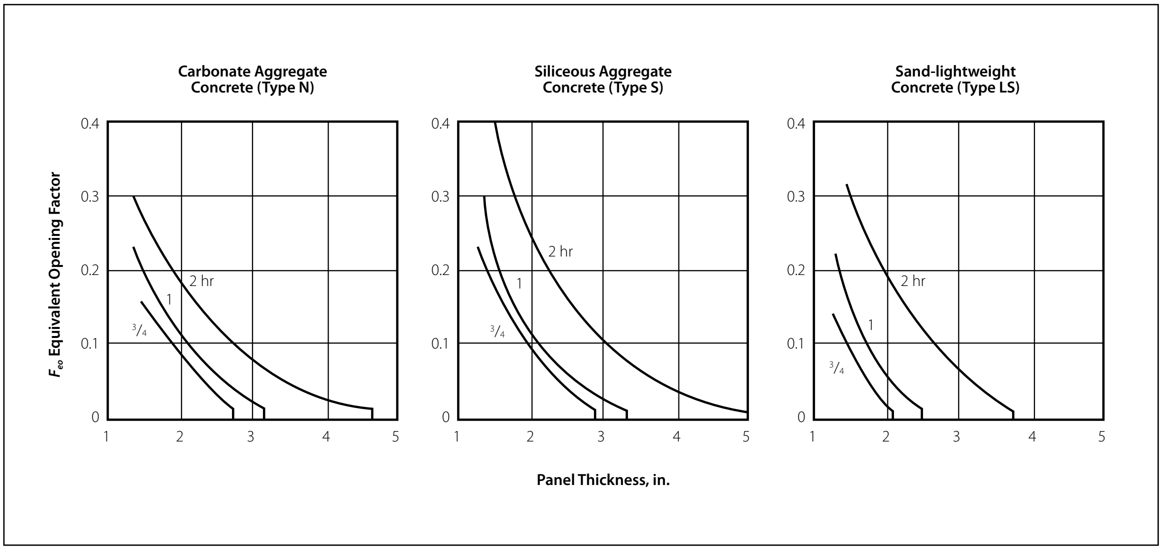


Figure 4 Equivalent opening factor, F_{eo}.

Figure 5 shows a method of fire stopping such safe-off areas. Safing is supported on a steel angle, with or without Z-shaped impaling pins, depending on gauge of steel angle. Safing insulation is available as mineral fiber mats of varying dimensions and densities.

The mineral fiber should be sealed with a sprayed-on firestop caulk. Care must be taken during installation to ensure that the entire safe-off area is sealed. The safing insulation provides an adequate firestop and accommodates differential movement between the wall panel and the floor.

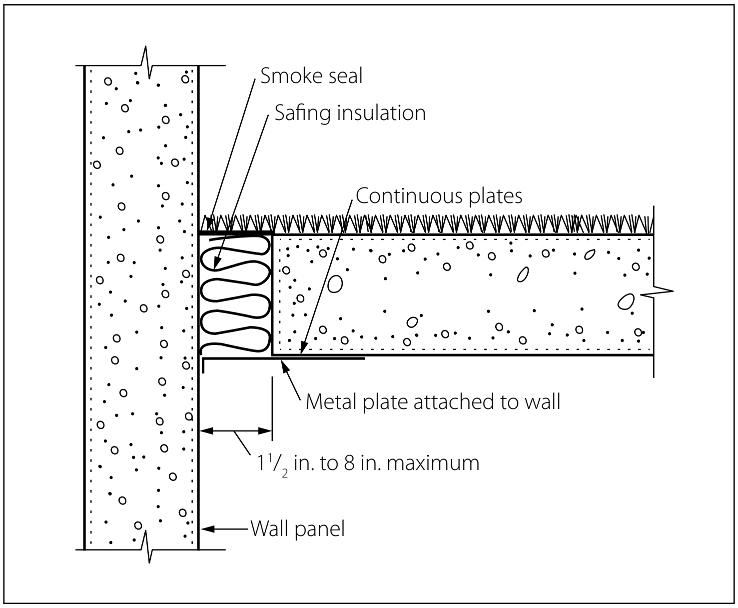


Figure 5 Methods of installing safing insulation.

Columns and Column Covers

Reinforced precast concrete columns have for many years served as the standard for fire-resistive construction. Indeed, the performance of concrete columns in actual fires has been excellent.

Table 5. Minimum sizes of concrete columns.

	Minimum column size for fire resistance rating, in.				
Aggregate Type	**1 hr**	**$1^1/_2$ hr**	**2 hr**	**3 hr**	**4 hr**
Siliceous	8	9	10	12	14
Carbonate	8	9	10	11	12
Sand-lightweight	8	$8^1/_2$	9	$10^1/_2$	12

The inherent fire resistance of concrete columns results from three factors:

1. Minimum size of a structural column is generally such that the inner core of the column retains much of its strength even after long periods of fire exposure.
2. Concrete cover to the primary reinforcing bars is generally $1^7/_8$ in. or more, thus providing considerable fire protection for the reinforcement.
3. Ties or spirals contain the concrete within the core.

Table 5 shows typical building code requirements for reinforced concrete columns, and the values shown apply to both precast and cast-in-place concrete columns with concrete strength less than or equal to 12,000 psi. In addition, they apply to cast-in-place concrete columns clad with precast concrete column covers, whether the covers serve merely as cladding or as forms for the cast-in-place column.

The IBC Code in Section 722.2.4.2 states that regardless of the type of aggregate used in the concrete and the specified compressive strength, the minimum thickness of concrete cover to the main longitudinal reinforcement shall not be less than 1 in. (25 mm) times the number of hours of required fire resistance, or 2 in. (50 mm), whichever is less.

Precast concrete column covers are often used to clad steel columns for architectural reasons. Such covers also provide fire protection for the columns. Figure 6 shows the relationship between the thickness of a concrete column cover and the fire endurance for various steel column sections. The fire endurances shown are based on an empirical relationship. It was also found that the air space between the steel core and the column cover has only a minor affect on the fire endurance. An air space will probably increase the fire endurance but by an insignificant amount.

Most precast concrete column covers are 3 in. (75 mm) or more in thickness, but some are as thin as $2^1/_2$ in. (63 mm). From Fig. 6, it can be seen that such column covers provide fire endurances of at least 2.5 hours and usually more than 3 hours. For steel column sections other than those shown, including shapes other than wide flange beams, interpolation between the curves on the basis of weight per foot will generally give reasonable results.

For example, the fire endurance afforded by a 3 in. thick (75mm) column cover of normalweight concrete for an 8 x 8 x $^1/_2$ in. (200 x 200 x 13 mm) steel tube column will be about 3 hours 20 minutes (the weight of the section is 47.35 lb/ft [691 N/m]).

Figure 7 displays some of the various shapes of precast concrete column covers, including (a) two L-shaped

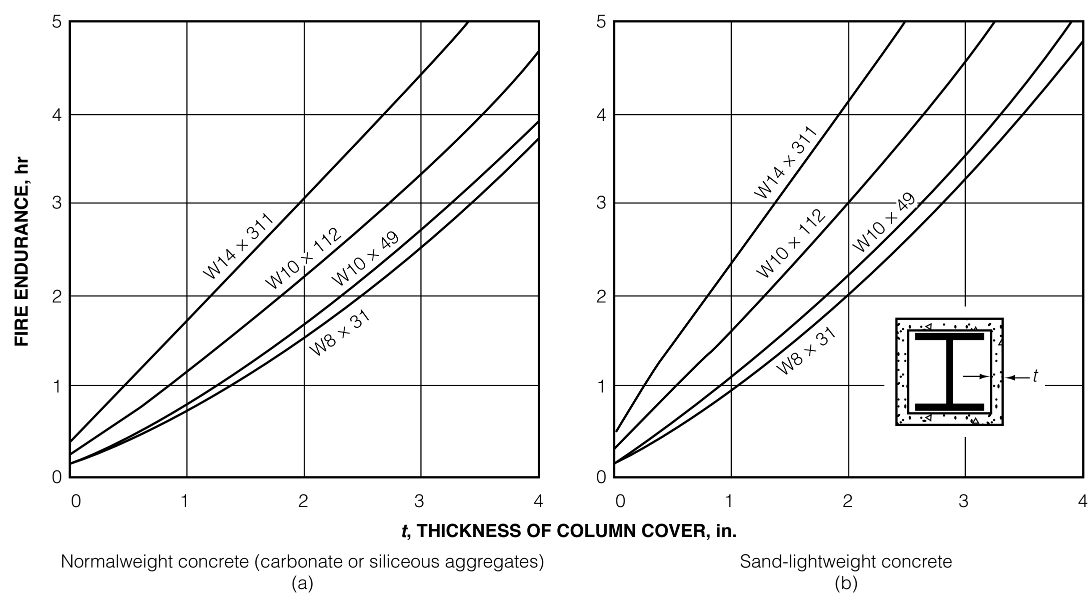


Figure 6 Fire endurance of steel columns afforded protection by concrete column covers.

units, (b) two mitered units, and (c) two U-shaped units. There are, of course, many other combinations that may be used to accommodate isolated columns, corner columns, and columns in walls.

To be fully effective, the column covers must remain in place without severe distortion. Many types of connections are used to hold the column covers in place. Some connections consist of bolted or welded clip angles attached to the tops and bottoms of the covers. Others consist of steel plates embedded in the covers that are welded to angles, plates, or other shapes which are, in turn, welded or bolted to the steel column. In any case, these connections are used primarily to position the column covers and as such, are not highly stressed. As a result, temperature limits do not need to be applied to the steel in most column cover connections.

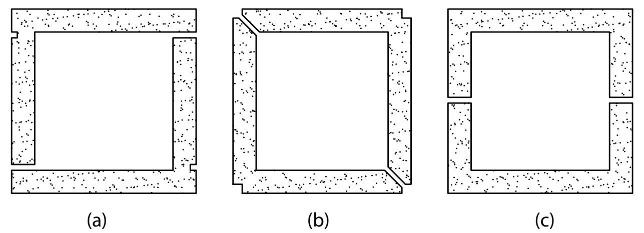


Figure 7 Types of column covers.

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Learning Objectives:

1. Discuss behavior of precast concrete under fire conditions.
2. Determine fire endurance of precast concrete walls.
3. Describe fire code requirements for sandwich wall panels and window walls.
4. Explain the necessary fire protection of reinforcing steel and connections as well as treatment of joints.

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


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PCI and its regional affiliates offer seminars and workshops all over the United States on a variety of topics. Visit www.pci.org/education for up-to-date seminar listings, additional information, and registration.

Lunch-and-Learns

PCI's lunch-and-learn/box-lunch programs are a convenient way for architects, engineers, and design professionals to receive continuing education credit without leaving the office. Industry experts visit your location; provide lunch; and present on topics such as sustainability, institutional construction, parking structures, aesthetics, blast resistance, the basics of precast, and many more. Visit www.pci.org/education/box_lunches for a list of lunch-and-learn offerings and to submit a program request.

PCI-Certified Plants

(as of June, 2014)

When it comes to quality, why take chances? When you need precast or precast, prestressed concrete products, choose a PCI-Certified plant. You'll get confirmed capability—a proven plant with a quality assurance program you can count on.

Whatever your needs, working with a PCI plant that is certified in the product groups it produces will benefit you and your project.

- You'll find easier identification of plants prepared to fulfill special needs.
- You'll deal with established producers—many certified for more than 30 years.
- Using quality products, construction crews can get the job done right the first time, keeping labor costs down.
- Quality products help construction proceed smoothly, expediting project completion.

Guide Specification

To be sure that you are getting the full benefit of the PCI Plant Certification Program, use the following guide specification for your next project:

"***Manufacturer Qualification***: The precast concrete manufacturing plant shall be certified by the Precast/Prestressed Concrete Institute Plant Certification Program. Manufacturer shall be certified at time of bidding.

Certification shall be in the following product group(s) and category(ies): [Select appropriate groups and categories (AT or A1), (B1,2,3, or 4), (C1,2,3, or 4), (G)]."

Product Groups and Categories

The PCI Plant Certification Program is focused around four groups of products, designated A, B, C, and G. Products in Group A are audited to the standards in MNL–117. Products in Groups B and C are audited to the standards in MNL–116. Products in Group G are audited according to the standards in MNL–130. The standards referenced above are found in the following manuals:

- MNL–116 *Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products*
- MNL–117 *Manual for Quality Control for Plants and Production of Architectural Precast Concrete*
- MNL–130 *Manual for Quality Control for Plants and Production of Glass-Fiber-Reinforced Concrete Products*

Within Groups A, B, and C are categories that identify product types and the product capability of the individual plant. The categories reflect similarities in the ways in which the products are produced. In addition, categories in Groups A, B, and C are listed in ascending order. In other words, a plant certified to produce products in Category C4 is automatically certified for products in the preceding Categories C1, C2, and C3. A plant certified to produce products in Category B2 is automatically qualified for Category B1 but not Categories B3 or B4.

Please note for Group B, Category B1: Some precast concrete products such as highway median barriers, box culverts, and three-sided arches are not automatically included in routine plant audits. They may be included at the request of the precaster or if required by the project specifications.

GROUPS

GROUP A – *Architectural Products*

Category AT – Architectural Trim Units

Wet-cast, nonprestressed products with a high standard of finish quality and of relatively small size that can be installed with equipment of limited capacity such as sills, lintels, coping, cornices, quoins, medallions, bollards, benches, planters, and pavers.

Category A1 – Architectural Cladding and Load-Bearing Units

Precast or precast, prestressed concrete building elements such as exterior cladding, load-bearing and non-load-bearing wall panels, spandrels, beams, mullions, columns, column covers, and miscellaneous shapes. This category includes Category AT.

GROUP B – *Bridges*

Category B1 – Precast Concrete Bridge Products

Mild-steel-reinforced precast concrete elements that include some types of bridge beams or slabs, sheet piling, pile caps, retaining-wall elements, parapet walls, sound barriers, and box culverts.

Category B2 – Prestressed Miscellaneous Bridge Products

Any precast, prestressed element excluding super-structure beams. Includes piling, sheet piling, retaining-wall elements, stay-in-place bridge deck panels, and products in Category B1.

Category B3 – Prestressed Straight-Strand Bridge Members

Includes all superstructure elements such as box beams, I-beams, bulb-tees, stemmed members, solid slabs, full-depth bridge deck slabs, and products in Categories B1 and B2.

Category B4 – Prestressed Deflected-Strand Bridge Members

Includes all products covered in Categories B1, B2, and B3.

GROUP BA – *Bridge Products with an Architectural Finish*

These products are the same as those in the categories within Group B, but they are produced with an architectural finish. They will have a form, machine, or special finish. Certification for Group BA production supersedes Group B in the same category. For instance, a plant certified to produce products in Category B2A is also certified to produce products in Categories B1, B1A, and B2 (while it is not certified to produce any products in B3A or B4A).

GROUP C – *Commercial (Structural)*

Category C1 – Precast Concrete Products

Mild-steel-reinforced precast concrete elements including sheet piling, pile caps, piling, retaining-wall elements, floor and roof slabs, joists, stairs, seating members, columns, beams, walls, spandrels, etc.

Category C2 – Prestressed Hollow-Core and Repetitive Products

Standard shapes made in a repetitive process prestressed with straight strands. Included are hollow-core slabs, railroad ties, flat slabs, poles, wall panels, and products in Category C1.

Category C3 – Prestressed Straight-Strand Structural Members

Includes stemmed members, beams, columns, joists, seating members, and products in Categories C1 and C2.

Category C4 – Prestressed Deflected-Strand Structural Members

Includes stemmed members, beams, joists, and products in Categories C1, C2, and C3.

GROUP CA – *Commercial Products with an Architectural Finish*

These products are the same as those in the categories within Group C, but they are produced with an architectural finish. They will have a form, machine, or special finish. Certification for Group CA production supersedes Group C in the same category. For instance, a plant certified to produce products in Category C2A is also certified to produce products in C1, C1A, and C2 (while it is not certified to produce any products in Groups C3 or C4A).

Group G – *Glass-Fiber-Reinforced Concrete (GFRC)*

These products are reinforced with glass fibers that are randomly dispersed throughout the product and are made by spraying a cement/sand slurry onto molds. This produces thin-walled, lightweight cladding panels.

Visit www.pci.org for the most up-to-date listing of PCI-Certified plants.

ALABAMA

Gate Precast Company, (251) 575-2803 .... **A1, C4A**
Hanson Pipe and Precast Southeast, Pelham (205) 663-4681 .... **B4, C4**

ARIZONA

Coreslab Structures (ARIZ) Inc., Phoenix (602) 237-3875 .... **A1, B4, C4A**
CXT Concrete Ties, Tucson (520) 644-5703 .... **C2**
Royden Construction Company, Phoenix (602) 484-0028 .... **B4**
TPAC, Phoenix (602) 262-1360 .... **A1, B4, C4A**

ARKANSAS

Coreslab Structures (ARK) Inc., Conway (501) 329-3763 .... **C4A**

CALIFORNIA

Bethlehem Construction, Inc., Shafter (661) 391-9704 .... **C3A**
Clark Pacific, Fontana (909) 823-1433 .... **A1, C3A, G**
Clark Pacific, Irwindale (626) 962-8751 .... **C4**
Clark Pacific, West Sacramento (916) 371-0305 .... **A1, C3A**
Clark Pacific, Woodland (916) 371-0305 .... **B3, C3A**
Con-Fab California Corporation, Lathrop (209) 249-4700 .... **B4, C4**
Con-Fab California Corporation, Shafter (661) 630-7162 .... **B4, C4**
Coreslab Structures (L.A.) Inc., Perris (951) 943-9119 .... **A1, B4, C4A**
CTU Precast, Olivehurst (530) 749-6501 .... **A1, C3A**
KIE-CON, Inc., Antioch (925) 754-9494 .... **B4, C3**
Mid-State Precast, L.P., Corcoran (559) 992-8180 .... **A1, C3A**
Oldcastle Precast Inc., Stockton (209) 466-4212 .... **C2**
Oldcastle Precast, Inc., Perris (951) 657-6093 .... **B4A, C2A**
StructureCast, Bakersfield (661) 833-4490 .... **A1, B3, C3A**
Universal Precast Concrete, Inc., Redding (530) 243-6477 .... **A1**
Walters & Wolf Precast, Fremont (510) 226-5162 .... **A1, G**
Willis Construction Co., Inc., San Juan Bautista (831) 623-2900 .... **A1, C1, G**

COLORADO

EnCon Colorado, Denver (303) 287-4312 .... **B4, C2**
Plum Creek Structures, Littleton (303) 471-1569 .... **B4, C3A**
Rocky Mountain Prestress LLC, Denver (303) 480-1111 .... **A1, C3A**
Rocky Mountain Prestress LLC, Denver (303) 480-1111 .... **B4, C4**
Rocla Concrete Tie, Inc., Pueblo (303) 296-3505 .... **C2**
Stresscon Corporation, Colorado Springs (719) 390-5041 .... **A1, B4A, C4A**

CONNECTICUT

Blakeslee Prestress Inc., Branford (203) 481-5306 .... **A1, B4, C4A**
Coreslab Structures (CONN) Inc., Thomaston (860) 283-8281 .... **A1, B1, C1**
Oldcastle Precast, Inc./dba Rotondo Precast, Avon (860) 673-3291 .... **B2, C1A**
United Concrete Products Inc., Yalesville (203) 269-3119 .... **B3, C2**

DELAWARE

Concrete Building Systems of Delaware, Inc., Delmar (302) 846-3645 .... **B3, C4**
Rocla Concrete Tie, Inc., Bear (302) 836-5304 .... **C2**

FLORIDA

Cement Industries, Inc., Fort Myers (239) 332-1440 .... **B3, C3**
Colonial Construction, Concrete, Precast, LLC, Placida (941) 698-4180 .... **C2**
Coreslab Structures (MIAMI) Inc., Medley (305) 823-8950 .... **A1, C4A**
Coreslab Structures (ORLANDO) Inc., Orlando (407) 855-3191 .... **C2**
Coreslab Structures (TAMPA) Inc., Tampa (813) 626-1141 .... **A1, B3, C3A**
Dura-Stress, Inc., Leesburg (800) 342-9239 .... **A1, B4A, C4A**
Finfrock Industries, Inc., Orlando (407) 293-4000 .... **A1, C3**
Gate Precast Company, Jacksonville (904) 757-0860 .... **A1, B4, C3A**
Gate Precast Company, Kissimmee (407) 847-5285 .... **A1, C3**
International Casting Corporation, Miami Lakes (305) 558-3515 .... **C3**
Metromont Corporation, Bartow (863) 440-5400 .... **A1, C3A**
Pre-Cast Specialties Inc., Pompano Beach (800) 749-4041 .... **C4**
Royal Concrete Concepts, LLC, Okeechobee (561) 689-5395 .... **C1**
Spancrete, Sebring (863) 655-1515 .... **C2**
Stabil Concrete Products, LLC, St. Petersburg (727) 321-6000 .... **A1**
Standard Concrete Products, Inc., Tampa (813) 831-9520 .... **B4, C3**
Structural Prestressed Industries, Medley (305) 556-6699 .... **C4**

GEORGIA

Atlanta Structural Concrete Co., Buchanan (770) 646-1888 .... **C4A**
Coreslab Structures (ATLANTA) Inc., Jonesboro (770) 471-1150 .... **C2**
\Metromont Corporation, Hiram (770) 943-8688 .... **A1, C4A**
Standard Concrete Products, Inc., Atlanta (404) 792-1600 .... **B4**
Standard Concrete Products, Inc., Savannah (912) 233-8263 .... **B4, C4**
Tindall Corporation, Conley (800) 849-6383 .... **C2A**
Tindall Corporation, Conley (800) 849-6383 .... **C4A**

HAWAII

GPRM Prestress, LLC, Kapolei (808) 682-6000 .... **A1, B3, C4**

IDAHO

Hanson Structural Precast Eagle, Caldwell (208) 454-8116 .... **A1, B4, C4**
Teton Prestress Concrete, LLC., Idaho Falls (208) 523-6410 .... **B4, C3**

ILLINOIS

ATMI Precast, Aurora (630) 896-4679 .... **A1, C3A**
AVAN Precast Concrete Products, Lynwood (708) 757-6200 .... **A1, C3**
County Materials Corporation, Champaign (217) 352-4181 .... **B3, B3-IL**
County Materials Corporation, Salem (618) 548-1190 .... **A1, B4, B4-IL, C4**
Dukane Precast, Inc., Aurora (630) 355-8118 .... **A1, B3, B3-IL, C3**
Illini Concrete Company of Illinois, LLC, Tremont (309) 925-5290 .... **B3, B3-IL**
Illini Precast, LLC, Marseilles (708) 562-7700 .... **B4, B4-IL, C3**
Lombard Architectural Precast Products Co., Alsip (708) 389-1060 .... **A1**
Mid-States Concrete Industries,
South Beloit (608) 364-1072 .... **A1, B3, B3-IL, C3A**
St. Louis Prestress, Inc., Glen Carbon (618) 656-8934 .... **B3, B3-IL, C3**
Utility Concrete Products, LLC, Morris (815) 416-1000 .... **B1A, C1A**

INDIANA

ATMI Indy, LLC, Greenfield (317) 891-6280 .... **A1, C2A**
Coreslab Structures (INDIANAPOLIS) Inc., I
Indianapolis (317) 353-2118 .... **A1, C4A**
Hoosier Precast LLC, Salem (812) 883-4665 .... **B3, C1A**
Precast, LLC dba Precast Specialties, Monroeville (260) 623-6131 .... **A1, B1**
StresCore, Inc., South Bend (574) 233-1117 .... **C2**

IOWA

Advanced Precast Co., Farley (563) 744-3909 .... **A1, C1A**
Cretex Concrete Products Midwest, Inc.,
Iowa Falls (515) 243-5118 .... **A1, B4B4-IL, C4A**
MPC Enterprises, Inc., Mount Pleasant (319) 986-2226 .... **A1, C3A**
PDM Precast, Inc., Des Moines (515) 243-5118 .... **A1, C3A**

KANSAS

Coreslab Structures (KANSAS) Inc., Kansas City (913) 287-5725 .... **B4, C4**
Prestressed Concrete, Inc., Newton (316) 283-2277 .... **A1, B4, C4**
Stress-Cast, Inc., Assaria (785) 667-3905 .... **C3A**

KENTUCKY

Bristol Group, Inc., Lexington (859) 233-9050 .... **A1, B3A, C3A**
de AM - RON Building Systems LLC, Owensboro (270) 684-6226 .... **B3, C3A**
Gate Precast Company, Winchester (859) 744-9481 .... **A1, C2A**
Prestress Services Industries LLC, Lexington (859) 299-0461 .... **A1, B4, C4A**
Prestress Services Industries LLC, Lexington (260) 724-7117 .... **B4, B4-IL, C4A**
Prestress Services Industries LLC, Melbourne (859) 441-0068 .... **B4, C3**

LOUISIANA

Atlantic Metrocast, Inc., New Orleans (504) 941-3152 .... **C2**
Boykin Brothers, Inc./Louisiana Concrete Products,
Baton Rouge (225) 753-8722 .... **A1, B4, C3A**
F-S Prestress, LLC, Princeton (318) 949-2444 .... **B4, C3**
Fibrebond Corporation, Minden (318) 377-1030 .... **A1, C1A**

MAINE

Oldcastle Precast, Auburn (207) 784-9144 .... **B2, C1**

MARYLAND

Larry E. Knight, Inc., Glyndon (410) 833-7800 .... **C2**
Oldcastle Precast Building Systems Div., Edgewood (410) 612-1213 .... **A1, C3A**

MASSACHUSETTS

Oldcastle Precast, Inc./dba Rotondo Precast, Rehoboth (508) 336-7600 .... **B4, C3**
Precast Specialties Corp., Abington (781) 878-7220 .... **A1**
Unistress Corporation, Pittsfield (413) 499-1441 .... **A1, B4, C4A**
Vynorius Prestress, Inc., Salisbury (978) 462-7765 .... **B3, C2**

Visit www.pci.org for the most up-to-date listing of PCI-Certified plants.

MICHIGAN

International Precast Solution, LLC, River Rouge (313) 843-0073......**A1, B3, C3**
Kerkstra Precast Inc., Grandville (800) 434-5830 .... **A1, B3, C3A**
M.E.G.A. Precast, Inc., Roseville (586) 294-6430.......................................**A1, C3A**
M.E.G.A. Precast, Inc., Shelby Township (586) 294-6430.................................**C3**
Nucon Schokbeton / Stress-Con Industries, Inc.,
Kalamazoo (269) 381-1550 ....**A1, B4, C3A**
Peninsula Prestress Company, Grand Rapids (616) 437-9618.................. **B4, C1**
Stress-Con Industries, Inc., Saginaw (989) 239-2447 .... **B4, C3**

MINNESOTA

Crest Precast, Inc., La Crescent (507) 895-8083..**B3A, C1A**
Cretex Concrete Products Midwest, Inc.,
Maple Grove (Elk River) (763) 545-7473 ....**B4, C2**
Fabcon Precast, LLC, Savage (800) 727-4444.......................................**A1, B1, C3A**
Hanson Structural Precast Midwest, Inc., Maple Grove (763) 425-5555..... **A1, C4A**
Molin Concrete Products Co., Lino Lakes (651) 786-7722.............................**C3A**
Wells Concrete, Albany (320) 845-2299..**A1, C3A**
Wells Concrete, Wells (507) 553-3138 ....**A1, C4A**

MISSISSIPPI

F-S Prestress, LLC, Hattiesburg (601) 268-2006 .... **B4, C4**
Gulf Coast Pre-Stress, Inc., Pass Christian (228) 452-9486 .... **B4, C4**
J.J. Ferguson Prestress-Precast Company, Inc., Greenwood (662) 453-5451 .. **B4**
Jackson Precast, Inc., Jackson (601) 321-8787..**A1, C2A**
Tindall Corporation, Moss Point (228) 435-0160 ....**A1, C4A**

MISSOURI

Coreslab Structures (MISSOURI) Inc., Marshall (660) 886-3306**A1, B4, C4A**
County Materials Corporation, Bonne Terre (573) 358-2773.......................... **B4**
Mid America Precast, Inc., Fulton (573) 642-6400................................ **A1, B1, C1**
Prestressed Casting Co., Ozark (417) 581-7009.. **C4**
Prestressed Casting Co., Springfield (417) 869-1263 ....**A1, C3A**

MONTANA

Missoula Concrete Construction, Missoula (406) 549-9682 .... **A1, B3, C3A**
Montana Prestressed Concrete, Billings (605) 718-4111 .... **B4, C3**
Montana Prestressed Concrete - MT City Plant,
Montana City (406) 442-6503 .... **B4**

NEBRASKA

American Concrete Products Co., Omaha (402) 331-5775.............................. **B1**
Concrete Industries, Inc., Lincoln (402) 434-1800.................................... **B4, C4A**
Coreslab Structures (OMAHA) Inc., LaPlatte (402) 291-0733 .... **A1, B4, C4A**
Enterprise Precast Concrete, Inc., Omaha (402) 895-3848.....................**A1, C2A**
Stonco, Inc., Omaha (402) 556-5544 ....**A1**

NEW HAMPSHIRE

Newstress Inc., Epsom (603) 736-9348 .... **B3, C3**

NEW JERSEY

Boccella Precast LLC, Berlin (856) 767-3861.. **C2**
Jersey Precast, Hamilton Township (609) 689-3700 .... **B4, C4**
Northeast Precast, Millville (856) 765-9088 .... **A1, B3, C3A**
Precast Systems, Inc., Allentown (609) 208-1987 .... **B4, C4**

NEW MEXICO

Castillo Prestress, Belen (505) 864-0238... **B4, C4**
Coreslab Structures (ALBUQUERQUE) Inc.,
Albuquerque (505) 247-3725.. **A1, B4, C4A**
Ferreri Concrete Structures, Inc., Albuquerque (505) 344-8823 ....**A1, C4A**

NEW YORK

David Kucera Inc., Gardiner (845) 255-1044.. **A1, G**
Lakelands Concrete Products, Inc., Lima (585) 624-1990............**A1, B3A, C3A**
Oldcastle Precast Building Systems Div., Selkirk (518) 767-2116....... **B3, C3A**
The Fort Miller Co., Inc., Greenwich (518) 695-5000.................................... **B3, C1**
The L.C. Whitford Materials Co., Inc., Wellsville (585) 593-2741 .... **B4, C3**

NORTH CAROLINA

Gate Precast Company, Oxford (919) 603-1633 ....**A1, C2**
Metromont Corporation, Charlotte (704) 372-1080................................**A1, C3A**
Prestress of the Carolinas, Charlotte (704) 587-4273 .... **B4, C4**
Utility Precast, Inc., Concord (704) 721-0106 .... **B3A**

NORTH DAKOTA

Wells Concrete, Grand Forks (701) 772-6687...**C4A**

OHIO

DBS Prestress of Ohio, Huber Heights (937) 878-8232 .... **C3**
Fabcon Precast, LLC, Grove City (614) 875-8601 .... **A1, C3A**
High Concrete Group LLC, Springboro (937) 748-2412.......................... **A1, C3A**
KSA, Sciotoville (740) 776-3238... **C2**
Mack Industries, Inc., Valley City (330) 483-3111 .... **C2**
Prestress Services Industries of Ohio, LLC,
Mt. Vernon (740) 393-1121 .... **B3, C1**
Prestress Services Industries of Ohio, LLC,
Mt. Vernon (800) 366-8740.. **A1, B4, C3**
Sidley Precast, Thompson (440) 298-3232..**A1, C4A**

OKLAHOMA

Coreslab Structures (OKLA) Inc. (Plant No.1),
Oklahoma City (405) 632-4944...**A1, C4A**
Coreslab Structures (OKLA) Inc. (Plant No.2),
Oklahoma City (405) 672-2325.. **B4, C1**
Coreslab Structures (TULSA) Inc., Tulsa (918) 438-0230 .... **B4, C4**

OREGON

Knife River Corporation, Harrisburg (541) 995-6327 .... **A1, B4, C4**
R.B. Johnson Co., McMinnville (503) 472-2430.. **B4, C3**

PENNSYLVANIA

Brayman Precast, LLC, Saxonburg (724) 352-5600...................................... **B1, C1**
Brayman Precast, Speers Plant, Saxonburg (724) 352-5600 .... **B1, C1**
Concrete Safety Systems, LLC, Bethel (717) 933-4107 ....**A1, B1A, C1A**
Conewago Precast Building Systems, Hanover (717) 632-7722 ....**A1, C2A**
Dutchland, Inc., Gap (717) 442-8282.. **C3**
Fabcon Precast, LLC, Mahanoy City (570) 773-2480 ....**A1, B1A, C3A**
High Concrete Group LLC, Denver (717) 336-9300 .... **A1, B3, C3A**
J & R Slaw, Inc., Lehighton (610) 852-2020... **A1, B4, C3**
Newcrete Products, Roaring Spring (814) 224-2121 .... **A1, B4, C4**
Nitterhouse Concrete Products, Inc., Chambersburg (717) 267-4505 ..... **A1, C4A**
Northeast Prestressed Products, LLC, Cressona (570) 385-2352........... **B4, C3**
Say-Core, Inc., Portage (814) 736-8018 .... **C2**
Sidley Precast, Youngwood (724) 755-0205 .... **C3**
Universal Concrete Products Corporation, Stowe (610) 323-0700....**A1, C3A**
US Concrete Precast Group Mid-Atlantic, Middleburg (570) 837-1774...... **A1, C3A**

RHODE ISLAND

Hayward Baker Inc., Cumberland (401) 334-2565 .... **C2**

SOUTH CAROLINA

Florence Concrete Products, Inc., Sumter (803) 775-4372.................... **B4, C3A**
Metromont Corporation, Greenville (864) 295-0295 ....**A1, C4A**
Tekna Corporation, Charleston (843) 853-9118... **B4, C3**
Tindall Corporation, Fairforest (864) 576-3230...**A1, C4A**

SOUTH DAKOTA

Gage Brothers, Sioux Falls (605) 336-1180.. **A1, B4, C4A**

TENNESSEE

Construction Products, Inc. of Tennessee, Jackson (731) 668-7305 ..... **B4, C4**
Gate Precast Company, Ashland City (615) 792-4871 ....**A1, C3A**
Mid South Prestress, LLC, Pleasant View (615) 746-6606 .... **C3**
Prestress Services Industries of TN, LLC, Memphis (901) 775-9880...... **B4, C3**
Ross Prestressed Concrete, Inc., Bristol (423) 323-1777............................ **B4, C3**
Ross Prestressed Concrete, Inc., Knoxville (865) 524-1485 .... **B4, C4**
Sequatchie Concrete Service, Inc., Chattanooga (423) 867-4510 .... **C2**

TEXAS

Coreslab Structures (TEXAS) Inc., Cedar Park (512) 250-0755 .... **A1, C4A**
CXT, Inc., Hillsboro (254) 580-9100 .... **B1, C1A**
East Texas Precast Co., LTD., Hempstead (936) 857-5077 .... **C4A**
Enterprise Concrete Products, LLC, Dallas (214) 631-7006 .... **B3, C3**
Enterprise Precast Concrete of Texas, LLC, Corsicana (903) 875-1077. **A1, C1**
Gate Precast Company, Hillsboro (254) 582-7200 .... **A1**
Gate Precast Company, Pearland (281) 485-3273 .... **C2**
GFRC Cladding Systems, LLC, Garland (972) 494-9000 .... **G**
Heldenfels Enterprises, Inc., Corpus Christi (361) 883-9334 .... **B4, C4**
Heldenfels Enterprises, Inc., San Marcos (512) 396-2376 .... **B4, C4**
Legacy Precast, LLC, Brookshire (281) 375-2050 .... **C4**
Lowe Precast, Inc., Waco (254) 776-9690 .... **A1, C3A**
Manco Structures, Ltd., Schertz (210) 690-1705 .... **C4A**
NAPCO PRECAST, LLC, San Antonio (210) 509-9100 .... **A1, C3A**
Rocla Concrete Tie, Inc., Amarillo (806) 383-7071 .... **C2**
Tindall Corporation, San Antonio (210) 248-2345 .... **A1, C3A**
Valley Prestress Products Inc., Eagle Lake (979) 234-7899 .... **B4**

UTAH

Hanson Structural Precast Eagle, Salt Lake City (801) 966-1060... **A1, B4, C4, G**
Harper Contracting, Salt Lake City (801) 326-1016 .... **B2, C1**
Owell Precast LLC, Bluffdale (801) 571-5041 .... **A1, B3A, C3A**

VERMONT

Dailey Precast, Shaftsbury (802) 442-4418 .... **A1, B4A, C3A**
J. P. Carrara & Sons, Inc., Middlebury (802) 388-6363 .... **A1, B4A, C3A**
S.D. Ireland Companies, South Burlington (802) 658-0201 .... **A1**

VIRGINIA

Atlantic Metrocast, Inc., Portsmouth (757) 397-2317 .... **B4, C4**
Bayshore Concrete Products Corporation,
Cape Charles (757) 331-2300 .... **B4, C4**
Bayshore Concrete Products/Chesapeake, Inc.,
Chesapeake (757) 549-1630 .... **B4, C3**
Coastal Precast Systems, LLC, Chesapeake (757) 545-5215 .... **A1, B4, C3**
Metromont Corporation, Richmond (804) 222-8111 .... **A1, C3A**
Rockingham Precast, Inc., Harrisonburg (540) 433-8282 .... **B4**
The Shockey Precast Group, Winchester (540) 667-7700 .... **A1, C4A**
Tindall Corporation, Petersburg (804) 861-8447 .... **A1, C4A**

WASHINGTON

Bellingham Marine Industries, Inc., Ferndale (360) 676-2800 .... **B3, C2**
Bethlehem Construction, Inc., Cashmere (509) 782-1001 .... **B1, C3A**
Concrete Technology Corporation, Tacoma (253) 383-3545 .... **B4, C4**
CXT, Inc., Spokane (509) 921-7878 .... **C2**
CXT, Inc., Spokane (509) 921-8716 .... **B1, C1A**
EnCon Northwest, LLC, Camas (360) 834-3459 .... **B1**
EnCon Washington, LLC, Puyallup (253) 846-2774 .... **B1, C2**
Oldcastle Precast, Spokane (509) 533-0267 .... **A1, B4, C4**
Wilbert Precast, Inc., Yakima (509) 248-1984 .... **B3, C3**

WEST VIRGINIA

Carr Concrete Corporation, Waverly (304) 464-4441 .... **B4, C3**
Eastern Vault Company, Inc., Princeton (304) 425-8955 .... **B3, C3**

WISCONSIN

County Materials Corporation, Eau Claire (800) 729-7701 .... **B4**
County Materials Corporation, Janesville (608) 373-0950 .... **B4, B4-IL**
County Materials Corporation, Roberts (800) 426-1126 .... **B4, C3**
International Concrete Products, Inc., Germantown (262) 242-7840 .. **A1, C1**
KW Precast, LLC, Burlington (262) 767-8700 .... **B4, B4-IL, C4**
MidCon Products, Inc., Hortonville (920) 779-4032 .... **A1, C1**
Spancrete, Valders (920) 775-4121 .... **A1, B4, C3A**
Stonecast Products, Inc., Germantown (262) 253-6600 .... **A1, C1**
Wausau Tile Inc., Rothschild (715) 359-3121 .... **AT**

WYOMING

voestalpine Nortrak Inc., Cheyenne (509) 220-6837 .... **C2**

MEXICO

PRETECSA, S.A. DE C.V., Atizapan De Zaragoza (011) 52-10360777 .... **A1, G**
Willis De Mexico S.A. de C.V., Tecate (011) 52-665-655-2222 .... **A1, C1, G**

CANADA

BRITISH COLUMBIA

Armtec Limited Partnership, Richmond (604) 278-9766 .... **A1, B4, C3**

NEW BRUNSWICK

Strescon Limited, Saint John (506) 633-8877 .... **A1, B4, C4A**

NOVA SCOTIA

Strescon Limited, Beford (902) 494-7400 .... **A1, B4, C4**

ONTARIO

Artex Systems Inc., Concord (905) 669-1425 .... **A1**
Global Precast INC, Maple (905) 832-4307 .... **A1**
Prestressed Systems, Inc., Windsor (519) 737-1216 .... **B4, C4**

QUEBEC

Betons Prefabriques du Lac Inc., Alma (418) 668-6161 .... **A1, C3A, G**
Betons Prefabriques du Lac, Inc., Alma (418) 668-6161 .... **A1, C2**
Betons Prefabriques Trans. Canada Inc.,
St. Eugene De Grantham (819) 396-2624 .... **A1, B4, C3A**
Prefab De Beauce, Sainte-Marie De Beauce (418) 387-7152 .... **A1, C3**

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PCI-Qualified & PCI-Certified Erectors

(as of June, 2014)

When it comes to quality, why take chances? When you need precast or precast, prestressed concrete products, choose a PCI-Qualified/Certified Erector. You'll get confirmed capability with a quality assurance program you can count on.

Whatever your needs, working with an erector who is PCI Qualified/Certified in the structure categories listed will benefit you and your project.

- You'll find easier identification of erectors prepared to fulfill special needs.
- You'll deal with established erectors.
- Using a PCI-Qualified/Certified Erector is the first step toward getting the job done right the first time, thus keeping labor costs down.
- PCI-Qualified/Certified Erectors help construction proceed smoothly, expediting project completion.

Guide Specification

To be sure that you are getting an erector from the PCI Field Certification Program, use the following guide specification for your next project:

"Erector Qualification: The precast concrete erector shall be fully qualified or certified by the Precast/Prestressed Concrete Institute (PCI) prior to the beginning of any work at the jobsite. The precast concrete erector shall be qualified or certified in Structure Category(ies): [Select appropriate groups and categories S1 or S2 and/or A1]."

Erector Classifications

The PCI Field Certification Program is focused around three erector classifications. The standards referenced are found in the following manuals:

MNL–127 *Erector's Manual - Standards and Guidelines for the Erection of Precast Concrete Products*

MNL–132 *Erection Safety Manual for Precast and Prestressed Concrete*

GROUPS

Category S1 - Simple Structural Systems

This category includes horizontal decking members (e.g., hollow-core slabs on masonry walls), bridge beams placed on cast-in-place abutments or piers, and single-lift wall panels.

Category S2 - Complex Structural Systems

This category includes everything outlined in Category S1 as well as total-precast, multi-product structures (vertical and horizontal members combined) and single- or multistory load-bearing members (including those with architectural finishes).

Category A - Architectural Systems

This category includes non-load-bearing cladding and GFRC products, which may be attached to a supporting structure.

Certified erectors are listed in blue.

ARIZONA

Coreslab Structures (ARIZ), Inc., Phoenix (602) 237-3875 .... **S2, A**
RJC Contracting, Inc., Mesa (480) 357-0868 .... **S1**
TPAC, Phoenix (602) 262-1360 .... **S2, A**

CALIFORNIA

Walters & Wolf Precast, Fremont (510) 226-9800 .... **A**
Encon Field Services, LLC, Denver (303) 287-4312 .... **S2, A**

COLORADO

Gibbons Erectors, Inc., Englewood (303) 841-0457 .... **S2, A**
Rocky Mountain Prestress, Denver (303) 480-1111 .... **S2, A**

CONNECTICUT

Blakeslee Prestress, Inc., Branford (203) 481-5306 .... **S2**
The Middlesex Corporation, West Hartford (860) 206-4404 .... **S2**

FLORIDA

All Florida Erectors and Welding, Inc., Apopka (407) 466-8556 .... **S2, A**
Concrete Erectors, Inc., Altamonte Springs (407) 862-7100 .... **S2, A**
Finfrock Industries, Inc., Orlando (407) 293-4000 .... **S2, A**
Florida Builders Group, Inc., Miami (305) 278-0098 .... **S2**
Gate Precast Erection Co., Kissimmee (407) 847-5285 .... **A**
Jacob Erecting & Construction, LLC, Jupiter (860) 788-2676 .... **S2, A**
James Toffoli Construction Company, Inc., Fort Myers (239) 479-5100 .... **S2, A**
Pre-Con Construction of Tampa Inc., Tampa (813) 626-2545 .... **S2, A**
Prestressed Contractors Inc., Palm Beach Gardens (561) 741-4369 .... **S1**
Solar Erectors U. S. Inc., Medley (305) 825-2514 .... **S2, A**
Specialty Concrete Services, Inc., Umatilla (352) 669-8888 .... **S2, A**
Structural Prestressed Industries, Inc., Medley (305) 556-6699 .... **S2**
Summit Erectors, Inc., Jacksonville (904) 783-6002 .... **S2, A**

GEORGIA

Bass Precast Erecting, Inc., Cleveland (706) 809-8098 .... **S2, A**
Big Red Erectors Inc., Covington (770) 385-2928 .... **S2, A**
Jack Stevens Welding LLP, Murrayville (770) 534-3809 .... **S2**
Rutledge & Son's, Woodstock (770) 592-0380 .... **S2**

IDAHO

Precision Precast Erectors, LLC, Worley (208) 660-5223 .... **S2, A**

ILLINOIS

Area Erectors, Inc., Rockford (815) 562-4000 .... **S2, A**
Mid-States Concrete Industries, South Beloit (800) 236-1072 .... **S2, A**
Trinity Roofing Service Inc, Blue Island (708) 385-7830 .... **S1**

IOWA

Cedar Valley Steel, Inc., Cedar Rapids (319) 373-0291 .... **S2, A**
Industrial Steel Erectors, Davenport (563) 355-7202 .... **S1**
Northwest Steel Erection, Grimes (515) 986-0380 .... **S1**

KANSAS

Carl Harris Co., Inc., Wichita (316) 267-8700 .... **S2, A**
Crossland Construction Company, Inc., Columbus (620) 429-1414 .... **S2, A**
Ferco, Inc., Salina (785) 825-6380 .... **S2**

MAINE

Cianbro Corporation, Pittsfield (207) 679-2435 .... **S2**

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MARYLAND

DLM Contractors, LLC, Upper Marlboro (301) 877-0000 ..... **S2, A**
E & B Erectors, Inc., Pasadena (410) 360-7800 ..... **S2, A**
E.E. Marr Erectors, Inc., Baltimore (410) 837-1641 ..... **S2, A**
L.R. Willson & Sons, Inc., Gambrills (410) 987-5414 ..... **S2, A**
Oldcastle Building Systems Div. / Project Services, Baltimore (518) 767-2116 ..... **S2, A**

MASSACHUSETTS

Atlantic Bridge & Engineering, Salisbury (978) 465-4337 ..... **S1**
Prime Steel Erecting, Inc., North Billerica (978) 671-0111 ..... **S2, A**

MICHIGAN

Assemblers Precast & Steel Services, Inc., Saline (734) 429-1358 ..... **S2, A**
Devon Contracting, Inc., Detroit (313) 221-1550 ..... **S2, A**
G2 Inc., Cedar Springs (616) 696-9581 ..... **S2, A**
Midwest Steel, Inc., Detroit (313) 873-2220 ..... **S2**
Pioneer Construction Inc., Grand Rapids (616) 247-6966 ..... **S2, A**

MINNESOTA

Amerect, Inc., Newport (651) 459-9909 ..... **A**
Fabcon Precast, LLC, Savage (952) 890-4444 ..... **S2**
Landwehr Construction Inc., St. Cloud (320) 252-1494 ..... **S2, A**
Molin Concrete Products Company, Lino Lakes (651) 786-7722 ..... **S2, A**
Wells Concrete, Wells (507) 553-3138 ..... **S2, A**

MISSISSIPPI

Bracken Construction Company, Inc., Jackson (601) 922-8413 ..... **S2, A**

MISSOURI

Acme Erectors, Inc., St. Louis (314) 647-1923 ..... **S2, A**
JE Dunn Construction Company, Kansas City (816) 474-8600 ..... **S2, A**
Prestressed Casting Co., Springfield (417) 869-7350 ..... **S2, A**

NEBRASKA

Structural Enterprises Incorporated, Lincoln (402) 423-3469 ..... **S2**
Topping Out Inc. / dba Davis Erection Omaha, Omaha (402) 731-7484 ..... **S2**

NEW HAMPSHIRE

American Steel & Precast Erectors, Inc., Greenfield (603) 547-6311 ..... **S2, A**
Newstress, Inc., Epsom (603) 736-9000 ..... **S2**

NEW JERSEY

CRV Precast Construction LLC, Eastampton (800) 352-1523 ..... **S2, A**
J. L. Erectors, Inc., Blackwood (856) 232-9400 ..... **S2, A**
JEMCO-Erectors, Inc., Shamong (609) 268-0332 ..... **S2, A**
Jonasz Precast, Inc., Westville (856) 456-7788 ..... **S2, A**

NEW MEXICO

Ferreri Concrete Structures, Inc., Albuquerque (505) 344-8823 ..... **S2**
Structural Services, Inc., Albuquerque (505) 345-0838 ..... **A**

NEW YORK

Koehler Masonry, Farmingdale (631) 694-4720 ..... **S2**
Oldcastle Building Systems Div. / Project Services, Selkirk (518) 767-2116 ..... **S2, A**
The L.C. Whitford Co., Inc., Wellsville (585) 593-2741 ..... **S2**

NORTH CAROLINA

Carolina Precast Erectors, Inc., Taylorsville (828) 635-1721 ..... **S2, A**

NORTH DAKOTA

Comstock Construction, Wahpeton (701) 642-3207 ..... **S2**
PKG Contracting, Inc., Fargo (701) 232-3878 ..... **S2**
Wells Concrete, Grand Forks (701) 772-6687 ..... **S2,A**

OHIO

Precast Services, Inc., Twinsburg (330) 425-2880 ..... **S2, A**
Sidley Precast Group, Thompson (440) 298-3232 ..... **S2**
Sofco Erectors, Inc., Cincinnati (513) 771-1600 ..... **S2, A**

OKLAHOMA

Allied Steel Construction Co., LLC, Oklahoma City (405) 232-7531 ..... **S2, A**
Bennett Steel, Inc., Sapulpa (918) 260-0773 ..... **S1**
Coreslab Structures (OKLA), Inc., Oklahoma City (405) 632-4944 ..... **S2, A**

PENNSYLVANIA

Century Steel Erectors, Kittanning (724) 545-3444 ..... **S2, A**
Conewago Enterprises, Inc., Hanover (717) 632-7722 ..... **S2**
High Structural Erectors, LLC, Lancaster (717) 390-4203 ..... **S2, A**
Kinsley Construction Inc., York (717) 757-8761 ..... **S1**
Maccabee Industrial, Inc., Belle Vernon (724) 930-7557 ..... **S2, A**
Nitterhouse Concrete Products, Inc., Chambersburg (717) 267-4505 ..... **S2, A**

SOUTH CAROLINA

Davis Erecting & Finishing, Inc., Greenville (864) 220-0490 ..... **S2, A**
Tindall Corporation, Fairforest (864) 576-3230 ..... **S2**

SOUTH DAKOTA

Fiegen Construction Co., Sioux Falls (605) 335-6000 ..... **S2, A**

TENNESSEE

Mid South Prestress, LLC, Pleasant View (615) 746-6606 ..... **S2**
River City Erectors, LLC, Rossville (901) 861-6174 ..... **A**

TEXAS

Coreslab Structures (TEXAS) Inc., Cedar Park (512) 250-0755 ..... **S2, A**
Derr and Isbell Construction, LLC, Euless (817) 571-4044 ..... **S2, A**
Empire Steel Erectors LP, Humble (281) 548-7377 ..... **A**
Gulf Coast Precast Erectors, LLC, Hempstead (832) 451-4395 ..... **S2**
Precast Erectors, Inc., Hurst (817) 684-9080 ..... **S2, A**

UTAH

IMS Masonry, Lindon (801) 796-8420 ..... **A**
OutWest C & E Inc., Bluffdale (801) 446-5673 ..... **S2, A**

VIRGINIA

The Shockey Precast Group, Winchester (540) 665-3253 ..... **S2, A**
CCS Constructors Inc., Morrisville (802) 888-7701 ..... **S2**

WASHINGTON

Oldcastle Precast, Inc., Spokane Valley (509) 536-3330 ..... **S2**

WISCONSIN

J.P. Cullen, Janesville (608) 754-6601 ..... **A**
Miron Construction Co. Inc., Neenah (920) 969-7000 ..... **S2, A**
Spancrete, Valders (920) 775-4121 ..... **S2, A**
The Boldt Company, Appleton (920) 225-6127 ..... **S2, A**

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