HEALTH CARE ISSUE

WINTER 2014

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- The Art and Science of Hospitals
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A Prescription for Building Success

When University of Kentucky Healthcare (UKH) set out to construct a new facility, it had a list of special requirements in addition to the requisite expectations of a high quality finished project.

On the outside, UKH wanted to match the exterior brick aesthetic already present on campus. Inside, the walls needed to feature an insulation system capable of meeting strict energy codes while also providing a continuous air and vapor retarder. UKH also needed a solution that would allow the administrative floors to become operational as soon as possible. Finally, this entire multi-year project needed to be constructed in a manner that provided minimal disruption to the local campus life.

To make these complex requirements a reality, Thermomass teamed with Gate Precast to provide UKH and its architectural partner, GBBN, a solution comprised of insulated architectural precast cladding panels designed to meet every need.

Insulated with Thermomass System NC, the panels proved exemplary in meeting the energy code requirements, providing an R-value comparable to R-29, while still providing an air barrier and vapor retarder.

The completed panels, featuring blended European thin-brick to match other campus buildings, were delivered and erected during overnight hours to reduce traffic problems around the site. Even with this off-hour construction, the contractor was able to open the administrative area well ahead of the original timeline, allowing UKH workers valuable months to move in and get set up while the patient floors were being completed.

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Features

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Healthcare – And High Performance Precast.

Welcome to the New Year! Hopefully, this year will be prosperous for you and the construction industry. Projections for construction this year are up about 7%, with select market segments doing better than others.

One thing clear is the amount and rate of change that occurs. For example, in a reasonably short time, we went from one of the greatest building booms to the lowest economic point in more than 60 years. Another example is components that once were options for obtaining LEED Certification are now code requirements.

Healthcare has probably experienced more changes than other field and will continue to do so, with the Affordable Care Act taking effect, people living longer, and even a shortage of medical professionals predicted.

One question designers obviously ask when they see these trends is: How will this effect facility design and construction? This issue of Ascent focuses on the healthcare industry, examining what designers are doing today and what healthcare professionals and owners think will happen in the future.

One consistent element in our articles is that precast concrete was selected for the envelope of all of these healthcare facilities. The benefits of doing so are extensive and are presented in each case. But why do we seldom see precast used for the structural system of healthcare facilities?

Some of the challenges include coordination of openings for mechanicals, flexibility for changing future needs, varying load conditions for new equipment, and vibration control. Some of these concerns have already been overcome in projects such as the Medical Center in Lincoln.

No matter what solutions are found, involving a precaster early in the design not only creates better coordination but also project optimization. This often results in reduced time of construction and costs while improving energy efficiency and building performance. Look for more articles on this subject in the near future.

The articles this time focus on the inherent versatility of precast concrete, especially as it applies to the healthcare industry. They showcase projects from around the country that have used precast concrete systems to meet high-performance needs and improve the overall optimization of projects performance, both during construction and operation. They serve as great examples of what is being done and as an inspiration for what can be done. Let's discover High Performance Precast!

ASCENT

On the cover: University of Kentucky Hospital (see page 26).

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This rendering shows how the new Convention Center Hotel in Spokane, Wash., will connect to the adjacent convention center via a skyway. The new hotel, the largest in the city, will be constructed with a precast concrete structural system.

15-Story Hotel Features Precast Concrete Structure

SPOKANE, WASHINGTON

Construction is under way on a 15-story hotel with 720 rooms across the street from the Spokane Convention Center. The $50-million hotel, the city's largest, features a total-precast concrete structural system, and is expected to be completed in 2015.

The hotel is being built by Davenport Hotel Collection, with Brick & Mortar Architecture Development serving as the architect of record. Worthy Enterprises is the general contractor on the project, and DCI is the structural engineering firm.

The complex will offer facilities for meetings as well as a 900-space parking garage. Spokane Public Facilities District is funding a skywalk to connect the hotel with the adjacent Convention Center.

The project features 4,373 precast concrete components fabricated by **Oldcastle Precast** in Spokane. That total comprises hollow-core slabs, solid slabs, inverted tee beams, rectangular beams, transfer floor beams, columns, stair-tower walls, elevator walls, demising walls, parking stairs, and wall panels.

Clark Pacific Celebrates 50th Anniversary

WEST SACRAMENTO, CALIFORNIA

Clark Pacific celebrated its 50th Anniversary on November 19th, at the Bently Reserve in San Francisco. More than 200 professionals from the state's developer, architectural, engineering, and construction community attended.

"Over the last 50 years, we have specialized in creating and revolutionizing how structural precast concrete and architectural concrete can be integrated into building design to improve the overall quality and lifespan of the structure," said Don Clark, president of business development for Clark Pacific.

"In recent years we've developed new techniques that enable buildings to meet new sustainability and energy-efficiency requirements while meeting aesthetic goals and furthering the seismic resilience of the building. We are excited to move forward and grow, to continue improving and innovating in our field, and to continue shaping the built environment in California."

LaFarge Teams with Solidia To Reduce Precast Footprint

PISCATAWAY TOWNSHIP, NEW JERSEY

Lafarge has signed a partnership agreement with Solidia Technologies, a New Jersey-based start-up company, to industrialize an innovative technology that could reduce CO_2 emissions in the manufacture of precast concrete by as much as 70%.

As part of the agreement, Lafarge will work with Solidia to demonstrate feasibility of commercial-scale production during the first half of 2014. The two companies will collaborate to market the technology. The program continues Lafarge's efforts to minimize concrete's CO_2 emissions, which have helped reduce emissions by nearly 25% per ton of cement since 1990, the company says.

Stresscon Wins Two DBIA Awards

COLORADO SPRINGS, COLORADO

Stresscon Corporation won two awards from the Design-Build Institute of America (DBIA) at its annual convention in October. The precast manufacturer earned a National Design-Build Award in the Civic Buildings category for the C-5-159th Readiness Center in Cheyenne, Wyo., the first design-build project produced for the Wyoming Military Department. It also won a Merit Award in the category for the Brigade Complex Company Operation Facility (COF) project in Fort Carson, Colo.

DBIA projects must achieve budget goals, schedule goals, and demonstrate advanced and innovative application of total integrated project delivery. This 10,000-square-foot total precast design-build project is a heated building solution providing space for vehicle storage and maintenance.

The C-5-159th project is owned by the Wyoming Army National Guard. The fast-track design project was erected in a week and incorporates a prestressed roof system of 10-foot-wide and 32-inch-deep double tees supported by 10-inch-thick insulated Structural Plus brand walls.

The COF project, owned by the U.S. Army Corps of Engineers' Omaha District, was erected on in 10 days and met the targeted budget of $15.3 million. It features prestressed 12-inch-thick insulated wall panels and split-face CMU formliner. The structural gray precast wall panels were painted after erection to achieve the desired aesthetic appearance.

One of Habitat for Humanity's new NetZero homes, built with precast concrete, is unveiled and handed over to its new family during a recent ceremony in Edmonton, Alberta, Canada.

Stantec Designs First Precast Concrete NetZero Homes

EDMONTON, ALBERTA, CANADA

Stantec Inc., working with Lafarge and Habitat for Humanity, has designed and built the first two NetZero energy homes in North America to be constructed with precast concrete components. The homes are expected to attain LEED Platinum certification.

The precast concrete design provides high thermal mass and energy efficiency. For the next two years, the homes' energy performance will be monitored by the Massachusetts Institute of Technology to determine if the high-efficiency design delivers on an operational basis. Results from all stages of the project will be incorporated into other sustainable residential solutions.

"These types of projects are so important if we are to find sustainable solutions to affordable home ownership," said Alfred Nikolai, president & CEO of Habitat for Humanity Edmonton. "The partnership between Habitat, Lafarge and Stantec demonstrates how community partners can work together for the benefit of humanity."

"Working with Lafarge and this group of designers to find solutions that make sustainable precast concrete homes a reality has been an exciting challenge, and the result is a testament to the teamwork that has taken place over the last two years," says Keith Shillington, Edmonton Capital Region vice president for Stantec. "Habitat for Humanity is such a valuable partner in the community for Stantec, and designing homes for two of their families made this project even more meaningful for our team."

Submit your headline news for consideration in a future issue of *Ascent* to Brian Miller at bmiller@pci.org.

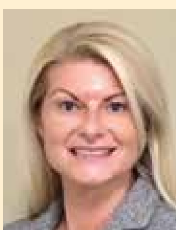
Spancrete Adds Director of Construction Services
WAUKESHA, WISCONSIN


– Per Faivre

Spancrete has added Per Faivre as director of construction services. In this newly created position, Faivre will oversee and direct project managers, superintendents, erection crews, subcontractors, and related services, the company said.

Faivre is a civil engineer with a degree from the University of Illinois. He previously worked as the precast division leader at Area Erectors Inc. in Rockford, Ill.

Meadow Burke Appoints Marketing/ New Products Manager
ATLANTA, GEORGIA


– Denise Senior

Meadow Burke has named Denise Senior to develop sales and marketing capabilities via new-product innovation and development. She spent the previous eight years with a global-contract services company developing new business sales and marketing strategies. She will work to continue Meadow Burke's success providing engineered product solutions to the concrete construction market.

Nominations for 2014 PCI Titans Now Being Accepted
CHICAGO, ILLINOIS

PCI is continuing its Titans of the Industry program in 2014. Up to 10 more Titans will be honored at the 2014 PCI Convention as we celebrate our 60th anniversary. Nominations for the 2014 Titan award are now open and will be accepted until April 18, 2014. If you would like to nominate a deserving person who qualifies, please send your nomination to PCI President's Office, 200 West Adams St., Suite 2100, Chicago, IL 60606-5230, or email it to presidentsoffice@pci.org.

For a list of qualification or more information, visit http://www.pci.org/About_PCI/PCI_Awards_Programs/ or contact Rebecca Coleman at bcoleman@pci.org.

Prestress Engineering Bought by County Materials
PRAIRIE GROVE, ILLINOIS

Prestress Engineering Co. has been purchased by County Materials Corp. in Marathon, Wis., which has 42 locations in the United States. Stockholders decided to sell the company, which had annual revenue of more than $5 million, due to slumping business. Prestress owner Chris Newkirk, who had been with the company for 30 years, plans to continue his philanthropic work in McHenry County, Ill., along with his wife, Kristine.

New Tools Assist in Designing for Sustainability

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

— Emily Lorenz, PE, LEED AP BD+C

Some previous design strategies for making projects more sustainable included sourcing building materials locally, reducing the volatile organic compounds in a material, or increasing the recycled content. Although those strategies are good, with our increasing understanding of sustainability, designers are realizing that there are often trade-offs with such single-attribute criteria. For example, choosing a material that contains a large percentage of recycled content may result in a material that also has a very high embodied energy. Another example would be selecting a less durable material, which does not provide the resiliency or long-term performance demanded by today's high-performance structures. Hence, this may result in a structures premature replacement or higher ongoing maintenance.

Life-cycle assessment (LCA) is moving into the mainstream as designers look for ways to better assess the sustainability of their design choices and make fair comparisons between materials or systems. As we embrace this next step in our understanding and application of sustainability to our projects, it is important to better understand LCA.

– 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.

What IS LCA?

LCA is a comprehensive method used to assess and quantify the environmental impact of a product or process over its entire life cycle. LCA can be performed on a small product (like a pencil), a large product (like a building), or a process (such as the process for manufacturing a car).

Although LCA studies can be performed with a more-limited scope or time scale, the most representative accounting of a product's environmental impact includes all environmental flows over the full life of the product. Environmental flows are material and energy resources that go into a product, as well as all emissions to air, water, and land that result from its manufacture and use. An LCA over the full life cycle of a product—from extracting raw materials from nature, any transformation or manufacturing of these raw materials into a product, the product use, and end-of-life scenarios such as recycling or disposal—is considered a cradle-to-grave study.

Manufacturers commonly perform cradle-to-gate LCAs for products that are sold to a customer without knowing the intended, final use of the product. This allows the product manufacturer to identify environmental hot-spots in its process.

No matter the product being studied, an LCA involves handling and tracking data related to materials, water, and energy use, as well as emissions to air, water, and land (typically in the form of waste). For more complex products or processes, LCAs can become quite time consuming as they require large quantities of data to be analyzed. Computer models are available to assist with the data compilation and assignment of environmental impacts.

Regarding the standardization of LCA, the International Organization for Standardization (ISO) standards ISO 14040:2006[1] and 14044:2006[2] specify requirements and provide guidelines for performing LCAs. The procedures presented in ISO 14040 and ISO 14044 are generally scientific, transparent, and repeatable. Requirements in ISO 14040 and ISO 14044 relate to the four iterative stages of an LCA:

- Definition of the goal and scope of the LCA
- Life-cycle inventory (LCI)
- Life-cycle impact assessment (LCIA)
- Life-cycle interpretation, which includes reporting and critical review of the LCA, limitations of the LCA, relationship between the LCA phases, and conditions for use of value choices and optional elements

Because LCA is iterative, information gathered in a latter phase can cause effects in a former phase, which can result in the former phase needing to be reviewed and revised.

Beware the Boundary

When comparing results of one LCA to another, it is important to carefully examine the system boundary used for each LCA. ISO 14044 allows the LCA practitioner to consider any boundary, and include or exclude any process, as long as these items are all explained in the LCA report. It is during the goal and scope phase that inputs and outputs to the boundary are selected. To truly understand the full environmental impact of a product or process requires consideration of all the environmental flows from cradle to grave. This is a common approach.

What is Relevant?

It is easy to forget when studying an LCA report that there were a significant number of assumptions made for that study. It is important to understand these assumptions to put the results in the correct context. Often times, data are presented with many decimal places, implying that all digits are significant, which is typically not the case. In fact, most data values can be truncated to two significant figures without any loss of accuracy. Although LCA is a good tool, and arguably the best tool we have, it is not perfect.

LCA practitioners understand that there is inherent variability within the data. When comparing results of different LCAs, the differences in some of the environmental impact categories might be quite small. But a small change in a small number may result in a large percentage shift. Therefore, if results are presented as a percentage, it's important to look at the absolute differences in values, and beware of the coefficient of variation within the data. The percent difference in values among data sets may be smaller than the coefficient of variation among the data, thus the difference is insignificant.

Full Set of Impacts, Whole Life Cycle

Another new tool that designers are using to assess the sustainability of products is an environmental product declaration (EPD). EPDs are better than single-attribute criterion for assessing the sustainability of a product because they are LCA-based, but it is important to realize that EPDs can be prepared with a limited life cycle. There are two primary types of EPDs: business-to-business (B-to-B) and business-to-consumer (B-to-C).

B-to-B EPDs are frequently created for those products that are created without knowing how the product will be used during the life cycle. Think of a unit volume of concrete. One can create an EPD for a unit volume of concrete that takes into account all the energy, materials, and emissions related to the manufacture of the concrete. However, there are infinite possibilities for the use of that concrete once it leaves the plant gate. It could be used as a sidewalk, in a wall, as a bridge component, as a pavement, or many other applications. An EPD for a product like concrete or steel is typically in a B-to-B format. It accounts for all the environmental impacts from the cradle to the gate, but it does not include environmental impacts related to the use phase. Thus, B-to-B EPDs should not be used for comparisons among products.

B-to-C EPDs, alternatively, do account for all the environmental impacts for the full life cycle. These types of EPDs are typically created for products that have a known use in a building context. Think of products like carpet, windows, or doors. It is much easier to model the full LCA of these products because it is known how these products will be used in the structure.

New Tools, More to Learn

Designers are getting more sophisticated in their understanding of environmental impacts and sustainable design. Tools that assist in that understanding, such as LCA and EPDs, are robust but complicated, thus it is important to understand them fully. This article has shown that LCA and EPDs can show different results depending on the system boundary chosen, the quality of the data, and the timeframe selected for comparisons. Thus, the best way to evaluate the full environmental impact of a product is through a cradle-to-grave, ISO-compliant LCA.

References

1. International Standards Organization (ISO). 2006. Environmental management—Life cycle assessment—Principles and framework. ISO 14040, ISO, Geneva, Switzerland.
2. ISO. 2006. Environmental management—Life cycle assessment—Requirements and guidelines. ISO 14044, ISO, Geneva, Switzerland.

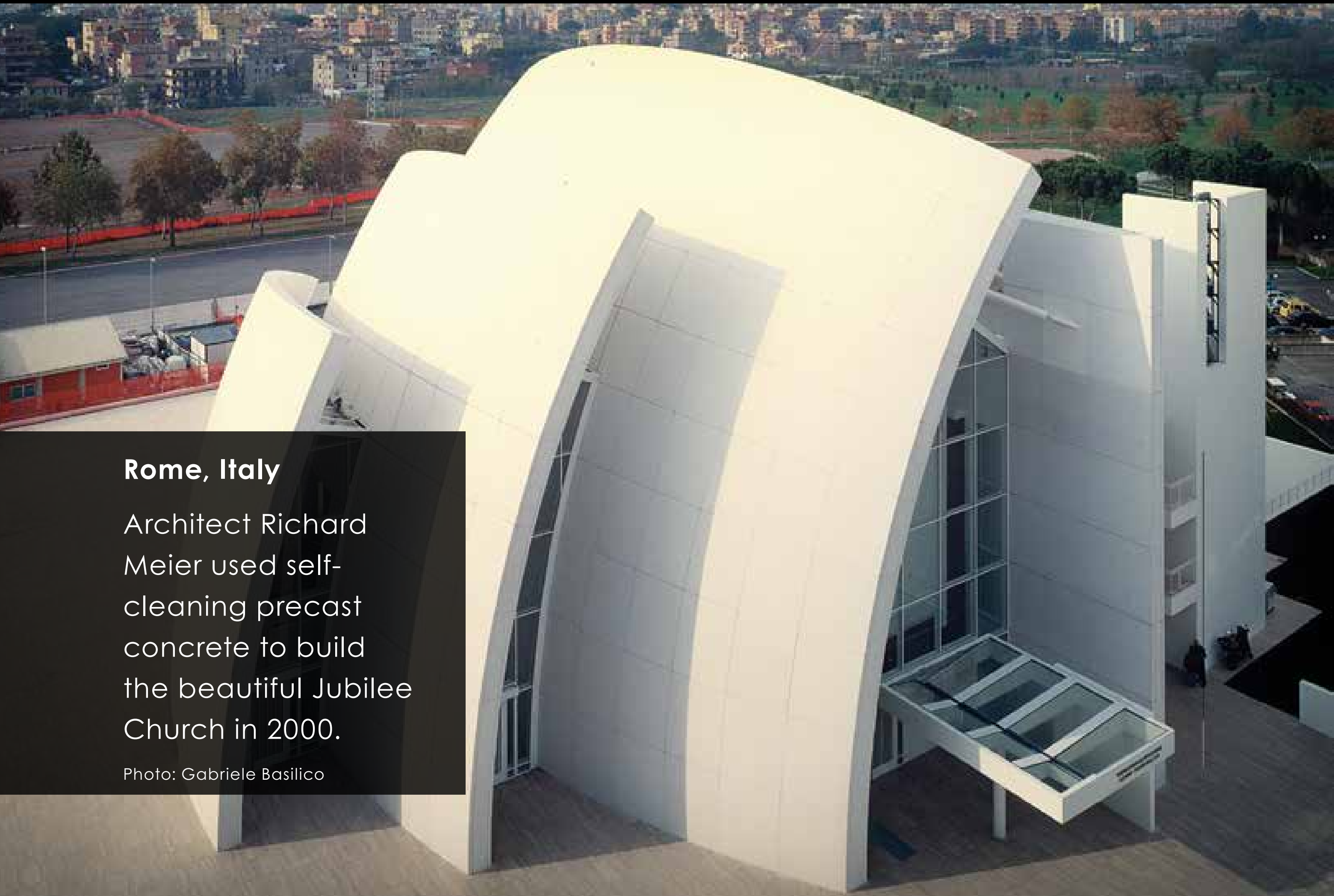
For more information on these or other projects, visit www.pci.org/ascent.

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

Precast's Versatility Aids Variety of Healthcare Needs

Healthcare facilities' wide variety of functions can be met using distinctive exteriors and high-performance structural systems

— Craig A. Shutt

Healthcare facilities require highly functional spaces, and no two are alike. Some need operating equipment, others focus on research and highly sensitive testing machinery, while others are stocked with heavy fitness paraphernalia. High performance precast concrete can help meet this range of needs with total-precast concrete structural systems and architectural precast concrete envelope systems.

As owners of healthcare facilities respond to the ramifications of the Affordable Care Act, they are finding that their needs are changing and expanding. As a result, more are reviewing their space and functional needs, as well as the image they are presenting to an expanding universe of clients.

The following projects give an indication of the range of functions being provided around the country by healthcare properties, and how high performance precast concrete is helping them meet a wide range of distinctive challenges.

University Science Building

The new Health & Biomedical Sciences Building at the University of Houston (UH) houses a variety of disciplines, highlighted by the school of optometry's diverse functions in research, surgery and eye care. To convey that focus, designers used several façade materials to convey the intricacies of light in unique ways. These included architectural precast concrete panels with sloping and rising triangular patterns in various degrees that create a multitude of peaks and valleys in horizontal bands.

The six-story, 167,000-square-foot complex serves as a touchstone for the campus' southeast corner. "The building's form and orientation maximize visibility and establish institutional identity for the academic and clinical optometry programs while signaling a visitor's arrival on campus," explains Luke Voiland, design architect at Shepley Bulfinch Inc. "The façade's design inspiration was drawn from several optical effects produced by the interaction of sunlight with the architectural materials."

The building houses light-sensitive research facilities, academic offices and classrooms, and surgery units for cataracts and LASIK operations. Fitting these functions into the building's design was complicated by the area's tendency to flood, Voiland notes. Initial plans to put the research functions below grade were scuttled by the possibility for flooding, but locating them higher precluded the inclusion of windows on those levels. Placing HVAC equipment above ground also created the need for two interstitial levels in the center of the building that likewise would not have fenestration.

"Window placement became a key issue," Voiland notes. Patient and exam rooms required small windows, but larger windows were desired at the entry to provide a welcoming appearance. "Precast concrete's aesthetic versatility aided in creating a design that could enliven the large areas of windowless spaces while creating a strong visual effect that worked with the other materials being used."

Designers wanted to mix fritted glass, limestone banding, and geometrically shaped precast concrete panels to create illusions to light and visual effects, he explains. "Our goal was to be very interdisciplinary in choosing these materials to create a simple system that appeared complex to the eye. We wanted to create a high-design aesthetic, but on a much tighter budget."

'We wanted to think systematically about how to vary the appearance'

Precast Planes Unite

The precast panels feature three planes that come together at different points to create depressions and elevations of 3 inches in either direction. The varying focal points for the planes create a variety of shadowlines as the sun moves through the sky. "We wanted to think systematically about how to vary the appearance and were worried about cost," he explains. "But the precaster explained that the face design wasn't important as long as the panel sizes and connections remained consistent. That was a big help."

The designs were created after reviewing options through three-dimensional, computer-generated layouts. Animations also were created, showing the varying effect as the sun moved across the face of each design option.

The geometric slopes were created with wooden blocks set into the forms, says Nick Faeber, project engineer at Coreslab Structures (Texas), who provided the precast. The panels were cast in 21-foot-long forms, with one form used to create pieces with 3-inch valleys while the next would provide the 3-inch peaks. At each end of the form, a transition was created

PROJECT SPOTLIGHT

University of Houston Health & Biomedical Sciences Building

Location: *Houston, Tex.*

Project Type: *University research/laboratory/medical building*

Size: *167,000 square feet*

Cost: *$54.6 million*

Architect of Record: *Bailey Architects, Houston, Tex.*

Designer: *Shepley Bullfinch, Boston, Mass.*

Owner: *University of Houston, Houston, Tex.*

Structural Engineer: *Haynes Whaley LLC, Houston, Tex.*

Contractor: *Tellepsen Builders, Houston. Tex.*

PCI-Certified Precaster: *Coreslab Structures (Texas) Inc., Cedar Park, Tex.Precast Components: 172,260 square feet of panels with custom patterns in a typical size of 6 by 21 feet|*

Architectural precast concrete panels cast with a variety of sloping and rising triangular patterns in various degrees create a multitude of peaks and valleys in horizontal bands across the façade of the new Health & Biomedical Sciences Building at the University of Houston. To acknowledge the building's specialty in eye-related medical research, the façade creates optical effects as the sun passes over it during the day. Photos © Nic Lehoux.

from peak to valley or vice versa. In one instance, the precaster cast a negative of a finished piece to serve as the form for the next piece, exactly matching the shape.

"These were complicated pieces with a number of variations as to where the peaks and valleys began in each triangular slope," Faeber says. Every other floor used similar designs to improve repetition and reduce costs without creating an obvious pattern to the design. The result was a half-dozen variations in the slopes that repeated at different lengths.

Color consistency in the panels was a key concern for the designers. Bailey Architects Inc. (BAI), Architect of Record, coordinated with Shepley to develop 12-inch-square samples that evaluate color and texture. Once approved by the UH design committee and Tellepsen Builders, the precaster provided a 48-inch-square control sample at the jobsite for review by the design team and owner's representatives. When the larger sample was approved, five panels were produced and reviewed at the plant. "Not only was the match to the control sample spot on, but the color consistency among the panels was remarkable," says Mark Boone, BAI's project manager.

The interstitial floors housing the building's HVAC equipment are 8 feet tall, providing a different banding effect at the building's mid-level. These levels include single-pane glazing installed at the owner's request. "We tried to match the transparency and reflectance of each window section despite the varying layers of glass," Voiland says. In the end, the differences add more visual complexity to the façade.

Limestone blocks were installed at the entry, providing another texture. "The contractor decided to use limestone rather than replicate it in precast concrete to provide a true texture," Voiland says. That created some challenges in aligning the pieces and added congestion to the site during the construction of the envelope. "We probably should have done it with precast concrete off-site and achieved the same goal."

The erection moved smoothly, with the panels matching up at their transition points as planned. The panels were connected column-to-column using a knife plate embedded in the cast-in-place frame, which fit into pockets cast into the back of the panels. The panels rest on the knife plates, avoiding any concerns with deflection that could disrupt the horizontal flow of the geometric slopes. The panels were stacked two at a time onto the plates and tied to the beam at their centerpoints.

Two tower cranes picked the panels from delivery trucks to erect them quickly. "It was really amazing how quickly they went up," says Voiland. The 172,260 square feet of precast panels were erected in four months.

The new science center connects to an existing masonry and precast concrete building to provide better access and flow to the new facility. A steel-frame bridge was created by removing some of the precast panels from the existing building and connecting the bridge to the structure,

Photo: Paul Brokering Photography.

Speed of construction was a key reason architectural precast concrete insulated sandwich wall panels were chosen to clad Mercy Medical Center's new Birthing Center in Williston, N.D. The design was value-engineered after owners decided to use the building to set a new aesthetic plan for its campuses. Thin brick was cast into the panels as laying brick in the short construction season with a limited labor supply would have added time and money.

PROJECT SPOTLIGHT

Mercy Medical Center Birthing Center

Location: *Williston, N.D.*

Project Type: *Hospital*

Size: *39,185 square feet*

Cost: *$15.27 million*

Designer: *Davis Partnership Architects, Denver, Colo.*

Owner: *Catholic Health Initiatives, Williston, N.D.*

Structural Engineer: *Structural Consultants Inc., Denver, Colo.*

Contractor: *J.E. Dunn Construction, Denver, Colo.*

PCI-Certified Precaster: *Stresscon Corp., Colorado Springs, Colo.*

Precast Components: *120 pieces of acid-etched, insulated wall panels in a typical size of 8 by 18 feet* after which the panels were reconstructed around the bridge.

The result is a distinctive design that provides a different appearance throughout the day without breaking the budget—or the schedule. The designer is currently working on a project with a similar concept for its precast concrete panels for an ambulatory care center in Bridgeport, Conn., where the panels also will be insulated.

"We're making the appearance more complicated this time," Voiland says. "Now that we have some experience with what precast concrete can do in these cases, we're upping our game."

Birthing Center

The Mercy Medical Center's Birthing Center in Williston, N.D., was created to accommodate the rapidly growing community's need for a number of medical services. The 39,185-square-foot Ambulatory Care Center features both an outpatient surgery center and a birthing center, as well as an enclosed walkway that connects the freestanding building to the existing hospital. To welcome patients to this new facility, designers chose a façade featuring architectural precast concrete insulated sandwich wall panels that provided a new design style for the hospital's facilities.

"The original plan was to provide a traditional brick veneer to match the 1970s style of the existing hospital campus," explains Tina Du Mond, project architect with Davis Partnership Architects. "But the owners decided to take a new direction for the campus, and that allowed us to incorporate some Midwest style into the design."

The change opened the door to new materials, and precast concrete panels quickly became the front-runner for the façade. "We liked precast concrete because it could be erected quickly, which was a key strength due to the short construction season in North Dakota," she says. "There also is a local labor shortage and a lack of housing in the area, which would have made it extremely difficult and costly to obtain the necessary labor force to deliver the multiple trades required for a stone façade."

Accelerated construction was a key factor, as the building had to be delivered on "an extremely fast-track, 12-month construction schedule," says Chris K. Brown, the project architect who oversaw the project as it progressed. "Using precast panels manufactured off-site allowed us to enclose the entire structure in just 12 days. That facilitated a much easier construction process during the winter months, allowing us to frame the building within an already enclosed structure."

The precast concrete panels also aided with a key challenge: designing the facility's fenestration and helping to create a smooth pattern. "Windows are a huge driver in healthcare design," explains Du Mond. Regulations require them in patient rooms, while other areas work best with no light coming in. Meanwhile, access points and lobbies typically are designed to be bright and airy, requiring a balance among all the functions. The panels were fabricated by Stresscon Corp., which worked with construction manager J.E. Dunn Construction and the architect beginning early in the design process.

Designers used precast concrete's aesthetic versatility to develop three textures in the precast panels at the building's entrance, resulting in a welcoming appearance. A standard formliner texture in a 2- by 4-foot customized size was used to cast a chiseled-stone appearance that was used along the base and in one wing of the center. These panels were acid-etched and contained an integral red pigment to achieve the final stone-like look.

The main section of the center features two additional finishes, a buff tone and a darker buff color, which were created by acid-etching panels cast with a mix of white cement and special aggregates. "We achieved the design we wanted by putting no more than two colors onto the face of one panel while using three colors throughout the center," says Brown. "That made the fabrication less complicated and kept costs down." Sample panels in a 2- by 2-foot size were cast for review, with the stone formliner approved on its first iteration.

Two-story vertical fins were inset into the panels along the façade to emphasize the verticality of the space and allude to the large cross installed on the curtain wall at the center's entry. That curved glass space is flanked by precast panels, with a porch roof jutting out of the face and supported with stone columns. "The cross is the first impression visitors have as they approach the center, and we wanted to express that theme on the other façades," Brown says.

The glass and precast concrete interfaced well, with no connection issues during erection, he notes. The site had no restrictions, so the crane could move quickly to erect each piece. The 120 precast concrete panels were erected in less than three weeks.

Insulated Panels Offer Efficiency

Providing the level of energy efficiency the owners required was a key challenge. The insulated sandwich wall panels feature $2^1/_2$ inches of polyisocyanurate insulation sandwiched between two wythes of concrete, achieving an R-17 value.

"We worked closely with the architect on the insulation design to ensure there was a continuous insulation layer," says Chris Montoya, project manager for Stresscon. That was easily accomplished on the long straight planes, but corners provided more of a challenge. "We determined how to ensure the insulation turned the corner with butt joints that backed out of the panel. The plan worked very successfully to ensure there were no gaps."

Another challenge came in delivering the panels to North Dakota from the precaster's Colorado Springs, Colo., plant, a distance of more than 700 miles. Panel sizes were limited to 8 by 18 feet to avoid any restrictions during transport across several states. "It was a long distance, but the precast concrete panels delivered the highest quality product possible due to the ease of control that off-site production affords," Brown explains.

We worked closely with the architect on the insulation design to ensure there was a continuous insulation layer.'

"Timing the arrival of panels was difficult over such a long period, so the panels were staged at the site until needed, Montoya says. That helped ensure the schedule was met in the short time frame available.

"It was a great benefit to have the contractor and precaster on board early in the design process to help work out design efficiencies," says Brown. "It made it very easy to check details early on and ensure we were going in the right direction."

The project has proven successful, to the point that the precaster is working with the same construction team—owner, architect, and contractor—on another medical center and office building in Dickinson, N.D.

The owners were pleased with what the precast concrete panels could achieve, Brown notes. "The precast concrete solution for this project allowed us to deliver the project on time while accommodating the unique challenge of working in an oil-boom economy with a severe lack of labor and almost no available housing, while fully enclosing the structure before the onset of what was a harsh North Dakota winter."

Wellness Center

Health and wellness facilities are expanding beyond traditional locations and reaching deeper into neighborhoods today. Synergies among companies can add to their attractiveness. An example can be seen in the New Brunswick Wellness Plaza in New Brunswick, N.J., where a new mixed-use building comprises a fitness and health-education center, a socially responsible supermarket, and a 1,200-space parking facility above them. The building features a high performance precast concrete structural system that met the varying challenges that each function required.

Within the Wellness Plaza, the Robert Wood Johnson Fitness & Wellness Center, operated by the nearby Robert Wood Johnson University Hospital, consists of 60,000 square feet of fitness services, including cardio and strength-training equipment, fitness and dance studios, lockers and showers, sauna, steam rooms, three pools, and meeting rooms. The center provides professional fitness assessments and health-education classes as well as personal trainers. Alongside the center is a 50,000-square-foot Fresh Grocer store, which sells affordable and healthy food options. The fitness center, with its large pool area, and the supermarket are located on the first two levels, with six levels of parking above.

The holistic theme brings with it options for more healthful lifestyle choices for residents in this up-and-coming neighborhood. "Typically, urban dwellers find it difficult to access supermarkets due to infrastructure and spacing challenges," explains Glenn Kustera, structural engineer at PS&S Architecture/Engineering Inc. "The surrounding community benefits by having affordable and nutritious food options."

The designers considered a variety of framing systems for the project, but quickly realized that keeping a consistent building system for the entire structure worked to everyone's benefit. "The majority of the structure

> The precast system provided simplicity in design, long-span, column-free areas, faster erections, fewer pieces to erect, and a consistent building system.'

is a parking garage, and everyone is used to seeing that as precast concrete," Kustera explains. "But using a parking system, with double tees, for the supermarket and wellness centers is not as typical. It was nice that the precast concrete solution wound up being the most economical system not just for the parking, but for the first-level, two-story tall facilities."

The precast concrete system provided a number of key advantages to all of the functions, Kustera notes. "The precast system provided simplicity in design, long-span, column-free areas, faster erections, fewer pieces to erect, and a consistent building system."

A key benefit for using the precast concrete system for the lower spaces was in the wellness center, where long-span double tees support the floor. The facility often is used for large aerobic and step classes, which could cause vibrations throughout the center. "With the precast concrete system, the double tees provided a solid floor system," Kustera says. "The owner is happy."

The spandrel panels feature a buff-colored finish with horizontal reveals used as banding. Some of the panels were stained in the plant to provide a different appearance. Upper levels feature solid panels with cut-outs to replicate windows, giving the building less of the look of a parking structure.

Helix Ramp Creates Challenge

A major challenge came in working around the variety of obstructions on the first floor to erect the higher levels. The key area of concern was around the ramp that is positioned directly over several wellness-center facilities, including an Olympic-sized pool and the Jacuzzi pool. The cast-in-place concrete helix was poured, cured, and brought up to strength before the precast concrete columns could be erected. The erectors worked in other areas as that work continued, with the intent that it would be ready when the construction reached it.

A 40-foot-deep concrete transfer girder spans the pool and supports some of the columns that support the six levels of parking above. The helix featured 2-foot-wide, V-shaped walls along its perimeter that curve along with the helix as it rises. "We had to cast and erect columns that could be positioned onto these supports that were essentially four stories in the air," explains Mike Achilles, High Concrete's northern regional sales director. "This was the most challenging part of the project by far, but it worked out well."

Kustera agrees. "If there would not have been a way to make the helix space work, it might have been a very different looking project. It was a matter of inches to make all this work within the footprint of the very tight, complex site.

The other challenge came from site restrictions caused by working within 30 feet of Amtrak railroad lines. The lines cut along one corner of the building, causing the top five levels to be erected at a skewed angle rather than come to a right angle to accommodate the tracks. Guy cables were used to direct and position components on this corner, according to Bo Kusznir, CEO/president at Precast Services, which erected the precast. "We used a crawler crane that had to

Photo: High Concrete Group LLC.

Photo: PS&S LLC.

Photo: PS&S LLC.

wick, N.J., combines a fitness and health-education center, a socially responsible supermarket, and a 1,200-space parking facility above them. A total precast concrete structural system was used to blend the functions while meeting site challenges that included nearby railroad tracks that cut off one building corner and a cast-in-place helix ramp that required precast structural components to be set above it.

Photo: High Concrete Group LLC.

PROJECT SPOTLIGHT

New Brunswick Wellness Plaza

Location: *New Brunswick, N.J.*

Project Type: *Mixed-use building with wellness c enter, supermarket and parking*

Size: *612,704 square feet*

Cost: *$60 million*

Designer/Engineer: *PS&S Architecture/Engineering Inc., Warren, N.J.*

Owner: *New Brunswick Development Corp., New Brunswick, N.J.*

Contractor: *Joseph Jingoli & Sons Inc., Lawrenceville, N.J.*

PCI-Certified Precaster: *High Concrete Group LLC, Denver, Pa.*

PCI-Certified Erector: *Precast Services Inc., Twinsburg, Ohio*

Precast Components: *Total precast concrete system, including double tees, interior and exterior columns, beams, light walls, exterior shear walls, solid slabs, stairs, and load-bearing and nonload-bearing spandrel panels.*

move down pretty narrow streets and work pretty high in the air to make it work."

To provide the required fire separation between the first-floor functions and the parking levels above, the precaster supplied double tees with a 2-hour, fire-rated flange. These were covered with a waterproofing membrane and a 3-inch wearing slab. A shock-bearing pad also was included to help mitigate vibrations further. "We've done a number of mixed-use projects, so we're familiar with the challenges of combining various functions," says Achilles.

The project has been well received—so well, in fact, that a 15-story mixed-use project including residential space is being built across the street by the same precaster. "The Wellness Center has led to more interest in the precast solutions that can help New Brunswick," says Achilles.

Adds Kustera, "The structure is a great example of a multi-use, "total-precast" concrete building that helps the community incorporate healthy lifestyle choices into everyday life. The new facility gives the city a lift by providing residents with a sense that there is an interest in improving their community. The precast concrete system played a very important role in making this a successful project for the owners and the end-users."

Heart Hospital

Moisture management, sustainable design, accelerated construction, congestion minimization, and other benefits led designers on the Sanford Heart Hospital in Sioux Falls, S.D., to specify a high-performance, architectural, precast concrete envelope system with embedded thin brick for the façade of the hospital's new facility. The 213,000-square-foot building consolidates cardiac programs under one roof, housing physician offices, outpatient testing, surgical services, laboratories, and consultation services. It includes 58 inpatient beds, operating rooms, clinic, and outpatient services.

"The goal was to maximize convenience for patients and their families," explains Michael Kennedy, design director for AECOM. The building connects to the lobby of the existing medical center, serving as a supplement that also connects to parking via a below-ground concourse. Administrators also wanted to create an energy-efficient design that promoted sustainable design and encouraged a healthy living environment.

To achieve these goals, designers specified architectural precast con-

PROJECT SPOTLIGHT

Sanford Heart Hospital

Location: *Sioux Falls, S.D.*

Project Type: *Hospital*

Size: *213,000 square feet*

Cost: *$75 million*

Designer: *AECOM, Minneapolis, Minn.*

Owner: *Sanford Health, Sioux Falls, S.D.*

Structural Engineer: *AECOM, Minneapolis, Minn.*

Contractor: *Henry Carlson Co., Sioux Falls, S.D.*

PCI-Certified Precaster: *Gage Brother Concrete Products, Sioux Falls, S.D.*

Precast Specialty Engineer: *E-Construct, Omaha, Neb.*

Precast Components: *936 pieces including brick clad spandrels and rock-faced base panels, along with 42 pieces for the Portochere.*

A number of benefits accrued from using architectural precast concrete panels embedded with thin bricks to clad the Sanford Heart Hospital in Sioux Falls, S.D. Significant time was saved by eliminating the need for masons and scaffolding on the site, as well as by using precast concrete's casting capabilities to eliminate a complicated structural framing for the clock tower and create monolithic bay windows in the tower. Photo: Robb Williamson, AECOM.

crete panels with embedded thin brick. The panels not only helped minimize energy concerns, but their aesthetic design helped create a "Collegiate Gothic" style for the campus, and for the hospital system in general, as part of a new master plan. Initially, the owners had expected to use conventional full brick with steel-stud backup, matching other buildings. But the design suggested by precaster Gage Brothers Concrete Products provided a number of key advantages.

"It was a very tight site on a large host campus, so site disturbance and space for a masonry crew did not make sense," says Kennedy. The facility also was located at the front of the campus, near the main entrance and the trauma center, and masonry scaffolding and equipment would have created obstacles for visitors. "The owners were surprised to find that the thin-brick embedded precast concrete not only solved the site problems but substantially cut on-site work and saved the project more than $1 million."

In addition, casting the brick into the panels off-site while other work progressed cut approximately four months from the schedule, he estimates. "The panels also reduced the project's cost by not requiring the heat and shelter necessary to install traditional brick in the cold winter months."

Using monolithic panels, in a typical size of 7 by 34 feet, also improved moisture control. "The precast provided much better humidity management for the hospital. With all of the brick banding, the moisture control would have been a major challenge with a conventional system. Integrally casting the banding within the precast panel system solved this problem." Improved moisture control reduces the potential for mold and mildew, helping improve indoor environmental quality.

The masonry facing consists of a four-brick blend, says Tom Kelly, president of Gage Brothers. "The hospital campus had been added onto over 75 years, so there were a variety of bricks used," he explains. "Our goal was to find a combination that complemented the surrounding buildings overall." The brick was used for more than 95,000 square feet of panels, including the adjacent clock tower and the porte-cochere that marked the entry.

Setting Arched Windows

A key challenge in casting the panels was casting blockouts for large, arched windows into the panels and laying the brick around them. Although similar in shape, many different sizes of windows were involved, requiring form changes. The windows feature red precast concrete surrounds outlining the fenestration along with redstone banding through the infill sections between windows.

The window arches were separated by infill sections cast between them to create panels of varying lengths, Kelly explains. An 8-inch band of concrete remained consistent at the top and bottom of the panel, with sides filled in as needed. Panels were varied in length from 12 to 18 feet to maximize efficiency of infill and window shapes. More than 100 window openings were cast.

> 'The thin-brick embedded precast concrete not only solved the site problems but substantially cut on-site work and saved the project more than $1 million.'

"It was challenging to create the surrounds and provide sufficient infill to create an efficient panel size in all cases," he explains. "But achieving this goal cut the piece requirements by hundreds. It also saved time in erecting the pieces and in the number of joints to be caulked."

Another savings was created in the design of bay windows provided in three stories of the massive clock tower that serves as a focal point, directing visitors to the adjacent entry under a precast concrete porte cochere. Gage Brothers cast integral sides, roofs, and floors for the bay windows, nicknaming them "clamshells." The design features an 8-foot-wide face, projects out 3 feet, and required no additional backup structure.

"The precaster provided a solution that saved a month of the schedule on the clock tower structure alone," says Kennedy. "By utilizing precast, the project was able to save tons of steel that would have been required with a conventional brick-and-stud system."

Solving Tower Backup System

The free-standing clock tower structure itself created some structural issues, rising five stories and topped with a three-story belfry with $2\frac{1}{2}$-story inset arched decorative element that includes an illuminated logo. "The large, elaborate clock tower created a challenge in designing a backup system," especially with the octagonal columns at each corner, Kennedy says. The original plan was to use brick on steel studs, requiring a huge backup system that would have extended the schedule, congested the site, and added cost.

The precaster solved the problem by stacking two levels of precast concrete panels at the base and then hanging the remaining levels from a structural steel frame. "There were too many ins and outs in the structural design to stack-load all of the panels," Kelly says. Adds Kennedy, "The self-supporting spanning nature of the precast panels eliminated the need for any backup structure and resolved the issue."

Brick-embedded panels were used to clad both the interior and exterior sides of the three-sided porte cochere, with redstone accents used to outline the arch and on the thickness of the panels facing each entry. The panels in this area are load-bearing, carrying the roof system. "The entry area is an entirely self-supporting structure," says Kelly.

Despite the significant size of the project, the erection moved smoothly. The 978 pieces were fabricated in about five months, with the first pieces erected before the final pieces were cast. The erection took approximately 100 days in several phases to complete.

The finished project provides efficiency, comfort, and a higher level of service for patients while offering benefits to hospital administrators and the staff. Best of all, the benefits will continue into the future, Kennedy notes. "Precast concrete reduced the long-term, life-cycle costs of the hospital, as the owner will never have to tuck-point the brick-clad precast panels."

It also opened eyes and minds in the area, notes Kelly. "The project is a true testament to the idea that you can do any type of structure with thin brick embedded precast that could be done with full brick, and you can do it faster and more economically."

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

Precast Design Provides Structural Versatility

Precast structural system on skilled nursing center in Denver saves time and material while meeting all of the facility's specialized needs

— Craig A. Shutt

Physical-therapy facilities are expanding their capabilities to better serve patients, providing more in-depth services that bridge the gap between hospital stays and returning home. The Center at Lincoln in Parker, Colo., provides those services, after community members in the Denver suburb decided existing facilities weren't sufficient. The design-build team chose a precast concrete structural system (or total precast system) that provided the structural and aesthetic versatility that the skilled nursing center needed to meet its goals.

The center, which features 96 private resident rooms, provides physical-therapy services of all types to patients who no longer need on-going hospital care but require full-time services prior to returning home. It offers a variety of facilities for occupational and speech therapy, as well as complex nursing care. The 80,000-square-foot center includes a 4,000-square-foot gym, fine-dining kitchen, media/theater room, multiple activity rooms, and an outdoor therapy garden. Patients stay a minimum of five days and receive up to 720 minutes of therapy per week.

"The center was opened as a result of community members who arrived at the conclusion that the status quo in skilled inpatient rehabilitation

When the original steel and masonry design for The Center at Lincoln, a skilled nursing facility in Parker, Colo., proved economically unviable, a total precast concrete system was used. It consisted of 64-foot-long double tees, columns, beams, and load-bearing architectural wall panels. Photo: Rocky Mountain Prestress.

The two-story, upper-level panels feature a darker color in a flagstone texture, while the first floor used a buff-colored limestone look with wide reveals. The rectangular pattern continued onto all four sides of column covers on the entry colonnade. Photo: Rocky Mountain Prestress.

was inadequate to satisfy patients' needs," according to a center spokesperson. "Prior to its opening, patients who required skilled nursing and rehabilitation had few choices other than be admitted to a traditional nursing home. The center provides additional choices to patients seeking rehabilitative care."

The developer, Development Solutions Group, tasked the design-build team with evaluating multiple framing and building-skin systems to find the one that best met the nursing center's needs. "We looked at a variety of options, and it came down to steel and masonry versus precast concrete," explains Gary Constant, vice president of preconstruction services at GH Phipps, which led the construction team on the design-build project. The key driver was the architectural standards set by the business park in which the center was located. Those required a brick or stone exterior appearance.

"Once it was set that we needed a high-end finish, we gravitated to the precast concrete option for the benefits it could provide." Phipps then worked with precaster Rocky Mountain Prestress (RMP) to consider formliner and color options to create a variety of finishes. Once that was set, moving to a total-precast concrete system was a simple matter, he says.

> We always go for the precast concrete structural system if we're using architectural panels.'

"We always go for the precast concrete structural system if we're using architectural panels," Constant says. "They can make the panels load-bearing and cast a lot of double tees very quickly, which makes them economical."

RMP provided 64-foot-long double tees with 24-inch stems, which added more benefits. "This design eliminated an entire beam and column line in each wing while creating virtually column-free spaces," explains Mike Hemberger, director of business development at RMP. "The single-span double tee provided a very efficient, cost-effective member."

Creating clear spans not only provided interior design flexibility but eliminated the need for foundations in the center of the building, where poor soil conditions would've made them more complicated, Constant says. "Pouring foundations only for the perimeter saved us time and money."

PPROJECT SPOTLIGHT

The Center at Lincoln

Location: Parker, Colo.

Project Type: Skilled nursing facility

Size: 80,000 square feet

Designer: HDR Inc., Denver, Colo.

Owner: Development Solutions Group Ltd., Denver, Colo.

Contractor: G.H. Phipps Construction Cos., Greenwood Village, Colo.

PCI-Certified Precaster: Rocky Mountain Prestress Inc., Denver, Colo.

Precast Specialty Engineer: FDG Inc., Arvada, Colo.

Precast Components: Total precast concrete structural solution including columns, beams, 64-foot double tees and load-bearing architectural panels

Two-story bay windows reflect the rounded curtain wall used at the entry. The windows rest on a curved precast concrete slab that cantilevers off the wall panels. Photo: Rocky Mountain Prestress.

The design consists of precast concrete columns, beams, double tees, and related structural components supported with load-bearing architectural precast concrete panels with multiple finishes. "The load-bearing design provides vertical support plus lateral restraint," Hemberger explains. "This approach provides an efficient, durable design that's easy to erect and very attractive." The designers also used grouted couplers and intermediate shear walls to enhance foundation efficiencies.

Two Wings Aided Repetition

The building features four wings projecting out at an angle from the central glass-enclosed curved entry at the center. "The wings are almost identical in design, so they allowed for a lot of repetition in casting panels," notes Degan Hambacher, president at FDG Inc., the precast concrete specialty engineer. "That sped up construction and made the design more economical."

The wings' angle creates a curved, welcoming shape that draws visitors to the entrance. The entry's curved curtain wall on the upper two floors cantilevers off prestressed precast concrete supports and sits on a cast-in-place ledge. "There were some gymnastics needed to create the curtain wall at the colonnade, but Rocky Mountain did a good job accommodating the needs," says Constant. "We worked closely with the engineer, precaster, and specialty engineer to ensure that constructability remained a key goal throughout the process."

A curved cornice was added to the panels on the top floor, creating a distinctive roofline. Photo: FDG Inc.

One of the biggest misperceptions of precast concrete is that it's not flexible for medical-center designs.

This curved entryway is reflected in curved bay windows on the second and third levels of each wing end. The windows sit on cantilevered precast concrete slabs that match the curve of the window projections. Other fenestration in the center consists of punched windows that were installed once the precast concrete panels were erected.

Two Finishes Featured

The three-story center features two concrete finishes, with a buff-colored, limestone-like appearance on the first level with wide reveals creating block-like rectangles. These walls are supported by slab-on-grade foundations. The design continues onto column covers that support the entrance colonnade, with two architectural half-column panels integrated to form the structural column.

The upper two levels feature a flagstone finish in a darker hue, cast from one of RMP's standard formliners but turned in different directions to ensure no two adjacent blocks had similar textures. A complementary band of the buff-colored texture separates the two floors and lines the roof line, where an integral overhanging cornice provides definition. "The cornice detail is a standard feature we can provide, but we don't often get the opportunity," says Hemberger. "It adds a nice complex feature, and we enjoy adding those details whenever we can."

The panels were cast to clad each floor separately, but many required several finishes, reveals, and cutouts. "We were able to cast panels with two colors and a variety of details without any problem, which created more efficient pieces to be picked and erected," says Hemberger.

Penetrations No Problem

Laying out interiors provided no unusual challenges, says Hambacher. Sensitive equipment is located on the first level, which consists of slab-on-grade flooring, so the double tees didn't have to account for vibrations, he says. Providing the required penetrations for utilities and other services created no problems, despite initial concerns by the architect that the double tees would limit penetrations options.

"One of the biggest misperceptions of precast concrete is that it's not flexible for medical-center designs dealing with MEP coordination and future modifications and load changes," Hemberger says. "This project demonstrates that this is not necessarily the case. The MEP coordination went very well on this project."

The key concern was that patient-room layouts on the upper two floors required bathrooms to be located in specific locations. "We were told that no plumbing could be moved, and we had to move stems to accommodate the plumbing," Hambacher explains. To accomplish this, blockouts were cast into the stems at key locations, allowing plumbers access to the penetrations. They installed elbows that then ran alongside the stems.

In some cases, double-tee positioning was reworked. "We could adjust our modules if needed to create the floor penetrations they needed," Hemberger says. "It worked very cleanly in the end." The 10-foot-wide double tees were adjusted by as much as 2′2″ in width to avoid any conflict of penetrations with the tee stems. "We can crop one wing and move it to accommodate whatever needs there are."

Levels were designed to be 14 feet tall, with dropped ceilings installed beneath the two-foot stems. The plenum provided sufficient space for mechanical needs.

The open site allowed for fast erection of components, with two cranes used to erect the two wings simultaneously. This accelerated construction, allowing the facility to open earlier. "The panels erected just like a layer cake and went very quickly," says Hemberger, whose company also did the erection.

Speed a Key Factor

That speed was a key factor in choosing the precast concrete system, notes Constant. "The hard costs between the steel-masonry-fireproofing option versus precast concrete were fairly neutral," he explains. "But the precast provided a lot of added benefits, especially in speed of construction. The precast design took six weeks off the schedule, which meant six fewer weeks for the developer to carry loans and interest on the development. That tipped the scales, because we could save time and money."

'The precast provided a lot of added benefits, especially in speed of construction.'

Panels feature several colors, reveals, and a variety of cutouts. Combining colors and textures into one panel reduced the piece count and sped up the erection process. Photo: FDG Inc.

Blockouts were cast into some of the double tees to allow penetrations that plumbers could connect to an elbow, allowing plumbing to remain set in the design. Photo: FDG Inc.

The precast system also eliminated scaffolding from the site, improving safety and allowing site work and landscaping to begin earlier. "That's really a great benefit," he says. It also provided inherent fire proofing. "We needed I-Occupancy fire rating, and the precast concrete structural provided that at no cost—literally."

RMP had worked for the developer on other properties, so they were familiar with the benefits of precast concrete. But this was the first time the precaster had supplied components for a skilled nursing center. "We do a lot of medical office buildings, but nothing along this line in the healthcare field," says Hemberger. That could easily change as more designers see the benefits that a total-precast concrete structure can provide in energy efficiency, speed, and cost effectiveness.

Constant agreed. "Being involved at the conceptual stage ensured we needed a solution that cured a lot of the challenges, and the precast concrete system did that. It reduced foundation needs, provided a high fire rating and clear interior spans, reduced site congestion, combined all exterior pieces into one supplier, met aesthetic requirements, and finished six weeks early. That's a great combination."

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

The Art and Science of Hospitals

University of Kentucky Hospital uses insulated precast concrete panels to create a high-performance envelope providing energy efficiency, strong aesthetics, faster speed of construction and other benefits

— Craig A. Shutt

Hospitals today are re-examining how to create healthy environments in which patients can thrive and be treated efficiently and effectively. Building-science research and technology are providing better understanding of the materials used to construct facilities and the efficiencies they can provide, leading administrators to look for ways to save money and encourage healthy surroundings. A number of these benefits were provided at the University of Kentucky's Albert B. Chandler Hospital's Pavilion A with the help of precast concrete insulated sandwich wall panels cast with embedded thin brick.

"As the new centerpiece of the hospital, Pavilion A bridges the art and science of medicine, assuring residents access to the best care within a healing environment," explains Thomas Gormley, principal at GBBN Architects, the architect of record on the project. "The University HealthCare's Guiding Principles focus on patients, staff, students, and technology, and these were used as a basis for all design and construction decisions."

The new 1.2 million square-foot facility serves as the "front door"

The new 1.2 million square-foot Pavilion A at the Albert B. Chandler Hospital at the University of Kentucky was designed as the new entry point for the complex, connecting to three existing facilities. Precast concrete insulated sandwich panels helped the building meet a number of its goals. Photo Pease Photography, courtesy of GBBN Architects and AECOM.

to the hospital campus, Gormley explains, unifying the complex and creating a new focal point as visitors arrive. It connects to three existing facilities, including a 1,600-car parking structure. As the new hospital nexus, it needed a dramatic appearance that blended with the existing buildings on the college campus.

"The design goal was to use the facility to enhance patient and family convenience and to make the functions easily comprehensible through orientation and wayfinding and maximize clinical efficiency throughout the hospital."

That orientation began with the siting and arrangement of the major elements at the entry. The lobby connects to the existing buildings as a common point of entry. At the entrance, the circular drop-off and two-story atrium lobby orient arriving visitors and provide a link to the new and old facilities. "The new lobby helps separate the 'on-stage' and 'off-stage' activities of the medical campus."

As patients and families move into the patient tower, a sense of place and orientation is maintained by the curved central lobby. Patient rooms have separate zones for family, patient, and staff. Each zone is planned with the specific user in mind, with the rooms featuring large windows that provide natural light and views. The patient floors have decentralized team stations to allow nurses to work closer to the patients and the point of care.

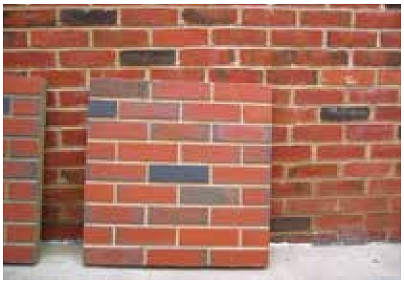
"The design and implementation of this project was a highly successful collaboration between GBBN Architects, AECOM, a fully engaged owner, and numerous engineering and specialty consultants," says Gormley.

Precast Helps Project Image

Projecting the exterior image that sets the stage for this healing environment required considerable advance planning, as administrators wanted a brick cladding with large window openings. The structural framing consists of a seven-story steel frame atop a five-story, cast-in-place concrete frame sitting on concrete piers. It was clad with insulated precast concrete panels cast with thin brick selected to complement the surrounding campus.

The precaster worked on a design-

The new pavilion connects to three adjacent buildings, including a parking structure with a similar brick exterior. Photo Pease Photography, courtesy of GBBN Architects and AECOM.



The precaster fabricated 1,758 panels using a blend of five brick colors. In all, more than 1 million pieces of brick were embedded into the panels. Photos: Gate Precast Co.

The pavilion is one of the largest capital projects the university has ever undertaken and required considerable advance planning. The precaster worked on a design-assist basis for about 1 ½ years before the project began construction, which was completed on a design-build basis. Photo Pease Photography, courtesy of GBBN Architects and AECOM.

PROJECT SPOTLIGHT

University of Kentucky Albert B. Chandler Hospital's Pavilion A

Location: Lexington, Ky.

Project Type: Hospital

Size: 1.2 million square feet

Cost: $352 million

Architect of Record: GBBN Architects, Cincinnati, Ohio

National Healthcare Design Architect: AECOM Inc. (formerly Ellerbe Becket), Minneapolis

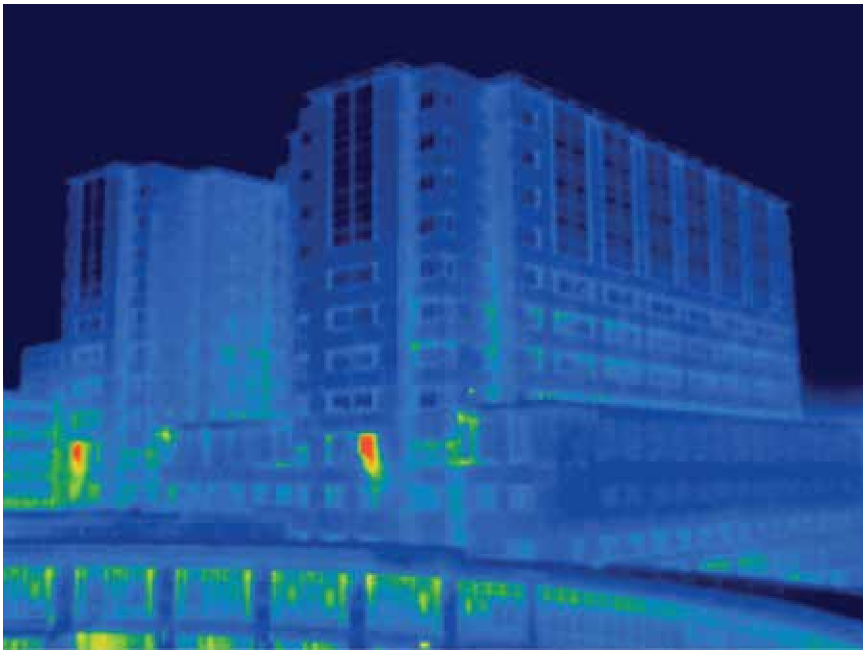
Owner: University of Kentucky, Lexington, Ky.

Structural Engineer: THP Limited Inc., Cincinnati, Ohio

Contractor: Turner Construction, Cincinnati,Ohio

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

Precast Components: 1,758 insulated panels 9 inches thick (4-inch interior structural wythe, 2 inches of polyisocyanurate insulation, 3-inch exterior architectural wythe) in four finishes: embedded thin brick, two finishes of buff-colored limestone like texture, and a granite-like texture.



This post construction thermal image shows the uniform, continuous insulation that was achieved for the hospital, which was a key requirement. The precast concrete insulated sandwich wall panels played a key role in reaching this goal. Photo: Gate Precast Co.

assist basis for about $1^1/_2$ years before the project began construction, which was completed on a design-build basis. "The pavilion is one of the largest capital projects ever undertaken by the university," Gormley explains. "A lot of infrastructure relocation and improvements had to be undertaken to construct the facility."

A major concern was enclosing the entire building quickly so trades could begin work on the complicated interiors and still meet the tight time frame. "The project team was challenged early on to eliminate a year from the construction schedule," Gormley says. "The building's exterior skin was a big component of the construction's critical path, so the need to accelerate construction of it resulted in reviewing all skin options."

The team visited several precast concrete installations to evaluate options and validate that the system could achieve the project's exterior-design objectives, he explains. "Insulated precast panels were selected because they could be erected quickly and had the benefit of providing a finished exterior wall with edge-to-edge continuous insulation." Complementing the panels was a curtain wall and windows that were unitized and installed quickly in the cast openings.

"Scheduling was a key challenge and a primary reason that precast concrete panels were chosen," says Bill Sparks, chief engineer at Gate Precast Company. "If they had tried to use hand-laid brick, it would've taken forever to get it completed, and the site—at the front of the hospital—would have been disrupted for a long time with materials and scaffolding." He estimates the precast panels allowed the building to be enclosed two to three times faster than would have been possible with field laid-up brick, and without the site congestion.

Continuous Insulation Provided

One of the primary challenges addressed in the early planning was the architect's desire for a building that had continuous insulation throughout, with no cold spots created by building material techniques. "It was great to achieve the goal of having continuous insulation before it became a code requirement," Gormley says. That meant not allowing any connections to interfere with the consistency of the insulation layer.

"The need for continuous insulation was one of the biggest challenges on the project," says Sparks. The panels consist of a 3-inch front wythe of concrete, which features another $^5/_8$-inch layer of thin brick; a middle 2 inches of polyisocyanurate insulation with ship-lapped edges, and an interior 4-inch structural wythe. The panels typically were 6'8" tall and 36 feet long. The precast envelope system has a noncomposite design, in which non-conductive fiber-composite connectors penetrate the insulation to secure the front and back wythes of concrete.

The biggest concern came with designing the load-bearing connections, as some of the panels stacked on top of others. That approach created loads up to 25 kips. The design consisted of large, thick plates from which a steel tube projected. "The panels' back face was full of concrete anchors and weldable rebar," Sparks says. "These were heavy panels, and they were heavily reinforced to provide enough support."

The project team was challenged early on to eliminate a year from the construction schedule.'

Prestressing Strengthens Panels

A significant aid to successfully meeting all of the panels' needs was the precaster's capability to prestress the panels. "Prestressing was a significant benefit due to the large sizes of the panels and the thinness of the wythes," Sparks says. Prestressing the panels added sufficient strength to ensure the forces created by stripping the panels from the molds would not crack them.

"The project definitely had its challenges," Sparks says. "But by prestressing the panels in the plant and with insulated and brick inlay projects under our belt, we felt prepared to meet those challenges successfully."

"The insulated system provided a very efficient wall system," Gormley says. "To not have to post-apply insulation in the interior wall assembly saved significant time and provided more uniform coverage. Additionally, with the pre-installed wall system, the owner didn't have to immediately finish floors for future expansions."

Understanding that the insulation represents a drainage plane is important when considering this type of system, Gormley notes. "How that drainage plane meets adjacent systems, such as curtain wall and window systems, and how it is properly flashed where it terminates, are important details that need to be studied," he explains. "Understanding the panelization of the precast with respect to the design intent, and

The brick facade features a blend of five brick colors, requiring more than 1 million pieces in all.

acceptable tolerances to achieve the design intent, are important considerations."

The panelized system provided additional benefits, he notes, including inherent mold and mildew resistance, as well as fire resistance, due to concrete's inorganic composition; minimal maintenance costs over the life of the building due to the panelized design resulting in less joints; high durability; reduced trades on site during construction; and excellent indoor air quality due to the lack of off-gassing or other chemical interactions. The insulated panels also offer noise dampening from exterior sources thanks to its high mass and elimination of air penetration.

A number of additional sustainable-design features were incorporated into the project. These broke down into five key areas:

- General planning, such as aiming for a 100-year service life and creating rooms that can be easily renovated for new purposes.
- Siting, such as ensuring access to public transportation, use of a previously developed site, and inclusion of a green roof that will reduce the heat-island effect and assist in retaining storm water.
- Energy efficiency, such as a highly efficient lighting system with motion sensors and mechanical systems with variable-speed drives.
- Material usage, such as the use of natural, recycled, and easily renewable materials with low VOC content and low-emitting adhesives, sealants, and paints.
- Indoor environmental quality, such as following a stringent air-quality plan during construction, ensuring 75% of public spaces have views outside, enhancing daylighting, and using environmentally friendly refrigerants in chillers.

"The entire project team is proud to have been able to develop these sustainable strategies within the allotted budget and the required schedule," Gormley says. "Each technique provides a return on investment that will bring real savings in the operation while providing a higher level of comfort to the patients, families and staff within the Patient Care Facility."

Precast concrete helped achieve these sustainable-design goals not only in the aforementioned benefits but by reducing construction waste and in using local products and manufacturing products locally. "We used many sustainable principles in the project, but the goal was not to seek LEED certification," Gormley says.

Inlaid Panels Pass Test

With the structural design issues worked out, designers and precaster could turn their attention to the building's aesthetics, he says. "Prior to our specifying the system, the precaster had to demonstrate how the brick-inlaid panels could achieve the look of the hand-set brick and stone used on adjacent buildings."

Gate produced numerous brick blends and mock-ups to provide the reassurances that were needed. "Providing samples is pretty typical, especially on projects of this size requiring brick blends," Sparks says. "Mock-ups are always a key component, and we went through several iterations. But there were no unusual brick lines or courses to follow, so it went smoothly."

The brick façade features a blend of five brick colors, requiring more than 1 million pieces in all. The brick panels are accented by panels in three finishes: two replicating buff limestone with a medium acid-etch finish and a third simulating field-applied granite.

The project was completed on time and on budget. "Precast concrete panels gave us the flexibility to achieve the project-schedule constraints," Gormley says. By casting the panels as site work progressed, the panels were ready for erection when the structural frame was ready and could be erected quickly. In all, 1,758 panels were cast and erected.

The hospital's podium, consisting of the lower five floors, were erected first onto a cast-in-place structure. The steel-framed tower then was clad using a tower crane. Both sections together required only 24 weeks to erect.

The result was a dramatic looking building that welcomes visitors while creating an efficient facility from both logistics and operations standpoints. "The design team's decision to integrate thin-set brick and insulation helped achieve the design objectives," says Gormley. "It seamlessly matched adjacent campus structures, formed a better thermally performing exterior skin, and was produced in an environment where quality of the construction could be better controlled and still take a significant amount of time off the project schedule."

That created a facility that sets a new standard, he adds. "This project serves as a stepping stone for any subsequent project to take a leadership role in the enhancement of our environment, stewardship in the use of facility funding, and the improved quality of life for every user."

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

Only 24 weeks were required to erect the entire structure, including both the podium or base section and the towers. Photo: Gate Precast Co.

Healthcare Facilities of the Future

Designers say major changes to healthcare delivery systems will affect locations, designs, material choices, and other factors

— By Craig A. Shutt

Healthcare has become a high-profile topic with the roiling debates over the Affordable Care Act (ACA) now being implemented. The law, in fact, is one response to what medical executives have seen coming for some time: Dramatic changes in how healthcare is delivered will impact locations, square footage, design, and material choices, among other factors.

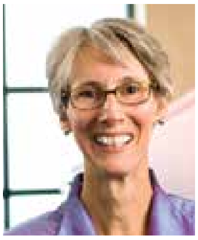
"Healthcare is undergoing an enormous transition now because it's clear that it's not reaching a large segment of the population that needs care," says Ellen Belknap, president of SMRT Architecture, Engineering and Planning based in Portland, Me. "In the United States, healthcare costs are very high, and outcomes don't measure up, especially compared with the care provided in other developed countries."

The gap occurs especially in caring for chronic illnesses that often can be treated easily and less expensively if caught early, she explains. Chronic illnesses take up about 75% of all healthcare costs, consuming about $1.5 trillion from $2 trillion spent on medical expenses. "The goal is to deliver better care at a lower cost, which requires a different approach."

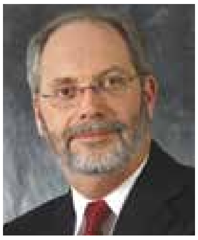
People are becoming aware that options exist and costs are uniform, adds Richard Molseed, executive vice president at Avera Health in Sioux Falls, S.D. "There is more consumerism today, and more people are price sensitive, which can be seen in the decline in elective surgeries," he says. "They want better access to healthcare earlier in the process."

ACA's goal is in line with those changes, notes John Messervy, director of capital and facility planning at Partners Healthcare System in Boston, Mass. "The trend has been coming for some time, and it's being accelerated by ACA," he says. "It is turning financial incentives on their head, because it motivates healthcare providers to keep people well in a lower-cost setting. That focuses more attention on lifestyle and wellness planning and how to address that."

Contributing Experts



– Ellen L. Belknap, AIA, LEED AP is the president of SMRT Architecture, Engineering and Planning in Portland, Me.



– Richard Molseed is the executive vice president at Avera Health in Sioux Falls, S.D.

– John Messervey, AIA is the director of capitol and facility planning for Partners Healthcare Systems in Boston, Mass.

– Paul Strohm, AIA, ACHA, LEED AP BD+C is the senior vice president and director of healthcare projects at HOK, St. Louis, Mo.

Ambulatory Care Grows

Wellness planning and avoidance of chronic conditions leads to a focus on educational and early-warning programs as well as diagnostic visits to catch problems early. "As hospitals move to a model of care that involves caring for patients' lives with a renewed focus on health and wellness, ambulatory care will be an increasingly important delivery setting," says Paul E. Strohm, senior vice president and director of healthcare projects at HOK in St. Louis, Mo. "Hospitals are being financially rewarded or penalized based on patient outcomes. This is driving a renewed emphasis on outcomes and patient satisfaction."

If patients are visiting diagnostic centers more regularly, they need readily accessible facilities. "Our approach to population health management is to focus on providing healthcare in increasingly retail settings at more convenient locations," says Messervy. "Facilities have to be on normal travel paths so it's convenient to drop in or to walk further down the mall."

Avera provides three sizes of clinics: smaller ones with traditional designs, larger ones with more dedicated space per patient, and major-sized ones. The middle option is growing fastest. "When we provide more space for care, with support services adjacent, doctors have higher productivity, see more patients per day, and spend more time being a doctor," Molseed says.

For major clinics, administrators are focusing on making systems as lean as possible before committing to capital

Avera Health's Prairie Center Cancer Institute in Sioux Falls, S.D., features precast concrete panels with inset thin brick, inset stone and several textures on the panels, saving more than $1 million over the original handset-brick design. Opened in 2010, the building set a new standard for the company in reducing energy consumption, using environmentally friendly construction materials, and sourcing materials locally. Gage Brothers in Sioux Falls fabricated the components. Photo: Avera Health.

'We as designers have to be responsive to making buildings resilient through siting, material use, and layouts.'

improvements. "Lean systems have been given lip service in the past, but now it's a focus," Molseed says. "They want to get their processes efficient before they start any capital allocation."

Hospitals with smaller facilities in more easily accessible locations will need more examination and consultation rooms along with diagnostic equipment, with fewer operating rooms and intervention spaces, Belknap says. "Hospitals will become less asset-driven and focused on bricks and mortar and more focused on the systems of care they deliver."

Flexibility Needs Rise

Smaller, decentralized treatment facilities are encouraged by the miniaturization of diagnostic equipment and the ability to monitor patients wirelessly from home, among other technologies. "Technology advances are huge," says Belknap. "There are a lot more personal devices today with the goal of keeping patients out of the hospital." Adds Strohm, "Technology is one of the most significant drivers impacting the changes in healthcare-treatment design. Technology is helping physicians and caregivers create better outcomes, operational efficiencies, and reduced costs. It's constantly evolving. We are building in as much flexibility as is financially feasible to accommodate the ability of buildings to evolve over time."

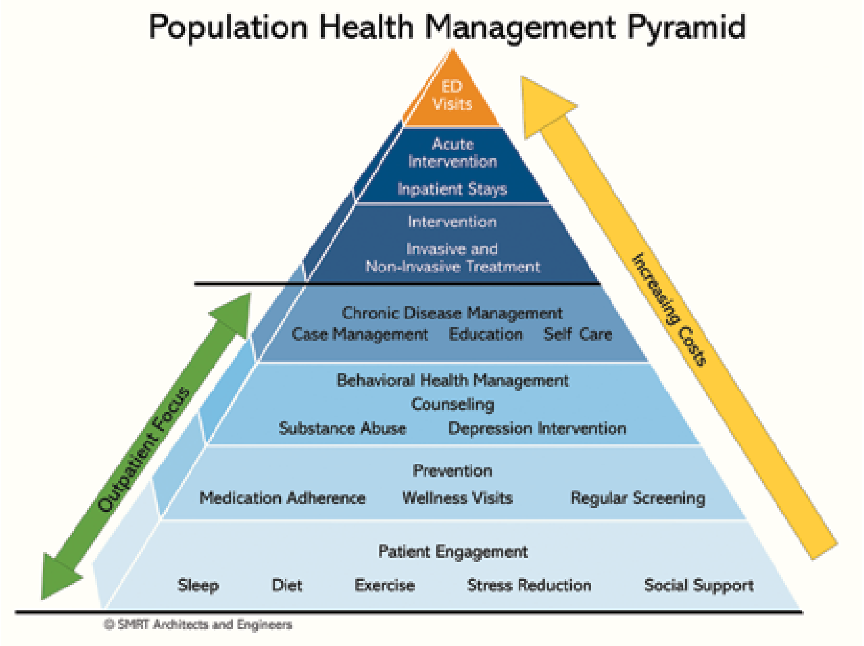
Equipment is being reduced to the point that some hospitals now have portable MRI machines, notes Messervy. But much of it is still heavy and sensitive, requiring structural support and attention to vibrations to avoid disruptions. Despite the ubiquity of wireless systems, much of a hospital's recods are still hard-wired, owing to the large size of digital images and medical files. "We need to keep offices flexible so they can take advantage of new technologies as they change. Flexibility of communication, power, and cooling systems has to be designed into any building being constructed today."

The focus will be on redesigning and revamping existing buildings to take advantage of new systems and approaches, Belknap says. "Renewal and replenishment of existing facilities so they are more versatile will be important. Previously, hospital costs were focused primarily on campus infrastructure. In the future, they will be divided among technological changes, communication, and more decentralized community based facilities."

More Resiliency Needed

In addition to flexibility, healthcare facilities must address resiliency, says Belknap. "We as designers have to be responsive to making buildings resilient through siting, material use, and layouts, because we are experiencing more extreme weather events. Healthcare facilities especially have to be protected from storm damage and flooding. Hurricane Katrina and Superstorm Sandy are wake-up calls that climate change is intensifying the effects of storms." New FEMA maps are expanding coastal land areas potentially exposed to 100-year and 500-year floods.

Climate change is making it onto the list of business risks for healthcare facilities. "Our CEO added climate change to his list of business risks last year," says Messervy, "and we are fully engaged in evaluating the potential exposures and developing the strategies to maintain operations. It's a very different scenario than hos-



The Population Health Management Pyramid organizes the types of healthcare services available in the Patient-Centered Medical Home model of care, with those lower in the pyramid cheaper and easier to provide. Patients without insurance often rely on service in the peak, going to emergency rooms for serious problems not caught or prevented earlier. Source: SMRT, 2013.

Healthcare designers are using more prefabricated components to speed construction and lessen site congestion. At the new Wexner Medical Center at The Ohio State University, James Cancer Hospital, and Solove Research Institute and Critical Care Tower in Columbus, Ohio, some 1,200 precast panels with thin-set brick in five colors and three sizes were erected at night, picking them from the truck and setting them into place immediately. Gate Precast Co. in Winchester, Ky., served on a design-assist basis and fabricated the components, which were erected by Precast Services in Twinsburg, Ohio. Photo: HOK.

pitals have planned for, and it's going to require very different solutions."

Resiliency extends to creating facilities that incorporate sustainable-design techniques, Belknap adds. "We as designers must do anything we can to prepare buildings to be resilient and to be lighter in their carbon footprint in the long term. It's a challenge that administrators are taking very seriously today."

Emphasizing green building comes naturally to facilities that want to encourage healthy living, notes Molseed. "Our recent facilities have all incorporated green techniques. There is still some premium for using these products, but it's much less than it was." Indoor air quality is a key concern, he adds, pointing to the company's recent completion of the Prairie Center Cancer Institute in Sioux Falls, where it was paramount not to introduce any potential carcinogens into the air from materials being used.

'Performance of the building envelope is as important as the optimization of building systems.'

Hospital's intensive use of energy is receiving more attention. "Performance of the building envelope is as important as the optimization of building systems," says Messervy. "The building enclosure is now being commissioned much as HVAC systems have been for the past 10-15 years. Great leaps have been made in the development and sophistication of design and modeling applications to allow the owner to optimize the performance of enclosure and mechanical systems."

'There is no excuse today for a leaky building that is an energy sieve.'

"Energy efficiency has to be a primary outcome of design today," says Belknap. "That includes wall and roof systems and providing higher R-values through the tightness of the building envelope. There's no excuse today for a leaky building that's an energy sieve. Administrators realize they have to step up to the plate and pay for buildings that are responsible."

High-efficiency HVAC systems are

becoming standard, Messervy says, and even operable windows are being reconsidered. Open windows haven't been popular, especially in healthcare facilities, he notes, because of infection-control concerns. But Partners recently completed the Spaulding Rehabilitation Hospital in Boston and included operable windows in public areas and therapy spaces, as well as in patient rooms via a key that building operations can access.

"Buildings that are sustainable operate at a lower cost and are healthier for the environment," says Strohm. An example he cites is the Eskenazi Hospital in Indianapolis, which has gone to a 100% outside air system for the hospital and ambulatory-care building while targeting LEED Silver, with the possibility of Gold.

Material choices play a key role in achieving sustainable design. "There is increasing awareness of chemicals in products, including formaldehyde in drywall and chemicals in furniture," says Molseed. "Carpeting, ceiling tiles, and paint all are changing formulations to be healthier, and there is more transparency today so designers can make more informed choices."

Hospital aesthetics also are evolving, including the design of their façades. As buildings become smaller in size and spread through more neighborhoods, a wider variety of styles will be needed to fit their locations, requiring some versatility.

"Healthcare buildings continue to evolve their design aesthetic," says Strohm. "The evolution includes a transformation to an aesthetic that is warm, brings in a lot of natural light, is high performance to help meet the sustainability-performance needs, and is visually appealing. Clients are exploring ways to evolve an aesthetic that can become a signature element in their branding program when multiple facilities are involved in the real-estate portfolio. A similar branding of the interiors of hospitals is being implemented to help target outcomes and patient experiences."

Integrated Project Delivery

The pressure to remove redundancy and waste from the design and construction process is driving the use of integrated project delivery says Belknap. The goal is to align the owner, designer, and construction team early in the process, going beyond design-build or construction-management formats to allow collaboration among all parties, including subcontractors.

"We have to get each construction partner out of isolation and allow them to collaborate," she says. "Real collaboration spurs innovation. This is an exciting emerging trend that produces positive results. By collaborating more closely, the team can accelerate the schedule and provide higher quality and value to the owner."

A key element of integrated project delivery comes from collaboration among subcontractors, which allows for prefabricating more components and integrating systems before materials arrive at the site. "IPD encourages the use of prefabrication," Belknap says. "You don't have to get isolated bids without true knowledge of what will be required. Subcontractors can team up to put pieces together in the plant. Building in the controlled environment of the plant and bringing prefabricated components to the site speeds construction, provides better quality, and reduces activity at the site. Everyone wins."

Integrated Project Delivery's Defining Characteristics

DEFINING CHARACTERISTICS

Mindshift	Trust
	Willingness to Collaborate
Structure	Early Involvement of Key Participants
	Joint Project Control
	Shared Risk (Risk Sharing "Bubble")
	Shared Reward Based on Project Outcomes
	Reduced Liability Exposure
	Jointly Developed Validated Targets
Catalysts	Building Information Modeling
	Lean Design and Construction
	Co-Location of Project Team
Outcomes	Schedule Acceleration
	Enhanced Pre-Fabrication
	Quality and Value to the Owner

Using an integrated project delivery model requires a host of elements, from the mindset that runs counter to typical design-bid-build delivery methods to the structures needed to ensure it works to the tools that help it operate efficiently. Source: SMRT, 2013.

'We're very interested in using as many prefabricated components as we can.'

Messervy agrees. "We're very interested in using as many prefabricated components as we can," he says. "It's being aided by the spread of BIM and offsite capabilities by subcontractors to provide high-quality while other work progresses. Prefabricated components can reduce time to market, improve quality control, and create a better environment." Partners is presently studying the development of a 20-bed, 100,000-square-foot hospital on Nantucket, Mass., constructed in nine months using predominantly prefabricated components assembled on the mainland.

Adds Strohm, "We are seeing new ways to utilize larger and pre-manufactured wall assemblies off-site. The assemblies are then brought to the site, lifted into place, and installed. This technique saves time, is less costly, and can achieve a high-quality assembly due to fabrication under controlled conditions."

He points to the company's work on the 20-story Ohio State University Hospital in Columbus, Ohio, which uses precast concrete panels with embedded thin brick and curtain wall. The envelope units were preassembled and delivered for immediate erection at the site. "There is a trend toward high-performance façades that deliver a more comfortable environment for patient care. Closer attention is being paid to continuity and quality of air barriers in an effort to control both air and moisture infiltration into the healthcare setting."

As these trends gain momentum, designers will need to respond by staying current with techniques, material choices, and collaboration opportunities. "Healthcare must respond to the Institute for Health Improvement (IHI) Triple Aim to simultaneously improve population health and the experience of care while lowering per capita costs," says Belknap. "We are driven by the idea that the best healthcare is the least amount that is needed."

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

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Digitally Fabricated Concrete: The future of manufacturing is already here

— Brad Bell, University of Texas at Arlington

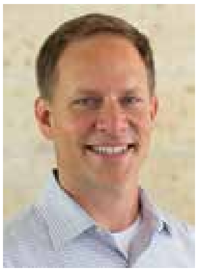
It is hard to visit the pages of a blog or magazine these days and not come across the term *3D printing*. From fashion to food, and from design to defense, 3D printing has taken popular culture by storm and does not appear to be letting up any time soon. When President Obama namechecks it in his State of the Union address as one of the primary technologies that will lead to a renaissance of American manufacturing it is hard to miss that something must be happening.[i] But for all the uproar and the nearly ubiquitous nature of the 3D printing trend, many people are still trying to figure out what the technology actually is and what the real implications are to their lives and, in many cases, their livelihood.

Three-dimensional printing is not a novel technology. The first machine to commercially utilize the technology was produced by 3D Systems Corporation of California in 1986. While the origins primarily came from the manufacturing industry, a wide range of disciplines immediately saw the potential of this new method for prototyping. This led to many different types of commercial and research applications that subsequently led to many different iterations of material and methodologies of fabrication. Initially the technology was termed rapid prototyping or layered manufacturing, both terms referring to these wide ranges of mediums and methodologies. But as the technology has become more popular, the term of 3D printing has taken over.

Regardless of the terminology, the process is almost entirely the same between mediums. At the most basic level 3D printing follows the same process of applying ink to paper, except instead of ink, a physical material is deposited in very thin layers that build-up until a solid object is produced. The primary function of the digital software is to take the object and produce a series of extremely thin slices or section cuts through the object that can then be transferred to the printed layer of material. In this way an object is printed slowly, layer-by-layer.[ii] Whether by powder and binder, plastics, metal or any other type of material, the process follows a similar method and has long been used as a prototyping medium. However, the maturation process with the technology has now facilitated some interesting new developments that have implications on the future trajectory of 3D printing and manufacturing.

Since 2007 3D printing sales have jumped 35,000%[iii] and it is estimated that by 2015 it could be a $3.7 billion industry.[iv] The rapid economic growth has touched almost every sector of the economy, with 20% of objects now printed as final output—with that number expected to rise to 50% by 2020[v]. The easiest method of assimilation into the precast industry is at the level of utilizing 3D printing in its current representational capacity to communicate design intention or detail and assembly sequencing. In this capacity, the 3D printed object serves as an invaluable tool that can be used from concept discussion to jobsite component implementation. The scaled 3D printed object quickly and effectively shows a range of design options and variations. Whether communicating to a client, an installer,

Figures 1 and 2. Contour Crafting "24 Hour House" and a panel prototype being fabricated. Images: Dr. Berok Khoshnevis, professor, University of Southern California.



– Brad Bell

Brad Bell is an assistant professor at The University of Texas at Arlington. He researches and teaches on the integration of advanced computing technologies into the architectural design process. Brad is also the director of TOPOCAST Lab, an experimental design and consulting practice focused on the application of digital fabrication technologies into casting methodologies. He has also co-founded, and is now co-director of, TEX-FAB, a non-profit organization that provides a platform for education on digital fabrication and parametric modeling to the professional, academic, and manufacturing communities in Texas.

Figure 3. Freeform Construction team at Loughborough Univeristy displays a composite wall prototype. Photo: Dr. Richard Buswell and Professor Simon Austin, Loughborough University.

an engineer, or designer, the capacity to accurately and quickly generate 3D printed objects is an effective tool in the design-to-manufacturing sequence. The affordable desktop ABS printers now make these types of applications a relatively easy entry point into rapid prototyping for almost any size company or firm.

Beyond the representational use of the technology, the limitation of 3D printing has traditionally been scale, especially when exploring larger manufacturing opportunities related to the building industry. However, this too is starting to change with substantial research and development investment from both academic and manufacturing sectors transcending the scale issue. Specifically as this pertains to the potential for 3D printing concrete, there are several interesting developments and two promising strategies. The first suggests the printing technology can increase in size to accommodate larger building components and be fit with the necessary rigging for concrete output. The second suggests a module-based concrete printing process that utilizes existing 3D printing technologies. This method requires a rethinking of material composition and component connection as parts begin to assemble together to make a larger part.

Large Composite Printing

The idea of linking a robotic armature to a large gantry to essentially 3D print with concrete is being explored by several different teams around the world. One obvious advantage to the concrete industry as a whole is the potential removal of formwork from the equation. Three-dimensional printing requires an unobstructed pathway for the deposition head to move when layering the concrete. Conventional use of formwork would obstruct the deposition head and the gantry movement. The opportunity to quickly deploy a large format concrete printer on a jobsite and start printing a structure would provide an economic advantage over many other forms of construction. The Contour Crafting: Robotic Construction System developed by Behrokh Khoshnevis, working in partnership with the University of Southern California, has developed one of the more advanced systems with future applications being lunar structures and the '24 hour house'[vi] **(Fig. 1, 2)**.

With the 3D printing apparatus being mobile, this procedure more closely follows a cast-in-place procedure. Similar challenges found in more traditional site-cast concrete, such as variable site conditions, quality control, and structural limitations would still be present. However the rapid deployment and high degree of customization might provide unique opportunities in certain scenarios. There is so far very little applied evidence of this approach, however with funding from NASA and the number of companies who have recently gotten behind this method, it would seem positive for larger scale evidence based demonstrations to appear in the very near future.

The Freeform Construction team working out of Loughborough University in connection with Hyundai Engineering & Construction, Foster+Partners, and Burro Happold, are utilizing very similar technology but focusing on fully integrated panel construction of component parts.[vii] This approach more closely replicates precast panel techniques in that wall systems and architectural components are divided into a system of parts that can be manufactured off-site and then delivered and installed. The fully integrated panel has potential for not only increasing the efficiency in how building systems can be combined, but also the added advantage of mass-customization, making this a highly unique opportunity for each component to take on a varied geometry at no additional cost **(Fig. 3)**.

With the 3D printing technology essentially removing the need for formwork, there is a direct fabrication benefit that comes from this approach. In addition to the composite wall application, Freeform Construction team suggests the technology is also ideally suited for doubly curved cladding panels and complex structural components **(Fig. 4)**. These two issues directly correlate to almost all forms of digital manufacturing, which utilize a digital file to create the fabrication methodology. With the control of the fabrication process now being dictated by a computer file, complex geometries no longer present the same manufacturing challenges as they might have in the past.

In both examples from Contour Crafting and Freeform Construction team, the use of advanced material science to achieve a suitable mix in the concrete is integral to the successful implementation of the technology. To ensure that formwork is not needed, and that a direct printed form can be achieved, the mixture of concrete must be compositionally able to set up at a speed such that each successive layer can support the previous in a very

Figure 4. Doubly curved surface fabricated by the Freeform Construction team, Loughborough University. Photo: Dr. Richard Buswell and Professor Simon Austin, Loughborough University.

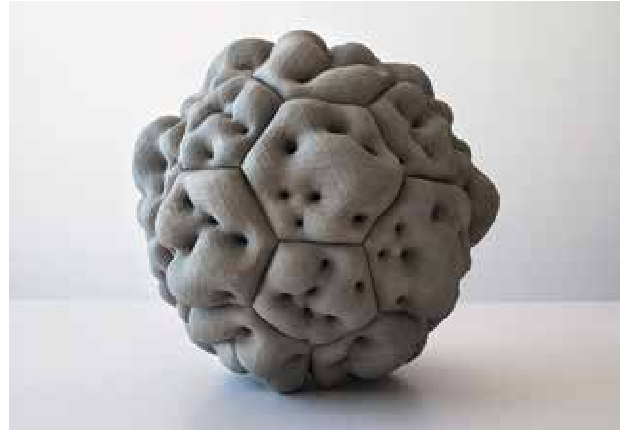


Figure 5 and 6. P_Ball Emerging Objects for Andrew Kudless. Images: Ron Rael + Virginia San Fratello, Emerging Objects.

short period of time.

Contour Crafting relies upon pumping concrete to the deposition head much the same way a traditional pumping mechanism would work, however the connection of the head to the robotic arm on the XYZ gantry makes this a highly customizable outcome in terms of geometry and a very fast and efficient way of controlling the distribution of the concrete. The flow of the concrete comes out in wider swaths and can be tooled or shaped by a processing tool working in coordination with the deposition head.

The Freeform Construction process, by contrast, uses a smaller build deposition size of 6mm high by 9mm wide and provides a dual print capability where one printhead provides the build layer while the other is capable of depositing a support layer that can be removed after completion.[viii] The introduction of the ability of dual printing furthers the capacity to explore a wider range of non-Euclidian geometries that might require preliminary support while the concrete is curing or being put into position. In both cases it is possible to achieve large build areas as a result of how the adaptation of the printing technology to larger format deposition heads, larger gantry systems, and site and factory modifications have facilitated construction and manufacturing capacity. These approaches will be one facet of the Rapid Manufacturing movement that will change the way we think of building in the very near future.

Smaller-Scale, Component-Based Printing

In contrast to the larger scale build techniques, the company Emergent Objects[ix], located in Oakland, Calif., and working with UC Berkeley, has initiated an alternate direction to the implementation of 3D printed concrete. Led by Ron Rael and Virginia San Fratello, Emergent Objects has opted to utilize existing 3D printing technology, but work more extensively with what they have described as a *digital materiality*[x] **(Fig. 5, 6)**. What this approach facilitates is the ability to work with the material science of concrete composition and leverage 3D printing technologies to pursue innovative and new geometric outcomes.

A deposition head on a 3D printer capable of working with a powder base material, in this case Portland cement, works with a 35-pico liter printhead. This essentially means that the binding agent deposited through the printhead works as aggregate and places layers on the Portland/sand mixture at 0.001 thickness to slowly build up the object. While this seems slow and possibly tedious, the benefit is the strength and resolution of the outcome. With Emerging Objects' approach, they are able to obtain a very competitive 4700 psi in compressive strength and, at the same time, provide unparalleled object definition. Because this process is transferable to almost any powder-based substance, Emerging Objects is capable of 3D printing in concrete, wood, paper, nylon, acrylic, and most recently salt. While this process is initially limited to build sizes and technologies of some of the current 3D printers, Rael and San Fratello have noted that there is no limitation to adapting their approach and material intelligence to larger formats. As this becomes available it may provide the capacity to achieve superior resolution, coupled with increased surface strength, giving the Emerging Objects approach an advantage long-term.

Broadening the Spectrum

Three-dimensional printing represents one aspect of how concrete component fabrication is changing the way the architecture, engineering and construction (AEC) and manufacturing industries are evolving. Within the broader spectrum of digital manufacturing methods impacting the precast and prestressed industry, there are several other outliers that show potential for transforming the industry. Much of this work is concentrated on the area of digitally fabricated formwork. This work possesses some of the lowest-hanging fruit for the industry in how already known factors of working with the casting process provides an easier on-ramp for technology transfer and workforce training. Areas of advanced structural integration, coupled with progress on new material possibilities like developments in Glass Fiber Reinforced Concrete (GFRC), suggest there are still areas open for exploration.

Because most of the digitally fabricated formwork explorations tend to follow component-based assembly system logic, the most compelling area for research lies in how parametric software will allow for more varied and yet integrated outcomes. The work of Dave Pigram's research group at University of Technology, Sydney (UTS)/ Supermanoeuvre[xi] **(Figs. 7, 8)** as well as TOPOCAST Lab[xii] at the University of Texas at Arlington **(Figs. 9,10)**, are exploring how performance-based software can inform the fabrication process. From structural to acoustic and solar mitigation, parametric design tools are helping to define more

Figure 7 and 8. Pre-Vault by University of Technology, Sydney and Aarhus School of Architecture. Photos: Dave Pigrim, University of Technology, Sydney/Supermanoeuvre, Ole Egholm Pedersen & Niels Martin Larsen, Aarhus School of Architecture.

articulated formwork capable of not only being aesthetically compelling, but also producing parts with highly specialized performance outcomes.

Conclusion

William Gibson, father of the cyberpunk science fiction genre wrote, "The future is already here—it's just not evenly distributed."[xiii] In many ways 3D printing suggests a future for manufacturing, design, and DIY culture that is already upon us. When taken with the broader spectrum of digital manufacturing, it is clear that the industrial paradigm is shifting. However, the fact remains that it is not so evenly distributed. No technology is uniformly adopted or implemented. production—it is safe to say the future of concrete component-based fabrication is already here.

Endnotes

i. http://www.whitehouse.gov/the-press-office/2013/02/12/remarks-president-state-union-address "Our first priority is making America a magnet for new jobs and manufacturing…There are things we can do, right now, to accelerate this trend. Last year, we created our first manufacturing innovation institute in Youngstown, Ohio. A once-shuttered warehouse is now a state-of-the art lab where new workers are mastering the 3D printing that has the potential to revolutionize the way we make almost everything. There's no reason this can't happen in other towns."

ii. For more information on the history and process of 3D printing and Rapid prototyping please see "Computer-Aided Manufacturing in Architecture" by Nick Callicott. Chapter 19: Solid Freeform Fabrication. Architectural Press, Oxford, 2001.

iii. *Bloomberg News*, Max Raskin & Ilan Kolet, October 23, 2012.

iv. Reuters Roll Call, Ben Deighton, March 6, 2013.

v. *The Economist*, "3D Printing: The Printed World," February 10, 2011

vi. http://www.contourcrafting.org & http://www.craft-usc.com.

vii. http://www.buildfreeform.com.

viii. Xavier De Kestelier of Foster + Partners and Richard Buswell of Loughborough University provide an in-depth analysis of their methods in "A Digital Design Environment for Large-Scale Rapid Manufacturing" ACADIA 09: reform. Proceedings of the 29th Annual Conference of the Association for Computer Aided Design in Architecture (ACADIA) Chicago, pp. 201-208.

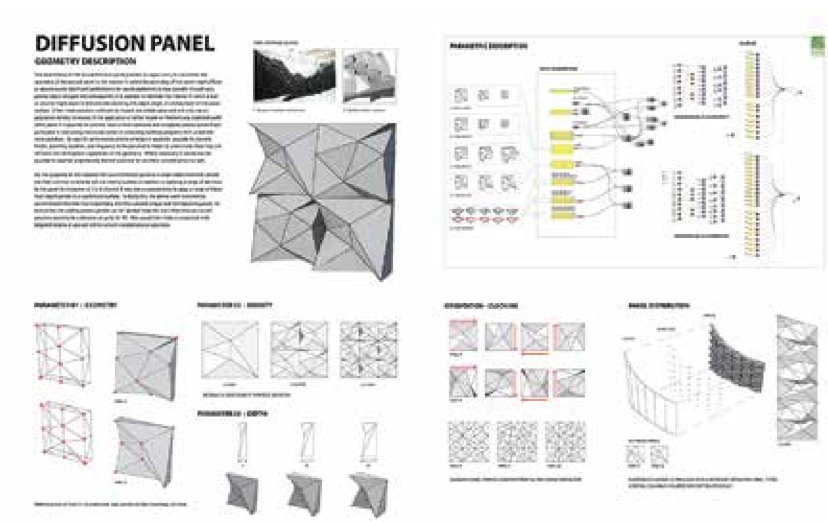
ix. http://www.emergingobjects.com.

x. Digital materiality as a term was originally introduced by Fabio Gramazio and Matthia Kohler, 2008. *Digital Materiality in Architecture*, Lars Muller Publisher.

xi. http://supermanoeuvre.com/pre-vault/.

xii. http://www.topocastlab.com .

xiii. *The Economist*, December 4, 2003.



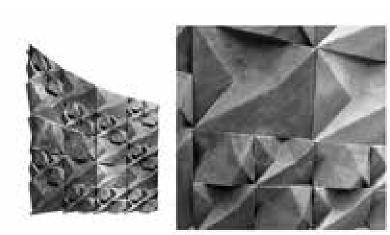


Figure 9 and 10. Parametric precast sound diffusion panels by TOPOCAST Lab at University of Texas at Arlington. Photos: Brad Bell, University of Texas at Arlington.

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

We're making amazing things happen with sustainable precast concrete

The new Higher Ground homeless shelter in Minneapolis, Minnesota is a case in point. Completed in June 2012, the structure is a state-of-the-art concept that encourages individuals to move up from emergency shelter accommodations to permanent housing. A total-precast building, components include insulated wall panels, pre-stressed hollow-core planks, and precast stairs. The structure is sustainable, energy efficient, and aesthetically versatile.

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Mountain Region
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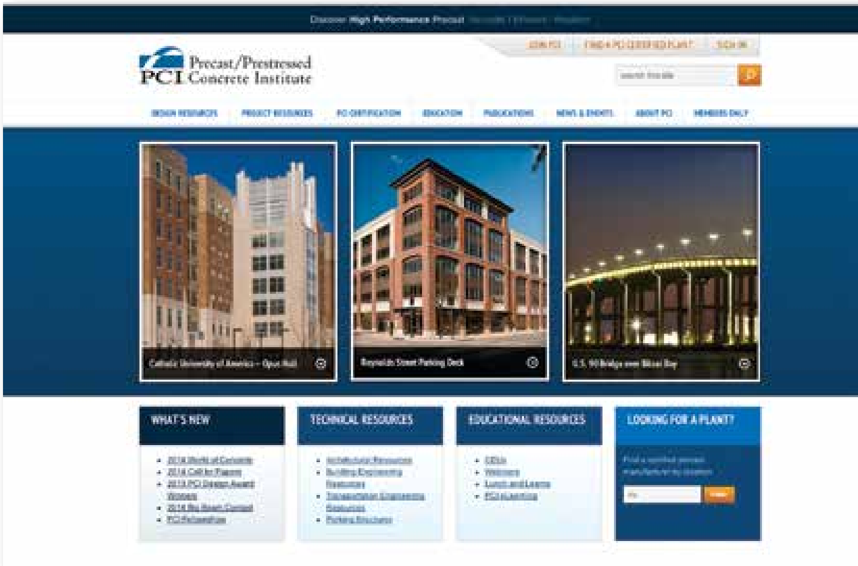
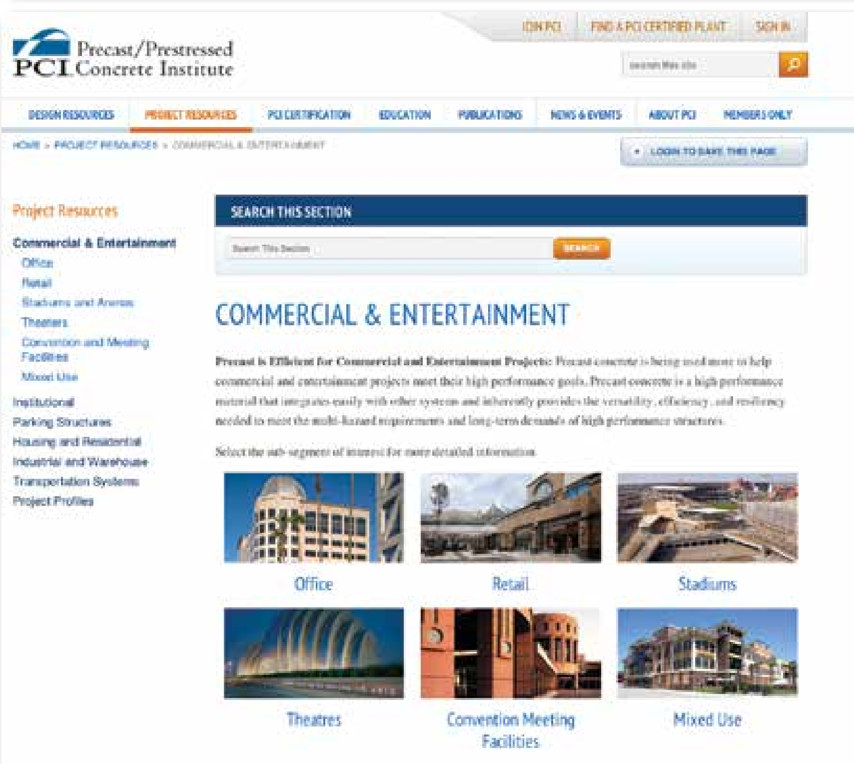
PCI launches New Website





The PCI website has been completely rebuilt, resulting in a greatly improved resource to help you with your work and project planning. The new PCI website offers a variety of tools and resources, along with improved navigation and an enhanced user experience.

Primary Navigation

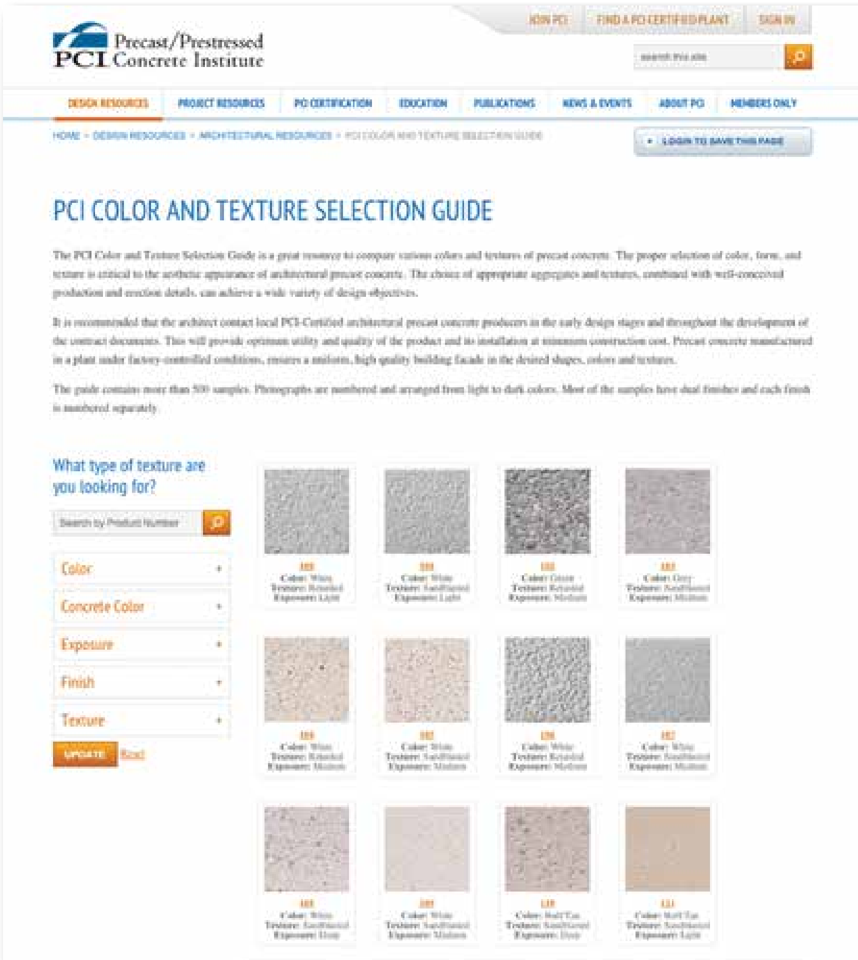
PCI's resources and tools are organized in two primary ways. The first is Design Resources which organizes the Body of Knowledge around design topics, such as Architectural Resources, which are described a later in this article. The second is Project Resources which organizes information by project type such as parking structures, schools, or healthcare. Either way will get you to the information you need. There is also information on PCI Certification, Education, PCI Publications, News and Events, and About PCI.

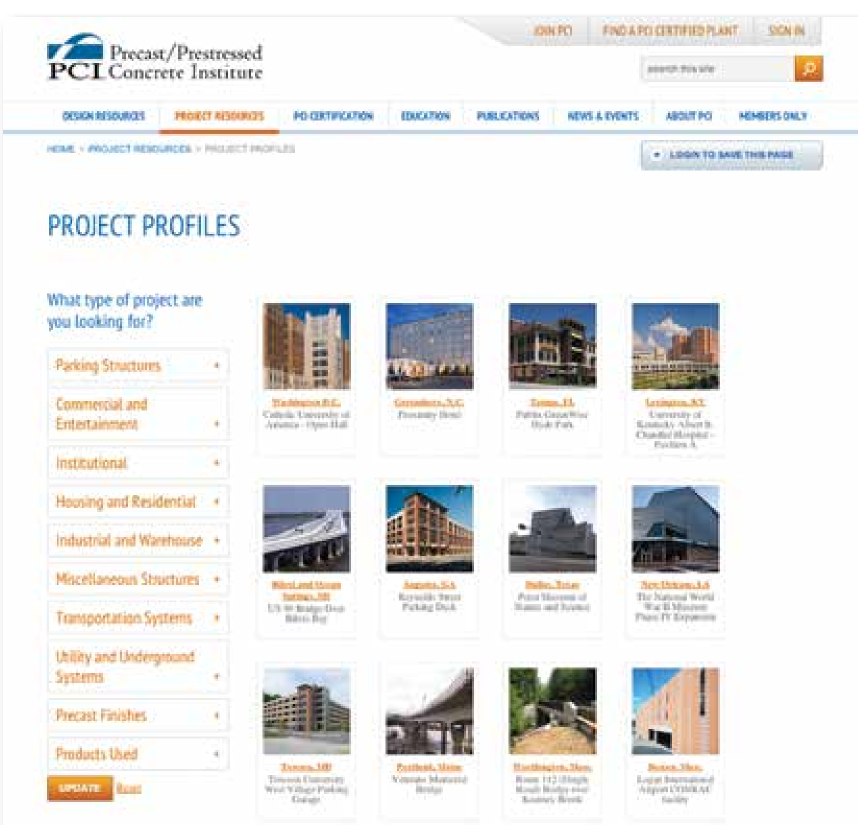
Specific Architectural Resources

- Finishes – Colors, Forms, and Textures: Explains the different finishes available with precast, as well as embedded and veneered materials.
- Design Details: Addresses envelope details such as connections, joints and interfacing.
- Envelope Design: Addresses envelope design considerations such as thermal design, moisture and vapors barriers, integration of systems, and more.
- Color and Texture Selection Guide: Allows the user to search through more than 500 samples of color and finishes of precast concrete.
- Designers Notebooks: The PCI Designer's Notebooks provide detailed, in-depth information on precast concrete relevant to specific design topics, such as acoustics, mold and sustainability. Each Designer's Notebook is originally published in Ascent magazine with many of the more recent ones being approved for 1 L.U. of continuing education.

Project Profiles

The new PCI Website has dozens of project profiles to see how other architects and design teams have used high performance precast to





meet and exceed their customer's program needs and expectations.

Continuing Education

PCI provides contiAng education courses via webinars, seminars, lunch and learns (in your office) and the PCI eLearning Center that provides continuing education whenever you need it. PCI maintains approved education provider status with the National Council of Examiners of Engineers and Surveyors (NCEES), the American Institute of Architects (AIA) and with the Green Building Certification Institute (GBCI). Our programs comply with the continuing education requirements of licensed engineers and architects in all 50 states!

You can learn more at www.pci.org/Education/

Ascent

You can find previous issues of Ascent magazine on the website. Simply visit www.pci.org/Publications/Ascent_Magazine/

Find a PCI Certified Plant/ Site Search

Users can use the PCI website to find a PCI Certified Plant as well as to verify a plant has the correct certification category to the proposed work. You can also search for any information by simply using the Search This site feature at the top of any page.

We invite you to visit our new Website and provide us with feedback. Simply submit any questions or feedback to Brian Miller at bmiller@pci.org.

PCI Members can receive FREE REGISTRATION to the World of Concrete and discounted seminar fees

January 20-24, 2014 • Las Vegas, Nevada

Don't miss out on these great opportunities for the precast concrete industry while at WOC:

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- **PCI Quality School, Level I (January 20 - 21, 2014)**
- **PCI Quality School, Level II (January 21 - 22, 2014)**
- **PCI Zones 1 & 2 meeting (January 22, 2014)**

The World of Concrete is an annual international event dedicated to the commercial concrete and masonry construction industries. It features more than 500,000 s.f. of exhibit space with the industry's leading suppliers showcasing innovative products and technologies, exciting demonstrations and competitions, a world-class education program, and the information you need to help sustain and grow your business. PCI members can attend a Level I/II Quality Control School and the Zones 1 & 2 meeting during the show.

For more information visit www.pci.org and click on the WOC icon or contact Megan Lanning at mlanning@pci.org..

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PCI is a registered continuing education provider with the American Institute of Architects (AIA), and the National Council of Examiners of Engineers and Surveyors (NCEES). PCI also has registered programs with the Green Building Certification Institute (GBCI). PCI's educational offerings include a variety of programs to fit your schedule and preferred learning environment, such as webinars, seminars, lunch-and-learns, and online education. To learn more, visit www.pci.org/education.

Distance Learning Opportunities

Webinars

PCI webinars are presented live each month by industry experts on a variety of topics from design and construction to sustainability and more. All webinars are FREE, one-hour long and presented twice during the webinar week, at noon Pacific (3:00 p.m. Eastern) and noon Eastern. Webinars provide an inexpensive way to stay up to date on new materials, products, concepts, and more while earning continuing education credits. Visit www.pci.org/webinars for the full webinar schedule and registration information.

Upcoming Webinars:

The 2014 webinar series will focus on High Performance Precast and include such topics as envelope commissioning, life cycle-assessment, storm design and more. The 2014 webinar schedule will be posted in January. Registration information will also be listed as it becomes available, so please check back often.

PCI eLearning Center

The PCI eLearning Center is the first education management system dedicated to the precast concrete structures industry. This free 24-hour online resource provides an opportunity for architects and engineers to earn continuing education credits on demand. Each course includes a webinar presentation recording, reference materials, and a quiz. Visit this new resource at www.pci.org/elearning.

In-Person Learning Opportunities

Seminars

PCI and its regional affiliates offer seminars 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.

- Architecture and Precast Concrete Seminar (1.5 LU + 1.0 HSW LU)
  February 13, 2014, 1:30 -4:30 p.m.
  Hilton Americas Hotel, Houston, Texas.
  visit https://www.pci.org/PCI_Events/Architecture_and_Precast_Concrete_Seminar/

Upcoming Seminars:

- **Quality Control Schools**
  Level I/II
  May 2014; Nashville. Tenn.
  September 2014; Chicago, Ill.
  November 2014; Nashville, Tenn.
  Level III
  May 2014; Nashville, Tenn.
  September 2014; Chicago, Ill.
  November 2014; Nashville, Tenn.
- **CFA/IES**
  May 2014; Nashville, Tenn.
  November 2014; Nashville, Tenn.
- **CCA**
  May 2014; Nashville, Tenn.

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 December, 2013)

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

ARKANSAS
Coreslab Structures (ARK) Inc., Conway (501) 329-3763 .... **C4A**
Rotondo Weirich, Hot Springs (215) 256-7940 .... **C1**

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**

CALIFORNIA
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 ....

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**
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 .... **C4A**
Tindall Corporation, Conley (800) 849-6383 .... **C2A**

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**
Prestress Engineering Corporation, Blackstone (815) 586-4239 .... **B4, B4-IL, C4**
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., 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, B4, B4-IL, C4A**
MPC Enterprises, Inc., Mount Pleasant (319) 986-2226 .... **A1, C3A**
PDM Precast, Inc., Des Moines (515) 243-5118 .... **B3, C4**

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**

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

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

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**

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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, B2, 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 ...... **C3**
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 ...... **C1**
Concrete Safety Systems, LLC, Bethel (717) 933-4107 ...... **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**

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 Concrete Products Inc., 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**
Eagle Precast Corporation, Decatur (940) 626-8020 ...... **A1, C3**
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**
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**

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UTAH

Hanson Structural Precast Eagle, Salt Lake City (801) 966-1060 ... **A1, B4, C4A, 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**
Central Pre-Mix Prestress Co., Spokane (509) 533-0267 .... **A1, B4, C4**
Concrete Technology Corporation, Tacoma (253) 383-3545 .... **B4, C4**
CXT, Inc., Spokane (509) 921-8716 .... **B1**
CXT, Inc., Spokane (509) 921-7878 .... **C2**
EnCon Northwest, LLC, Camas (360) 834-3459 .... **B1**
EnCon Washington, LLC, Puyallup (253) 846-2774 .... **B1, C2**
Wilbert Precast, Inc., Yakima (509) 248-1984 .... **B3, C3**

WEST VIRGINA

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**
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, Inc., Valders (920) 775-4121 .... **B4, C3**
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 (000) 000-0000 .... **A1, G**
Willis De Mexico S.A. de C.V., Tecate (000) 000-0000 .... **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 December, 2013)

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**
TPAC, Phoenix (602) 262-1360 .... **S2, A**

ARKANSAS

Coreslab Structures (ARK) Inc., Conway (501) 329-3763 .... **S2**

CALIFORNIA

Coreslab Structures (L.A.), Inc., Perris (951) 943-9119 .... **A**
Walters & Wolf Precast, Fremont (510) 226-9800 .... **A**

COLORADO

Encon Field Services, LLC, Denver (303) 287-4312 .... **S2, A**
Gibbons Erectors, Inc., Englewood (303) 841-0457 .... **S2, A**

CONNECTICUT

Blakeslee Prestress, Inc., Branford (203) 481-5306 .... **S2**
Jacob Erecting & Construction LLC, Durham (860) 788-2676 .... **S2, A**
The Middlesex Corporation, West Hartford (860) 206-4404 .... **S2**

FLORIDA

All Florida Erectors and Welding, Inc., Apopka (407) 466-8556 .... **S2**
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**
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**
Specialty Concrete Services, Inc., Altoona (352) 669-8888 .... **S2, A**
Structural Prestressed Industries, Inc., Medley (305) 556-6699 .... **S2**
Summit Erectors, Inc., Jacksonville (904) 783-6002 .... **S2, A**

GEORGIA

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**

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**

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**

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MAINE

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

MASSACHUSETTS

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**
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Midwest Steel, Inc., Detroit (313) 873-2220 .... **S2**
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The Shockey Precast Group, Winchester (540) 665-3253 .... **S2, A**

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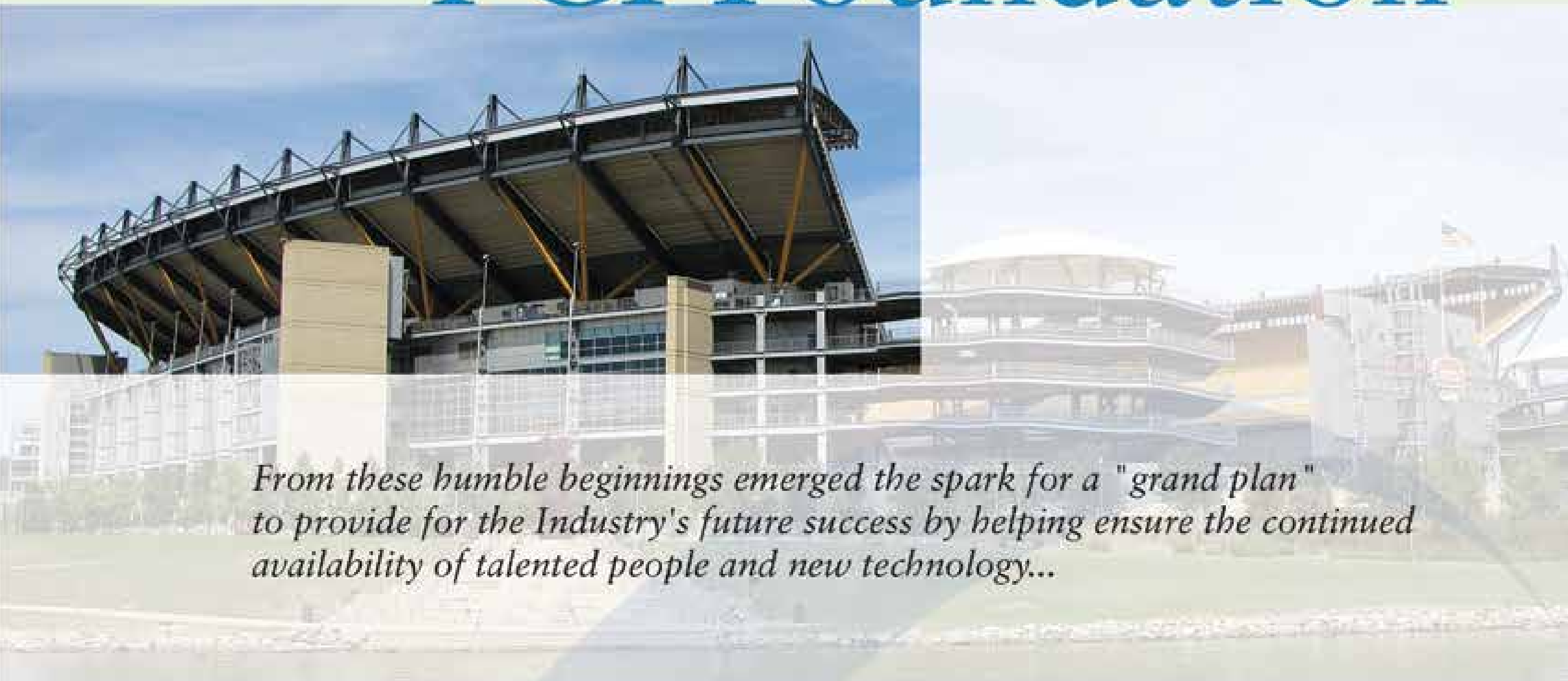

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