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SUMMER 2016

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Features

Departments

PCI Regions—On call for you

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

Central Atlantic Bridge Associates—Monica Schultes, P.E.
phone: (888) 542-0666
email: info@caba-bridges.org
www.caba-bridges.org

PCI Mountain States—John Dobbs, P.E.
phone: (303) 562-8685
email: jdobbs@pcims.org

Florida Prestressed Concrete Association (FPCA)—Terri Trimbath
phone: (813) 579-7232
email: info@fpcaweb.org
www.fpcaweb.org

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

PCI Gulf South— Dan Eckenrode
phone:(228) 239-3409
email:pcigulfsouth1@att.net

Mid-Atlantic Precast Association (MAPA)—Monica Schultes, P.E.
phone: (302) 222-1385
email: info@mapaprecast.org
www.mapaprecast.org

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

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

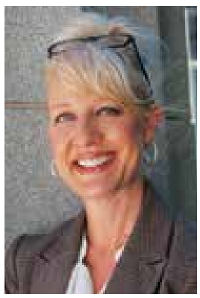
PCI Northeast—Rita L. Seraderian, P.E., LEED AP
phone: (888) 700-5670
email: contact@pcine.org
www.pcine.org

PCI of Illinois & Wisconsin (PCI-IW)—Amy Holliday
phone: (312) 505-1858
email: info@pci-iw.org
www.pci-iw.org

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

PCI West—Doug Mooradian, AIA
phone: (818) 247-6177
email: doug@precastconcrete.org
www.precastconcrete.org

Welcome to the 2016 summer issue of *Ascent* magazine.



Dawn Parker, MBA
Executive Editor
dparker@pci.org

The *Ascent* editorial staff along with the *Ascent* Advisory Committee sets our editorial content over a year in advance of every publication and this summer we are focusing on innovation in precast concrete construction.

Innovation ÷ *noun* in•no•va•tion \ˌi-nə-ˈvā-shən\
: a new idea, device, or method
: the act or process of introducing new ideas, devices, or methods

Precast concrete production and construction of the past has sometimes been viewed by the design community as being simple and utilitarian, however the content in the following pages will highlight many of the new techniques, procedures and methods, and delivery of precast concrete.

We would be remiss in not recognizing one of the true innovators the precast industry. Dame Zaha Hadid took innovation to a whole new level with her expressive designs and certainly opened the door for what could be accomplished with precast. Hadid's passing left a huge void, not only in the design community, but with PCI certified precast producers, who regularly took on her challenges, which ultimately transformed our industry. We will celebrate her life in an article dedicated to her influence and forward-thinking, in the hopes that we can express our appreciation and thanks for her vision of innovative precast façades.

Be sure to check out the high-tech innovation that led to the revival of Boston College's 1917 facility, including how laser-scanning, Revit, and specialized concrete mixes helped to reconstruct the decorative Collegiate Gothic style using precast concrete to replace cast stone.

I hope you enjoy all of the articles within this issue, as we focus on innovation and advancement in the precast concrete industry and illustrate the inherent precast concrete attributes of versatility, efficiency, and resiliency. Let us show you what you can achieve with precast!

ASCENT

On the cover: St. Mary's Hall at Boston College, Chestnut Hill, Mass. Photo: Boston College.

Executive Editor: Dawn Parker, MBA
Editor: Jim Lewis
Managing Editor: Craig Shutt
Editorial Administration: Brenda Banks
Ad Sales:
Kirstin Osgood
Sr. Manager, Sales and Member Recruitment
kosgood@pci.org
(312) 360-3206

Reprint Sales: Brenda Banks
(312) 583-6782
bbanks@pci.org
Precast/Prestressed Concrete Institute:
Robert Risser, PE, President and CEO
Industry Technical Review Team: Alicia Allamena, Peter Finsen, Sidney Freedman, Corey Greika, Thomas Ketron, Ed Knowles, Jane Martin, Mark McKeny, Brian Miller, and Kim Wacker
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Asnuntuck College Features Precast Panels

ENFIELD, CONNECTICUT

Students at Asnuntuck Community College will have their career opportunities expanded through the creation of a new facility for the school's Precision Manufacturing curriculum, which teaches them to use high-tech equipment in manufacturing positions. To emphasize the manufactured nature of the building and meet a tight timeline, insulated architectural precast concrete panels are being used to clad the building.

When completed in 2017, the building will house the school's machining, welding, and other disciplines, including Additive Manufacturing, in which alloys are broken down into powders and recombined into objects using 3D printers. The building required special foundations to support the loads of the new equipment.

The exterior of the one-story, warehouse-sized building will be clad with 20,105 square feet of insulated architectural panels with preinstalled granite water tables, sills, embedments for canopy and sunshade attachments, and recessed areas to support anodized aluminum panels.

Coreslab Structures (CONN) Inc. in Thomaston, Conn., is fabricating the components, which will be cast in July, with erection to take place in October. Fusco Corp. in New Haven, Conn., is serving as general contractor, with Macchi Engineers LLC in Hartford, Conn., as the structural engineer.

PCI Certification Aids Supplier on Hadid Project

MIAMA, FLORIDA

The supplier of the GFRC components for the 1000 Museum condominium project, designed by the late Zaha Hadid and being built in Miami, Fla., had to become PCI-certified to cast the components.

Arabian Profile Co. Ltd. (APL) met certification requirements for its plant in Sharjah, UAE. "The plant worked closely with a U.S.-based consultant in preparation for certification, which is relatively common for plants in North America," explains Dean A. Frank, PCI director of quality and sustainability programs. PCI's standards often are referenced overseas, including in the UAE, he notes. "This made the process for APL a smooth one."

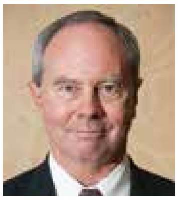
Arabian Profile was the first overseas precaster to apply for certification in many years, Frank notes, but it probably won't be the last. "Because PCI is well-known and frequently referenced internationally, additional overseas precast concrete plants are expected to seek certification from PCI in the future."

These include precasters in the Middle East, India, and Indonesia. "We expect PCI Plant Certification to become a requirement in several overseas jurisdictions in the future. As such, more and more plants will be required to obtain PCI Plant Certification to do business in their local market."

For more on the project and others by Hadid, see the profile article in this issue.

Prussack Elected 2016 PCI Chairman

CHICAGO, ILLINOIS



PCI has elected Chuck Prussack its 2016 chairman. The manager of sales, engineering, and quality control for Oldcastle Precast Inc. in Spokane, Wash., Prussack joined Oldcastle Precast in 1979 when it was known as Central Pre-mix Prestress Co.

He is a member of the American Society of Civil Engineers and the Structural Engineers Association of Washington. He is also a PCI Fellow, a panel member on several National Academy of Sciences bridge-related projects, a prestressed concrete lecturer, and a presenter on various bridge projects. He earned his bachelor of science degree in civil engineering from Washington State University.

Executive Order Ensures Earthquake-Resistant Design

WASHINGTON, D.C.

President Obama earlier this year signed Executive Order 13717, "Establishing a Federal Earthquake Risk Management Standard," to improve the capability of federal buildings to function after an earthquake. The order requires federal agencies responsible for the design and construction of a new building or alteration of an existing building to ensure earthquake-resistant design provisions from the most current building codes are followed.

PCI's award-winning PRESSS (Precast Seismic Structural Systems) and DSDM (Diaphragm Seismic Design Methodology) programs both can fulfill the executive order's requirements and provide enhanced seismic safety for these structures. For more information, contact your local PCI member precaster.

Submit your headline news for consideration in a future issue of *Ascent* to Brenda Banks at bbanks@pci.org.

Perot Museum, Henderson-Hopkins School Win AIA Awards

NEW YORK, NEW YORK

Perot Museum of Nature and Science in Dallas.

Two projects incorporating architectural precast concrete panels, the Perot Museum of Nature and Science in Dallas, Tex., and the Henderson-Hopkins School in Baltimore, Md., received 2016 Honor Awards for Architecture from the American Institute of Architects.

Henderson-Hopkins School in Baltimore.

The Perot Museum, designed by Morphosis Architects and Good Fulton & Farrell Architects, features a stratified façade of precast concrete panels to emphasize its connection to nature. Completed in 2012, the 182,000-square-foot museum incorporated a variety of active and passive sustainability concepts. The precast concrete panels were fabricated by Gate Precast in Hillsboro, Tex.

In naming the project to win the award, the jury commented that "The feel of connection of concrete to nature was a great use of a nature and science museum." The project also won a 2012 Design Award from PCI.

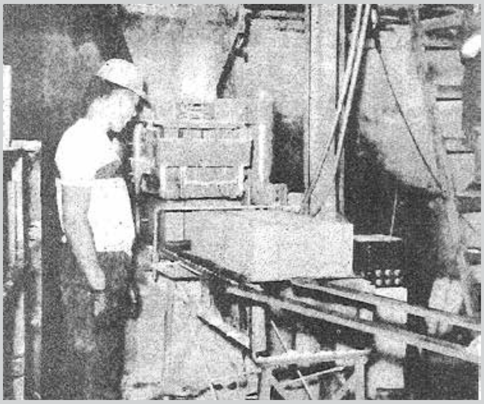
Also receiving an Honor Award was the Henderson-Hopkins school, designed by Rogers Partners Architects+Urban Designers. The façade of the school, encompassing two city blocks of classroom clusters and related facilities, features grooved precast concrete panels that were designed to mimic the local Formstone Neighborhood streets. Metromont in Richmond, Va., fabricated the panels.

The jury said of this project that, "The school is deftly woven into the neighborhood with welcoming indoor and outdoor spaces."

Spancrete, County Materials Celebrate 70th Anniversaries

WAUKESHA, WISCONSIN

Spancrete in Waukesha, Wis., and County Materials in Marathon, Wis., both are celebrating their 70th anniversaries this year with special celebrations.



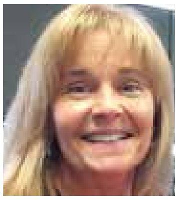
A block machine used in the early days at County Materials.

Spancrete's celebration was held on June 6 at its six U.S. locations. The firm is now in its third generation of family ownership, led by founder Henry Nagy's grandson, John Nagy, as CEO. The company's production facilities and partnerships reach as far as Kazakhstan, China and beyond.

County Materials, in Marathon, Wis., has launched a 70th-anniversay web page (www.countymaterials.com/70years) and plans special events in selected markets. The firm is led by President Tim Sonnentag.

Brenda Banks Rejoins PCI as Marketing Assistant

CHICAGO, ILLINOIS



Brenda Banks has been named marketing assistant at PCI and will manage participation in industry trade shows, assist with coordination of Ascent magazine, coordinate the annual PCI Design Awards programs, and coordinate external advertising and marketing webinars. She previously worked for the Kankakee School District business office, coordinating benefits and assisting the director of business.

Oldcastle Partners with Module X Solutions

SHREVEPORT, LOUISIANA

Oldcastle Precast has formed a joint venture with Module X Solutions, a maker of modular buildings for the telecommunications, petrochemical, oil and gas, fiber-regeneration, and solar industries. Module X Oldcastle LLC will be based in Shreveport.

The joint venture allows the firms to more effectively target the growing market for protective modular buildings in the United States, according to Steven L. Schoonover, Module X Oldcastle chairman. The firm will offer a variety of products and services to projected growth industries.

Gage Brothers wins 2016 Communications Award

SIOUX FALLS, SOUTH DAKOTA

The Society for New Communications Research of The Conference Board (SNCR) has recognized Gage Brothers Concrete with a 2016 Excellence in New Communications Award. The awards honor organizations for their exemplary use of digital, mobile, and social media.

Gage Brothers received top honors in the Visual Storytelling Category for the Corporate Division for its broad-based social media and public relations campaign that spotlighted its employees and products.

The awards were presented at a ceremony on May 18th at the Conference Board's Manhattan headquarters in conjunction with the 21st Annual Corporate Communications Conference at Fordham University.

PCI Foundation Accepts Washington U. Proposal

ST. LOUIS, MISSOURI

Hongxi Yin

PCI Foundation trustees have accepted a proposal to help fund an educational program at Washington University in St. Louis, Mo. The program will focus on aiding the university's submissions for two programs, the Solar Decathlon and the Race to Zero student-design competition.

A U.S. Department of Energy program, the Solar Decathlon challenges college teams to design, build, and operate solar-powered homes. The Race to Zero student-design competition, based on the six dwelling units in St. Louis, challenges 20 teams from architecture schools to present the best blend of affordability, consumer appeal, and design excellence with optimal energy production and maximum efficiency.

"The two-year program will have a variety of studios and experiences for the students, all working with precast concrete," says Hongxi Yin, the I-CARES (International Center for Advanced Renewable Energy and Sustainability) associate professor in charge of the program. "Participants will become aware of how architecture is so closely related to both the environment and technology through these problem-solving studio workshops."

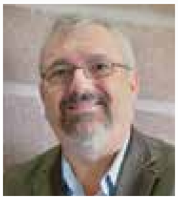
Clark Pacific, Ironrock Name Sales Executives

SACRAMENTO, CALIFORNIA & CANTON, OHIO

Gene Alhady

Gene Alhady has joined Clark Pacific as executive director of Sales and Marketing. He will be a key member of the business-development team, helping to develop and implement advanced technology in constructive solutions. Most recently, Alhady served as general manager of Trimble Buildings' Real Estate and Workplace Solutions Division.

Ironrock, maker of MetroBrick and Royal Thin Brick products, has named Rob Schrock as its national sales manager – Thin Brick. Schrock will make presentations to architects and specifiers, distributors, precasters, and others. Most recently, he worked with Glen-Gery Corp.



Rob Schrock

Trimbath Named Interim Executive Director of FPCA

TAMPA, FLORIDA

Terri Trimbath has been appointed interim executive director of the Florida Prestressed Concrete Association (FPCA). Trimbath will coordinate FPCA's programs, operations, business plan, and committees while a new executive director is found. She is the vice president of operations at LEAP Associates International Inc.

Spancrete Names Hennessee VP-Precast Operations

WAUKESHA, WISCONSIN

Spancrete has named David Hennessee vice president of Precast Operations for its Wisconsin facility. He joins Spancrete after spending 10 years as a plant manager and division manager at Standard Concrete Products. Highlighted by his PCI Level III certification, Hennessee has extensive experience in production and operations management. He will oversee precast concrete operations for the company's Wisconsin location.

Zaha Hadid, Concrete Virtuoso

The world lost a true innovator with concrete when the renowned architect died in March, leaving behind a dramatic portfolio that will continue to inspire future generations.

— Craig A. Shutt

Mary McCartney

Dame Zaha Hadid, DBE, who died in March at age 65, designed a number of dramatic, ground-breaking structures worldwide that helped expand the language of architecture. She was a strong supporter of precast concrete and glass-fiber-reinforced concrete (GFRC), pushing material boundaries with creative concepts, both in America and overseas. Her impact will be felt for generations to come, as one of those dramatic structures even now is being constructed with a GFRC exoskeleton in Miami, Fla.

Her designs "left a mark on skylines and imaginations around the world and in the process reshaped architecture for the modern age," said the *New York Times* in its obituary for the London-based architect. "She was not just a rock star and a designer of spectacles. She also liberated architectural geometry, giving it a whole new expressive identity."

Hadid contracted bronchitis and died of a sudden heart attack while hospitalized in Miami, where she was overseeing the construction of her latest project, the 1000 Museum, a 62-story, high-rise condominium building. That project features more than 4,800 pieces of GFRC as a supporting exoskeleton.

Born in Baghdad, Iraq, in 1950, Hadid combined interests in engineering and architecture to create dramatic concrete shapes that emphasized geometry, free-flowing lines, and high-quality, unique textures. She studied mathematics at the American University of Beirut before shifting to the Architectural Association in London in 1972. She founded Zaha Hadid Architects in London in 1979, garnering a worldwide reputation for her use of materials and shapes.

The Rosenthal Center for Contemporary Art in Cincinnati, Ohio, built in 2003, features a dramatic "as-cast" finish to emphasize the raw concrete material. The New York Times called it "the most important new building in America since the Cold War."

In 2004, she became the first woman to receive the coveted Pritzker Architecture Prize, and she twice won the Royal Institute of British Architect's Stirling Prize, Britain's most prestigious architecture award. Among her other awards was the Republic of France's Commandeur de l'Ordre des Arts et des Lettres and Japan's Praemium Imperiale. She was an Honorary Member of the American Academy of Arts and Letters and a Fellow of the American Institute of Architects.

Her first prominent concrete project was the Vitra Fire Station in Weil Am Rhein, Germany in 1994. Her fascination and love for concrete's capabilities were apparent in her designs, and that interest encompassed precast concrete and GFRC.

Cincinnati's Rosenthal Center

Her work with precast concrete made designers worldwide take notice, and she continually pushed the material's potential. A pivotal project was the Rosenthal Center for Contemporary Art in Cincinnati, Ohio. Created in 2003, it gave Hadid a chance to "conceive a stunning new take on curating and museum experience," said the Design Museum of London. She imagined the building, the museum quoted her as saying, would serve as "a kit of parts" that curators could customize for each show.

Each façade appears carved from a single block of concrete. The effect was achieved with thin concrete "fins" in the finish to make it appear as if the building was cast in place as individual gigantic pieces of concrete. The galleries were formed as horizontal tubes "floating above ground level, between which ribbon-like ramps zig and zag skywards," the Design Museum noted.

The effect, it said, was to create "an urban carpet," ushering visitors in from a busy intersection to a back wall illuminated with "light bands" to the walkway. "It's about promenading," the Design Museum quoted Hadid as saying about the design. "Being able to pause, to look out, look above, look sideways."

The *New York Times* described the center as "the most important new building in America since the Cold War." The Design Museum said it "silenced all those who said Zaha Hadid's architecture was impossible to build."

Achieving her vision certainly demonstrated the capabilities of precast concrete. "The architect wanted the building to be truthful, raw, and natural," says Kevin Iddings, who worked at High Concrete Group as general manager during the project. High Concrete produced 140 spandrel panels in its Springboro, Ohio, facility for the project. Hadid chose a straight form finish and dictated that gaps between the plywood forms be created, resulting in visible joints.

Her goals for the façade took a different approach than the precasters were used to, but they rose to the challenge. "Using only structural gray concrete, we couldn't control the color, and you can really see that in the building," Iddings notes. "The

The concrete surfaces on Hadid's Aquatics Centre in London, England, designed for the 2012 Olympic Games, were left exposed to use the texture and finish as a design statement. Photo: ®Hufton+Crow.

variation and natural appearance of the material gave the effect the architect was looking for."

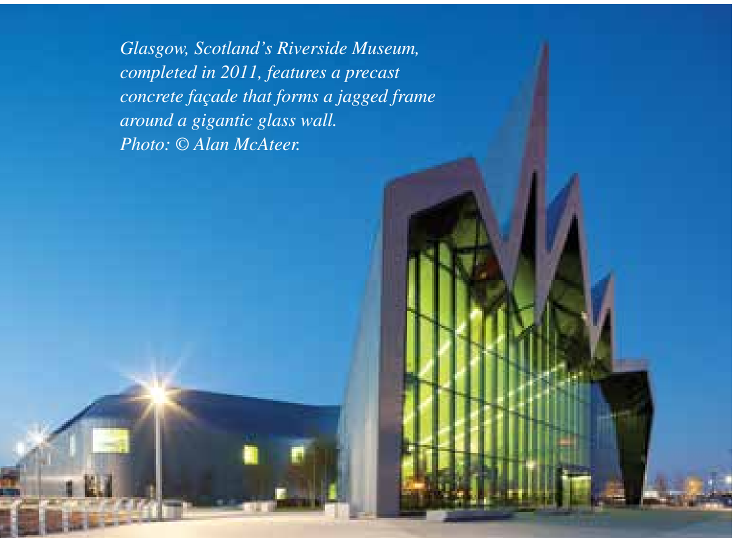
> 'She knew what she wanted, and it worked. That's the difference between an artist and a layman.'

"Our production people thought she was out of her mind," admits Jim King, senior design engineer at Gate Precast, who worked at High Concrete at the time of the project. They ultimately came to understand what she wanted to accomplish. "She was very pleased with the results," he says. "She knew what she wanted, and it worked. That's the difference between an artist and a layman."

Each time Hadid challenged the precaster, the crew rose to the challenge to achieve her goals. "The angles in the building weren't common angles, like 45 or 90 degrees," Iddings notes "But the dimensional control of the panels was excellent. They went up without any issues."

International Projects

After her triumph in Cincinnati, Hadid produced a variety of projects worldwide that featured precast concrete as a star material. They include the Riverside Museum in Glasgow, Scotland, which opened in 2011 as her first major public commission in the United Kingdom. It features a precast concrete façade that forms a jagged frame around a gigantic glass wall, which was described as a "saw-toothed gable" by Britain's *Architecture Today*. "The Riverside Museum is a building which embraces both the rational and the romantic," it said.



Glasgow, Scotland's Riverside Museum, completed in 2011, features a precast concrete façade that forms a jagged frame around a gigantic glass wall. Photo: © Alan McAteer.

"I wanted the building to reflect the importance of its location and allow for the innovative and inspirational display of its outstanding collection," Hadid said in a statement. "The fluid design continues Glasgow's rich engineering traditions; a true demonstration and celebration of the skills and passions of local engineers and contractors who helped to bring this building to life."

One of her best known projects to feature precast concrete is the London Aquatics Centre, designed for the 2012 Olympic Games. Its concrete surfaces were left exposed to use the texture and finish as a design statement. "The concept was inspired by the fluid geometry of water in motion, creating spaces and a surrounding environment in sympathy with the river landscape of the Olympic Park," the architect explained. The precast concrete roof creates an undulating form that "sweeps up from the ground as a wave, enclosing the pools with its unifying gesture of fluidity, whilst also describing the volume of the swimming and diving pools."

She also used precast concrete for the façade of Pierresvives ("living stones"), a government building housing regional archives, sports activities, and a multimedia library in Montpelier, France. The project, completed in 2012, features more than 1,000 precast concrete panels with an ultra-smooth finish cast as long, zig-zagging horizontal stripes interspersed with bands of green glass.

International GFRC Uses

Hadid used GFRC in a variety of projects around the world. These include the Capital Hill residence in Moscow, Russia, built in 2008, which has been likened to a spaceship due to its undulating shape and twin towers jutting upward. The project earned "Best Project" at the 16th World GRC Congress.

"During the design phase, the architectural team was contemplating natural stone, GFRC, and GFRP [glass-fiber-reinforced polymer] for the façade," says the GFRC provider, Fibrobeton in Istanbul, Turkey. "After seeing the first mock-up, the architect decided the best alternative to put the project into practice was GFRC. This technology made extremely significant contributions to both the designer and the main contractor."

Another significant project was the Nanjing Youth Olympic Conference Center near the Nanjing Jianye District of China. Built for the 2014 games, it features twin towers containing

The 1000 Museum condominium project in Miami, Fla., currently under construction, features an exoskeleton of GFRC panels being shipped from Dubai by a PCI-certified precaster. The design provides a rigid exterior frame that will be functional and decorative. Rendering: © 2014 Paul Morris.

a 68-story five-star hotel and a 58-story meeting hotel connected by a six-story conference center. Hadid was quoted as saying she used sail boats as influences as she created a "space yacht," on which the athletes would set out on their brave voyages. Because of its irregular and complex design, it was created with steel framing clad with GFRC, requiring more than 12,700 different shapes of panels.

"At the interface between tower and podium, the glass façade gradually transforms into a grid of rhomboid fibre-concrete panels, giving the large surfaces of the podium and conference center a solid and sculptural appearance, underlining the dynamic character of the form and providing daylight to the building's interior," her firm explained.

It was an unusual application for the GFRC provider, Nanjing Beilida New Materials System Engineering Co. Ltd. "The lightweight GFRC wall panels will definitely help the material make greater contributions to the building design development in the future, just as is demonstrated on this project," the company said. "It was an unprecedented application in the larger irregular building structure."

New GFRC Project Underway

"Unprecedented applications" were routine for Hadid. The project she was overseeing at the time of her death shows she was continuing to challenge concrete materials to achieve more. When completed, the 1000 Museum condominium in Miami, at 68 stories one of the tallest buildings in Miami, will feature a curving exoskeleton to help hide balconies and create a dramatic image while also serving structural needs. It consists of GFRC panels which are being shipped from Dubai by Arabian Profile Co. Ltd., which became PCI-certified for the project.

The form will provide a rigid, stiff frame that protects the building from hurricane-force winds while removing columns from the interiors, freeing interior design. The thin profile and flowing exoskeleton required drilling foundations to record depths of more than 170 feet. "We wanted to avoid that generic, modernist typology," Hadid was quoted as saying about the building at ArchDaily.com.

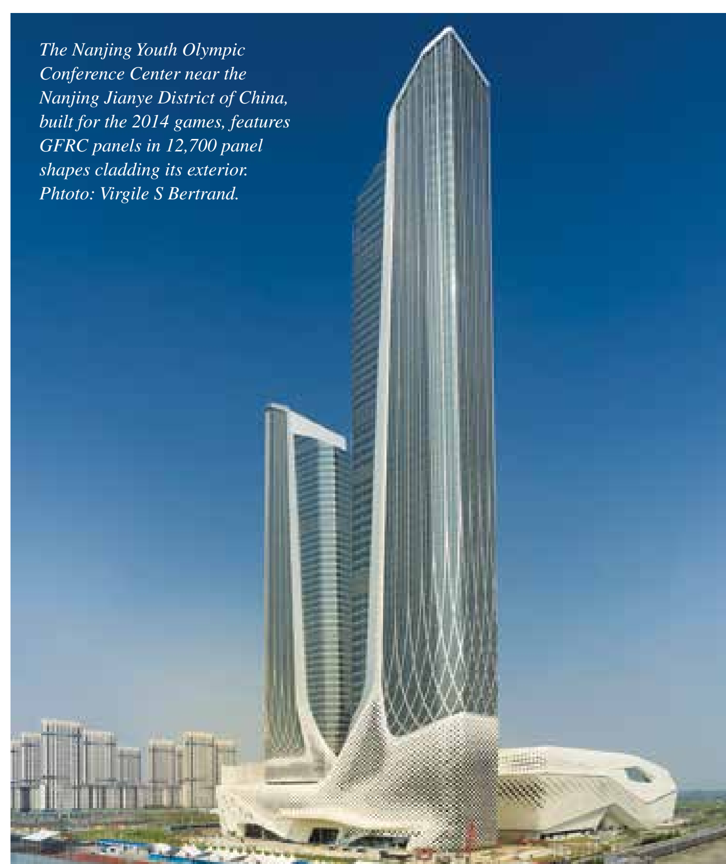
The design combines engineering and architecture, according to project director Chris Lepine. "What you see is literally structure getting thicker and thinner as needed," he was quoted in *Architect* magazine as saying. "There's a continuity between the disciplines, between the architecture and engineering, to create that impression."

Influence Will Grow

Hadid's concepts for expressing form in concrete and pushing the capabilities of the material will no doubt continue, as her projects inspire more people. Hadid's death "was sad on many levels," Cincinnati's *CityBeat* magazine reported in April. "One of those is that she won't get a chance to see the Contemporary Arts Center's brilliant use of her building for its current installation, Do Ho Suh's Passages."

The British artist's sculptural presentations, writer Steven Rosen said, "is the best fit for Hadid's building that I've seen there. The artist seems as dedicated to transforming architecture and transcending conservative notions of what a 'building' should look like as Hadid. Like her, he also thinks big but has a sensitive, poetic touch for the smallest details."

Hadid's work no doubt will inspire architects as well as artists of all types. Her widespread commissions ensure that people throughout the world will continue to see how a material as solid as concrete can have a plasticity and flow that suggests more possibilities are available as soon as they can be conceived. A



The Nanjing Youth Olympic Conference Center near the Nanjing Jianye District of China, built for the 2014 games, features GFRC panels in 12,700 panel shapes cladding its exterior. Phtoto: Virgile S Bertrand.

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SPOTLIGHT

Cook Children's Medical Center

CCMC's new South Tower project is an extraordinary update for one of the busiest pediatric emergency care facilities in the United States. The expansion will extend the hospital's already impressive capabilities through space for new operating rooms, laboratories, additional intensive care units, a heart center, and special procedure areas.

Thermomass partnered with Gate Precast to supply insulated precast panels that would provide an energy-efficient building envelope with long-term thermal resistance and condensation control. The finished panels are extremely durable and perfectly match the natural limestone exterior of the existing hospital buildings.

Precast Promotes Innovation In Every Type of Project

The plasticity, design flexibility, aesthetic versatility, resiliency, and economical effectiveness of precast concrete helps designers and contractors meet challenges and create striking buildings

— Craig A. Shutt

Developers, architects, structural engineers, and contractors regularly confront challenges that impact their designs. Many times, they turn to precast concrete components to help them resolve these issues so they can create buildings with unique and distinctive elements while overcoming constraints in the site, budget, or schedule. As they push the envelope, precasters respond by using precast's attributes to engineer solutions to meet those demands.

High-performance precast concrete components offer ever-growing capabilities due to their versatility, efficiency, and resiliency. Each attribute offers multiple advantages that designers and contractors can emphasize to aid their needs. (For more on these attributes, see the sidebar.)

These benefits can be engineered to meet a variety of needs, and precasters continue to build on them and combine them to help create innovative structures. The following examples in diverse building categories show ways in which precast concrete was used to achieve unique designs with stringent requirements.

Drexel University Housing

The new 861-bed residential development on Chestnut Street in Philadelphia, Pa., provides Drexel University students with two- and four-bedroom suites organized as duplexes, with a living room and kitchen at the entry and bedrooms alternately above and below. This unusual layout was mandated by the tight site on which the project was built, a 50-foot-wide infill site that hadn't previously been considered developable. Developer American Campus Communities (ACC) worked with Drexel administrators to procure the site for the facility, which ACC rents to students.

Students aren't assigned to the housing; the developer must rent it each year. "If they don't rent it quickly for the next academic year, their pro forma suffers," explains

Unique elements created in architectural precast concrete panels add distinction to the new 861-bed housing development at Drexel University in Philadelphia, Pa. The building features large projections along the low-rise portion of the building and panels with four levels of sandblasting to mimic the variety of textures in real limestone blocks. Photo: ©Peter Aaron/Esto.

Kevin Smith, a partner at Robert A.M. Stern Architects, the architectural firm on the project. That meant the building had to be attractive and high quality.

Despite its odd footprint, the building sits on a prominent location, Smith notes. "It's located at the school's front door, just off the newly enhanced main quad," he explains. Nearby are the new business school building and a new science center, which have limestone façades to express a high-quality image. "This building is at the core of the campus and had to integrate while making a statement."

To achieve this, designers used architectural precast concrete panels to clad the building, which offers two long, low-rise portions six stories tall and a high-rise segment 18 stories tall. To give the building extra dimensional interest, the architects created large, squared-off projections across the low-rise section and replicated the variegated look of nearby limestone buildings by using five levels of sandblasting on portions of each panel within segments created with false joints. The low-rise sections sit above transparent ground-level retail spaces supported by columns that frame a view toward a nearby theater.

> 'Our calculations showed that precast concrete gave us the lowest cost and best longevity.'

Many Options Considered

Designers considered a variety of façade options before deciding on precast concrete, Smith says. Those included metal panels, masonry, and composite panels. "Our calculations showed that precast concrete gave us the lowest cost and best longevity. It was only a few dollars per square foot more than an EIFS system, which no one involved judged appropriate."

The architects worked closely with precaster Universal Concrete early in the design phases to determine the variety of finish options that could be selected. "Administrators were a little alarmed when we suggested precast concrete because they didn't have an up-to-date image of what precast concrete can do."

The key goal was to approximate the look of limestone, and its success was critical due to the nearby university buildings with limestone façades, especially one directly across the street. "A donor had paid for the limestone on the science building, and the university was adamant that this building provide the same look but without the cost."

This was accomplished by casting the panels with a multitude of false joints to create the appearance of six to eight blocks of limestone joined together within the panel. The false joints also helped to disguise where the real joints were located. Each block was treated with one of five levels of sandblasting to create varying textures and colors.

The levels were randomly assigned but meticulously tracked. "We were given what looked like a paint-by-number scheme, with each block within the panels indicated and numbered with the level of sandblasting to provide," explains Bill Hydock, preconstruction manager.

To ensure only portions of each panel received each subsequent level of sandblasting, the precaster created shields for the finished pieces, providing essentially a stencil that continued blasting only the portions of the panel requiring more finishing. "The sandblasting took a lot of extra plant time, but we had factored that into our casting schedule," he says.

Photo: ©Peter Aaron/Esto.

CHESTNUT STREET RESIDENCES

Location
Drexel University, Philadelphia, Pa.

Project Type
Student housing

Size
331,800 square feet

Designer
Robert A.M. Stern Architects, New York City, N.Y.

Owner
American Campus Communities, Austin, Tex.

Structural Engineer
SCA Houston, Sugar Land, Tex.

Contractor
Hunter Roberts Construction Group, Philadelphia, Pa.

PCI-Certified Precaster
Universal Concrete Products, Stowe, N.Y.

Precast Specialty Engineer
Detailers Plus 10, Hammonton, N.J.

Precast Components
710 architectural panels encompassing 141,180 square feet

The precaster also cast the projections for each floor. Each unit features two punched windows across its front with a narrower punched window on each side. "The articulated façade creates a giant egg-crate appearance that adds space and visual interest," says Smith. "It gives the building a more monumental scale to help it fit with the other larger campus buildings around it."

'The articulated façade creates a giant egg-crate appearance that adds space and visual interest.'

The projections were cast as one panel, with beefed-up connections and lifting points. The panels are 6 inches thick at the connection points and taper to 2'4" at their face. A ribbed pattern was cast between the windows to add more texture and contrast. The panels were cast one-story tall, or approximately 11 feet, which enabled ease of transportation. Two-story segments feature two panels joined together. "You have to look really closely to see the joint," Smith notes.

Strip windows were used to denote the living rooms in each unit, which lead either upstairs or downstairs to bedrooms. The alternating pattern was necessary due to the narrow site. "These are essentially nested townhouses, but each has a living room as an entry point," Smith says.

The panels were no more difficult to cast than others, Hydock notes. "They were heavier to deliver and to lift, but that meant we just had to be more careful with them," he says. No special delivery equipment or racks were required, although some were erected using a ground crane, as they were too heavy for the tower crane in use. Those pieces were erected on weekends when the crane could be positioned in the street.

The ease of erection also held true for the sandblasted panels. "The beauty of working with precast concrete is that once the panels were finished, they were no different than any other panels," Hydock says. "They erected the same and went up quickly despite all the work that went into them."

J-I-T Delivery Used

The panels were delivered and erected on a just-in-time (J-I-T) basis due to the tight and narrow site. Erection over existing occupied spaces, including restaurants, was done when nearby housing units were unoccupied in the summer. The high-rise and low-rise segments of the project were erected separately. "They were treated more as two separate projects," Hydock says. "That required lots of attention to sequencing and more details to work through. But everything went very smoothly."

Precast Concrete's Attributes Aid Innovation

As a highly engineered material, precast concrete can contribute a wide range of attributes to a project that helps overcome constraints and meet an array of challenges. The material provides versatility, efficiency, and resiliency in a host of ways:

Versatility

Precast offers aesthetic versatility through its ability to mimic many architectural finishes, including brick, stone, and granite via formliners and finishing techniques. It also can have masonry units embedded into its surface, creating a durable aesthetic that secures the material, eliminating future tuck-pointing. This capability allows it to reflect any historical design required or create a dramatic contemporary appearance.

Its structural versatility comes from its capability to provide long-span components and load-bearing envelopes that create open spaces for design flexibility. These sections are cost-effective and combine multiple functions in one piece.

It provides user versatility in offering recycled content and being recyclable as well as being adaptable to renovation by removing existing end panels, adding onto buildings and replacing the panels.

Efficiency

Site efficiency can be gained through specifying precast concrete because it moves many activities (panel fabrication, brick laying, insulation) off-site to a controlled environment. Those controls also reduce waste and accelerate construction by beginning fabrication while site work is underway.

Energy efficiency is created through the inherent mass of precast concrete, which can absorb heat during the day and release it during cooler nights. Embedded insulation layers create an envelope of continuous insulation that reduces HVAC needs, while precast concrete's durability reduces needs for cleaning, repairs, and other maintenance that provides a long service life that eliminates the need for using new materials.

Designers and contractors can reduce risk factors by using the precaster on a design-assist basis to ensure components are created at maximum efficiency for transporting and erecting. This aid can reduce schedule time and minimize field adjustments.

Resiliency

Structural durability is achieved through precast concrete's long service life, and its monolithic mass that provides an impenetrable rain barrier. It also stands up to high winds and storms and can be designed to provide any level of earthquake or blast resistance that codes or requirements demand. Its inherent inorganic composition adds passive fire resistance to supplement active systems to create a safer building as well as aiding indoor air quality, with no off-gassing.

Precast's local manufacture, energy efficiency, reduced waste, lessened site congestion, and use of recycled, local materials add significant points to any project trying to achieve LEED certification. Precasters can ensure all of these characteristics are maximized if they are consulted on the project early in the design process.

Inset thin brick was used in a few areas to add contrast and texture, while a small amount of limestone was used at the main entrance and at corners to provide stone texture at eye level. "But it's really hard to tell the difference," Smith says. "After it was installed, the owners questioned whether they really needed to add real limestone in those locations."

Such comparisons make the economics and aesthetic appeal of precast concrete apparent. "It's a great message about the ability of precast concrete to replicate the look of limestone," Smith says. "The developer is very proud of what we could achieve. It's a very handsome building. It sets a great tone for what Drexel wants its buildings to be."

Manhattan West

Precast concrete's continuing evolution to achieve longer spans and greater load capacities was epitomized by its use in an innovative project in Manhattan that used 2,400-ton segmental concrete box beams spanning 240 feet to create a platform from which a new housing development of luxury condominiums and other services could rise. Although bridge components were used, the concept offers great potential for designers on building projects in heavily congested urban areas.

The challenge presented to designers was to connect the two portions of a 7-million-square-foot development spanning 15 railway lines and related electrical services near Penn Station. The platform also had to support a parking structure topped by a public plaza that serviced two high-rise residential buildings flanking the site.

The design and construction team turned to precast concrete components to provide the best solution for spanning the rail lines 55 feet below street level without adding columns or supports. The key to meeting the challenge was to erect the platform using a launching gantry that could set the segments from overhead, avoiding any disruptions to activities at track level.

The office buildings' columns don't bear on the platform itself. The core structures of the building are founded on bedrock, while the curtain-wall columns penetrate through deck openings in the platform and extend down to track level. The smaller columns for the parking structure bear on the platform and support the pedestrian plaza above it.

MANHATTAN WEST

Location
New York, N.Y.

Project Type
Building platform over train tracks

Size
130,000 square feet

Cost
$70 million

Designer
Skidmore Owings & Merrill, New York, N.Y.

Owner
Brookfield Office Properties, New York, N.Y

Structural Engineer
Entuitive, Toronto, ON, Canada

Project Construction Manager
Turner Construction Co., New York, N.Y.

Construction Manager
Rizzani de Eccher USA, Bay Harbor Islands, Fla., and Pozzuolo del Friuli, Italy

Launcher Gantry Designer
McNary Bergeron & Associates, Old Saybrook, Conn.

Launcher Gantry Supplier
DEAL, a subsidiary of RdE USA, Bay Harbor Islands, Fla.

Launcher Gantry Operator & Platform Erector
Metropolitan Walters LLC, New York City

PCI-Certified Precaster
Jersey Precast, Hamilton Township, N.J.

Precast Specialty Engineer
McNary Bergeron & Associates, Broomfield, Colo.

Precast Components
612 segments of segmental box beams

A platform built from 2,400-ton segmental concrete box beams spanning 240 feet supports a plaza that connects two portions of a 7-million-square-foot development spanning 15 railway lines and related electrical services near Penn Station in Manhattan, N.Y. A transverse launching gantry allowed the segments to be installed from overhead, alleviating congestion at street level.

‘The crews were working over some of the busiest railway tracks in the world, so they had to ensure the integrity of the girder-setting process.’

“The site provided major challenges,” notes Phil Marsh, project engineer with McNary Bergeron. “The crews were working over some of the busiest railway tracks in the world, so they had to ensure the integrity of the girder-setting process, to avoid any slippage or accidents that would interfere with the rail service.” Rail-service stoppages to allow work at track level were available for no more than 2 hours at a few limited times.

Transverse Launching Gantry

The platform features 16 2,400-ton segmental beams, each comprising 37 to 39 match-cast precast concrete segments that span the 240-foot opening between the two sides of the development. The custom-built launching gantry, which set the beams from overhead, ran on rails running parallel to the abutments that supported the beams.

Initially, a temporary protection platform was built over the rail lines. “This horizontal space not only protected the rail lines as work was set up, but it served as the underslung bed from which the launching gantry could be assembled and the initial beams could be set into place,” explains Andrea Travani, project engineer with Rizzani de Eccher USA. After the first two beams were set, the platform was used as the stage from which subsequent beams were fabricated.

The 612 precast concrete components were cast at the precaster’s New Jersey plant and delivered to the site over a 5-month period. The 39 segments needed for each beam, each weighing approximately 56 tons, were stored in a 6,100-square-foot yard on the site. The segments, made with 9,500-psi concrete, were double-stacked because of the vertical web design of the box, which allowed direct transfer of load from the box above to the webs of the box below. “That cross-section geometry allowed the construction sequencing to be simplified and maximized the small available space for staging the segments,” Marsh notes.

The components were delivered to the site from Jersey Precast’s Hamilton, N.J., plant in a two-stage process due to limitations on moving oversized loads in the state. The daily deliveries had to wait at the George Washington Bridge until dusk to drive into Manhattan, explains Amir Ulislam, owner of Jersey Precast. “It took a lot of planning and coordination to make it work.”

The gantry picked each segment from the staging area using a C-hook, which lifted the segment beneath its top slab and carried it into place on top of the underslung equipment, Travani explains. Each segment was positioned after being set onto three screw jacks and leveled against the previous match-cast piece. The segment joints were epoxied and first-stage tendons were post-tensioned using a specially designed and fabricated custom-stressing platform. The beam was then moved to a second location on the platform where additional work was performed including tensioning of the remaining tendons.

Hydraulic System Lowered Beams

“The gantry moved smoothly and quietly, considering the immense size and weight of the beams being placed,” notes Travani. The gantry moved 10 feet per minute and lowered the beams into place at a rate of 1/2 foot per minute. The lowering system consisted of hydraulic cylinders with pins and slotted bars. The pins held the beam in place while the bars were lowered into the next holes, after which the pins were removed and the beam lowered into the next slot via the hydraulic action.

“This slow, methodical approach ensured that the beam remained under our complete control at all times and eliminated any concern that the lowering process could slip, causing the beam to fall onto the tracks,” Travani says.

Each beam required 100 tons of post-tensioning, using 20 37-strand and 14 31-strand tendons. The 16 girders create a platform 480 ft wide with an 11.5 feet depth with three distinct sections. This design allowed for movement of the completed structure.

Cast-in-place concrete was placed between pier segments to create three solid structures and provide movement joints. The beams and joints between them were covered with a 6-inch cast-in-place concrete slab. Conduit was installed in the cast-in-place slab to contain power and control systems for the ventilation system, track and platform lighting, security cameras, power, and other needs.

Pre-engineered openings were created in the flanges of the beam segments to allow columns to be installed later. Openings were also placed in the webs of the box girders to create ventilation holes to evacuate smoke in case of a fire on the tracks below. Alternating girders had web openings and a fan room for the ventilation system. “Smoke would be drawn up through the holes to street level if necessary,” Marsh explains. The platform also acts as a fire-break with a 4-hour fire rating.

An added benefit of using the precast concrete design was that the material was inherently fireproof, notes Ulislam. “If we had gone with a steel design, we would have needed extra support columns and a lot of fire-proofing.”

Typical girders have access openings in their end diaphragms of approximately 10 square feet. However, end diaphragms for girders with ventilation openings were required to have an opening of 100 square feet, so the typical end diaphragm details wouldn’t work, Marsh says. Instead, diaphragms between adjacent girders were designed to provide torsional restraint for the deck system. Numerous form-saver rebar and duct couplers also were used on end-segment faces to provide the necessary connections to the cast-in-place diaphragms.

“Some cracking occurred in the segments during one of the post-tensioning events, but it was all very small,” Marsh says. They were sealed with methacrylate crack sealer. Most of the cracks appeared at openings due to splitting the forces created as stresses flowed around the column openings.

The new six-level, 400,000-square-foot parking structure at the gateway to the University of California at Davis Medical Center in Sacramento, Calif., features a precast concrete hybrid moment frame that allows the structure to self-right after a seismic event. A distinctive "lap-siding" design for spandrels provides visual interest while helping to keep the façade clean.

The project proved successful and offers potential for other situations. "We got everything done without interrupting service, and the entire team did a fantastic job," says Ulislam. "I'm very proud of this project."

It was a team effort, says Marsh. "The members of the construction team worked together closely throughout the project to ensure it ran smoothly under challenging conditions in producing a first-of-its-kind structure."

It may offer concepts other designers can use, Travani notes. "The project offers great potential for developers in highly developed, high-demand areas where the urban environment generates a lot of activity and little maneuvering room for construction, much less development."

Marsh agrees. "The combination of top-down construction and precast concrete's off-site fabrication creates speedy construction with little disruption to the area and a high level of safety," he says. "It offers a new and fast way to literally create high-end real estate for development out of thin air."

Medical Center Parking Structure

The new parking structure at the University of California, Davis' Medical Center in Sacramento, Calif., was designed to meet the needs of an expanding population of patients and visitors to the center, an academic health center focused on advanced care, and new treatment options. To reflect this cutting-edge work, administrators wanted a design that expressed a contemporary feel that projected the center's professional reputation while still meeting the facility's functional needs, which included providing a structural system that could meet the area's high-seismic needs.

To meet these goals for the six-level, 400,000-square-foot structure, designers chose a precast concrete structural system and architectural panels, along with poured floors. The framing system features a precast hybrid moment-frame design that meets the seismic needs by uncoupling the connections so the building can self-right after a seismic event. For its aesthetic plan, architects created a modern appearance that features an integrally colored white architectural finish with lap-siding-shaped reveals emphasized by a series of metal panels attached to the entry.

"Some parking structures are treated as utilitarian buildings and are hidden behind the main facility, but this one sits at the front of the medical center," explains Matt Engleking, project manager at Clark Pacific, the precaster on the project. "Given its location, administrators wanted

UNIVERSITY OF CALIFORNIA AT DAVIS MEDICAL CENTER PARKING STRUCTURE III

Location
Sacramento, Calif.

Project Type
Parking structure

Size
400,000 square feet

Architect/Engineer
Watry Design, Redwood City, Calif.

Design Architect
Dreyfuss and Blackford Architects, Sacramento, Calif.

Owner
UC Davis Medical Center, Sacramento, Calif.

Contractor
McCarthy Building Co., Roseville, Calif.

PCI-Certified Precaster
Clark Pacific, West Sacramento, Calif.

Precast Components
689 architectural panels, 134 spandrels, 96 moment beams, 20 moment columns, 55 gravity columns, 61 gravity beams, 61 elevator panels, and 14 wall panels

the structure to act as the center's highly visible 'front door' while blending with the existing campus architectural style."

Specifying precast concrete for the project was an easy choice, says Jason A. Silva, design principal at Dreyfuss + Blackford Architecture, the design architect on the project. "I've been a fan of precast concrete for a long time." Silva has used the material on a variety of projects, including four in the past eight years. "This was the first time we could leverage the hybrid moment frame, which offers a lot of opportunities."

> 'It shows the ingenuity and talent of the designers when they can create a dynamic appearance that's also efficiently produced and economical.'

A key advantage is the flexibility it offers. "I like to work with precast concrete as a kit of parts," he explains. "It has a certain modularity and uniformity that helps guide the design. It can be something of a challenge to work within those constraints, but it's also a benefit because it can help reduce the design to its fewest parts while creating an elegant solution. It doesn't create any engineering challenges, and it provides a design approach that speaks to the process required to get there."

The economics also appeal to him. "If I can make the structure more efficient, I can put more of the budget into the finishes inside," he explains. "Precast concrete comes with an architectural finish inherent in it, so it saves time and money by not having to apply those afterward, and it offers a high-quality appearance that's very efficient. I can't reduce my costs by removing the finish from the panels, so the finish is not part of the budget decisions, it's part of the primary structure."

As a result, he achieves a much higher quality appearance than would be possible with other materials. "It requires diligence to maximize the appearance, but the options are unlimited," he says. "It shows the ingenuity and talent of the designers when they can create a dynamic appearance that's also efficiently produced and economical."

The designers evaluated a cast-in-place structure, but the added finishing costs eliminated it from consideration. "A cast-in-place design would have required precast concrete panels hung from the exterior to match the surrounding buildings, so it didn't make sense."

Lap-Siding Profile Cast

The design plan used the appearance of lap siding as its influence, with a "shingling" shape that adds texture and visual interest. "The quality of the material really helped to achieve the look we wanted," he says. The architect worked with Clark Pacific on a design-assist process to work out how the various pieces could be cast to maximize efficiency. They also worked out embeds into the panels for the array of metal louvers and aluminum panels attached to the concrete panels. "By working on a design-assist process, we could ensure continuity of the architectural style with the existing medical campus buildings," says Engleking. Silva agrees. "We've worked well with them in the past, and we always invite them to give feedback and help create more efficiencies."

A key benefit of working closely from the beginning was the level of precision that could be provided, Silva says. Dimensions could be planned tightly, with the architect confident the components would fit closely. Reveals were added to spandrels alongside thin, horizontal openings to emphasize the horizontal nature of the parking structure, and other architectural accents were added as well. Metal louvers were focused on key points, including the entry, to direct visitors to the entrances clearly.

The campus palette focuses on four main materials, Silva explains: white precast concrete, off-white aluminum metal pieces for canopies and awnings, anodized aluminum, and green glass. The parking structure was designed to emphasize the first two especially.

The horizontal rectangles created by the reveal pattern have an added benefit in their lap siding, which has each segment angling outward, with the one beneath indented behind it. That helps ensure the pure-white concrete mix will stay white, Silva says. "Cars in large parking structures generate soot, and it can settle into reveals. To minimize that concern and add more shadowlines, we added the lap form to prevent streaking after a rain." Tops of the crash rails also slope inward to ensure no staining flows from the interior.

"It was a challenging form for Clark Pacific to create, since it's more complicated than traditional panels with reveals, but it achieved its goal," Silva says. "The form works very efficiently and the quality we received was very high."

Metal panels, mesh, and aluminum louvers were attached to the panels on façades facing the street. The louvers were designed with consideration for traffic, with each angled differently to diffuse headlight glare while creating a sense of movement from one set of louvers to the next. The embeds were placed and panels were installed smoothly. "They worked perfectly, just as intended," Silva says. "They had a high level of accuracy."

Hybrid Moment Frame

Seismic needs were met by the precast concrete hybrid moment frame. "I always advocate for the moment frame due to the open space it can provide while meeting seismic needs," Silva says. "This is a 24-hour facility, with many visitors feeling very emotional as they arrive and depart. They need clear, open lines of sight for safety, security, and accessibility." The interior was painted white to add to this. "The white concrete reduces the ability of dirt to cling to the walls and adds brightness."

The benefit of the hybrid frame is that it uses the joints as a controllable focus for absorbing force and flexing with it, providing an easily inspected and repaired location after a seismic event. In other types of structures, that deformation can occur randomly and at an unknown point, producing time-consuming and expensive inspection and repair processes.

The precast concrete moment-resistant frame absorbs seismic energy independent of the integrity of the structural members. The post-elastic performance concentrates in the connection region rather than a structural member. By combining both inelastic and elastic responses, minimal damage occurs to the moment frame, typically in the form of minor spalling. The benefits that result from this design include life-safety enhancements and economics, as well as open interiors through eliminating shear walls.

The designers considered using double tees rather than cast-in-place floors, but the irregular shape of the parking structure and tight site made that design impractical. "We have a 180-foot ramp that had to be warped a little to fit the space, and it was too tight to make double tees work efficiently," Silva explains. "In most situations, I would have used a total-precast concrete design."

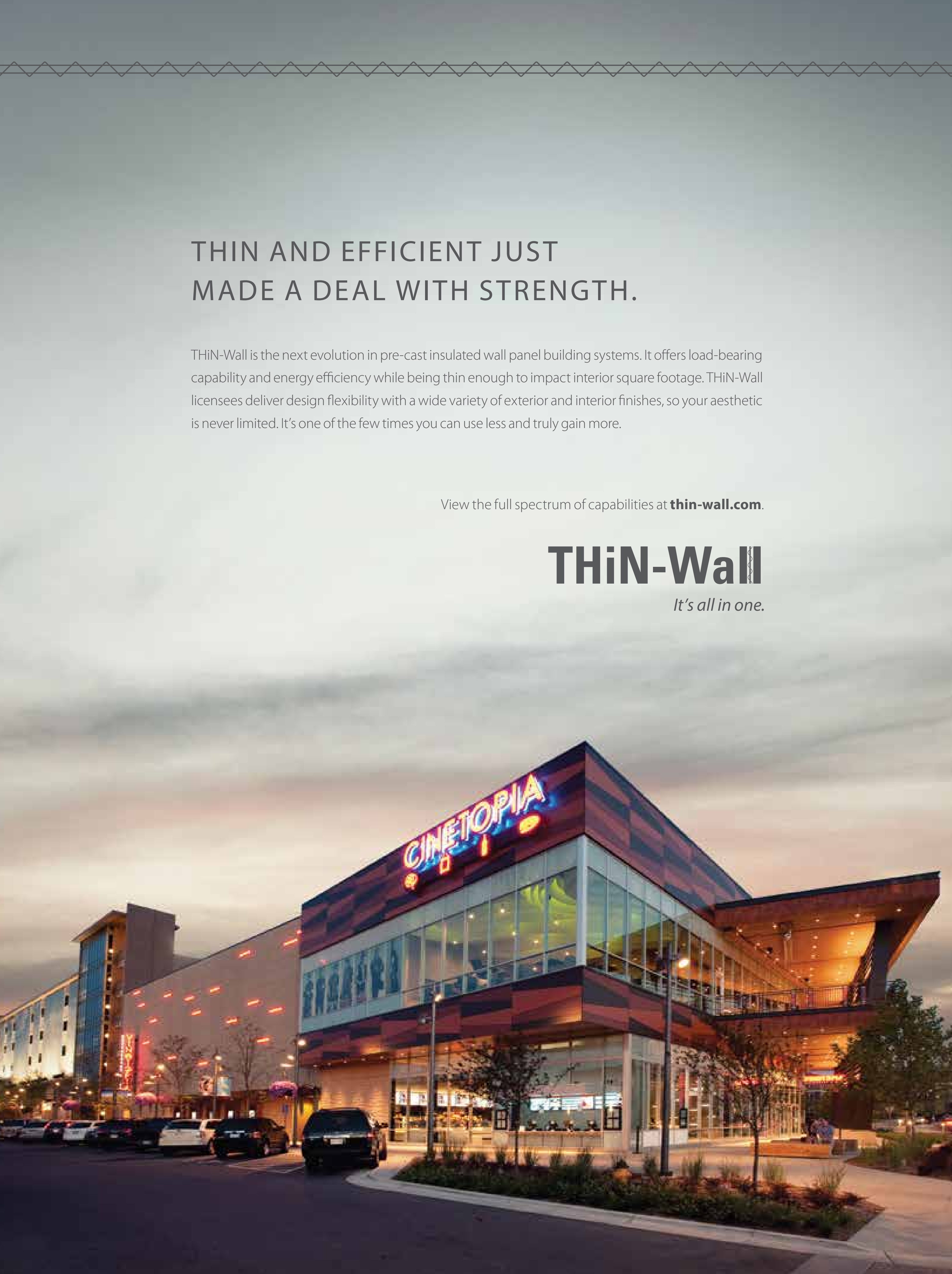
All of the components were delivered to the site and erected on a just-in-time basis, with trucks arriving and pieces being picked before the next truck arrived. "We could time trucks about 15 minutes apart, which really helped, as we had no staging area," Silva says. "It eliminated the concern of having a pump truck sitting on site for days."

The crane was placed at the center of the footprint, and the structure was built out from the edges due to the tight site. "We were 30 feet from the hospital, with the property line on two sides and the hospital on the others," Silva says. "We had no maneuvering room, so we stayed inside our footprint." Using precast and building rapidly in this fashion cut 2 months from the schedule, he estimates, and reduced the impact on the campus. "I advocate for this system whenever I have to build to the property line."

The project fulfills the University of California System's standards for sustainable practices as well, incorporating energy-efficient and sustainable features. These include a photovoltaic power system, which provides 145 kW of power to the hospital and electric-vehicle charging stations.

The result is a parking structure strategically located as a signature statement for the hospital campus that offers functional service and strong life-safety measures in case of a seismic event. "It very effectively showcases the functionality and aesthetic versatility of precast concrete," Engleking says.

Silva agrees, to the point that he's using precast concrete again on his next project, now underway at Sacramento State for an 1,800-car facility. "We have more room and a less complicated footprint, so it will be a total-precast concrete structure," he says. "I've been considering some design ideas that will maximize the benefits of the precast concrete double-tees at the perimeter to add daylight to the interior. You'll see those come to fruition on this new design."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CINETOPIA

Modular Design Speeds Dorm Completion

Precast concrete components plus bathroom and MEP modules maximize prefabrication to ensure graduate dormitory at University of Michigan meets tight schedule

— Craig A. Shutt

Innovation takes many forms in the architectural community. For a new graduate dormitory constructed at the University of Michigan in Ann Arbor, the living arrangements were based on new concepts for how graduate students could interact to heighten their learning experience. The dorm itself used innovative techniques to make efficient use of modular components, including bathroom units, MEP modules, and a precast concrete framing system.

The format and construction techniques were driven by a donation from philanthropist and U of M alumnus Charles T. Munger. His gift in 2013, the largest ever in the university's history, was designed to create a "transdisciplinary environment" that would encourage student residents to develop networks across disciplines. He also was a proponent of efficiency through modularization, which was needed in this case due to a tight schedule to ensure the project was ready for occupancy for the Fall 2015 semester.

"This project was the brainchild of Charlie Munger," says Paul Stachowiak, president and principal in charge at Integrated Design Solutions (IDS), the architectural firm on the project that worked in association with design architect Hartman-Cox Architects. "He believed that changing the living arrangement for graduate students could create great things. By creating networks among the individual silos in which most graduate students work, we have an opportunity to create collaboration and interdisciplinary learning."

The 370,000-square-foot Munger Graduate Residence houses 630 graduate students in apartment-style layouts. Floors one through seven of the eight-story building feature 96 furnished apartments, each with six to seven single-occupancy bedroom suites and a private bathroom. The bedrooms connect via a corridor to common areas of dining and living spaces, including full kitchen and laundry. The suites typically exceed 2,700 square feet, with more than 1,000 square feet devoted to communal spaces. The eighth floor contains study spaces, seminar room, a convenience store, catering kitchen, and fitness center. A rooftop terrace features a running track with a view of Michigan Stadium and downtown.

The 370,000-square-foot Munger Graduate Residence at the University of Michigan was designed to emphasize modular construction, including slide-in bathroom units, MEP modules, and a precast concrete framing system.

Modularization Emphasized

A key stipulation for the project was that modularization be used in a significant way. Munger believed in the efficiencies that such construction could provide and wanted to see it in use on the dormitory. "The donor had a lot to do with the material selection," says Nick LaForest, project architect at IDS. "He wanted to use modular design, and he wanted the project built expeditiously."

The combined need for speed and modularization led the team to a precast concrete design. "The biggest reason for specifying the precast structure was the tight schedule," says Stachowiak. "Just behind that was the combination of durability and the ability to work with our other prefabricated components smoothly." Quality was also a key issue. "The quality of precast concrete we received was very high. We toured the facility in advance to see their capabilities, and we stressed the speed required to meet the schedule. They were an invaluable partner in the process."

Munger approved of the use of precast concrete, having earlier funded a graduate-housing dormitory incorporating it at Stanford University. "Charles Munger has a good sense of the benefit of repetition in construction and how it can create economies of scale," says Greg Kerkstra, president/CEO at Kerkstra Precast, which fabricated the precast concrete components.

The building features architectural precast concrete wall panels as well as hollow-core floors, stairs, stair walls, interior demising walls, and other components. Interior walls were left exposed and painted, while exterior walls served as a backing wall for laid-up masonry. The dormitory's distinguishing mansard roofs at the seventh floor also were prefabricated to reduce high field work from lifts or scaffolding.

> 'This high-rise dormitory was truly a design-build project on an extremely fast-track schedule.'

Kerkstra Precast was brought in to assist with design evaluation, detailing, and cost control. This process allowed fabrication of precast components to begin much sooner than with a typical design-bid-build process. "This high-rise dormitory was truly a design-build project on an extremely fast-track schedule," says John Ciulis, project engineer with Kerkstra.

To meet the project's challenges, the design team convened weekly for day-long meetings at the architect's office. The team consisted of representatives from the university, construction manager, architect, engineer, and precaster. "Numerous hours and days were spent interacting to determine each other's needs and then how to satisfy them with the most economical, efficient, and quality-based construction methodology possible," Ciulis says. As those meetings progressed, Kerkstra was already beginning the engineering and drafting process.

To meet the tight schedule, precast production had to begin by November 2013. "This was extremely challenging, considering there were 3,760 pieces of various types," says Ciulis. "The architect's design required a largely barrier-free basement to accommodate their MEP-equipment needs, thus making the structural analysis unique." Precast concrete transfer beams were used in the basement to support the

Each single-occupancy bedroom in the suites includes its own bathroom, which was slid into place as a unit.

exterior and interior walls and hollow-core plank, which framed the 12 apartments on each floor.

BIM (Building Information Modeling) was used throughout the process, with designers transferring two-dimensional drawings into three-dimensional plans. This was especially helpful in laying out the penetrations for the modular bathrooms. "We overlaid the plans in our CAD system to show strand placements," says Kerkstra. "It was important to have all the team players at the table to work out the penetrations and determine the maximum depths for hollow-core spans with BIM. It created a visual concept for what needed to be done."

As part of this planning, the team created an online delivery map that allowed the contractors to show times when deliveries were scheduled, sometimes months in advance. "While many projects still use whiteboards with hand-written times, our online delivery map electronically detailed times and places for drop-offs, eliminating many inevitable conflicts in the schedule," says Mark Corey, senior project manager at Walbridge, the construction manager.

Complicating the process was construction across the street for a major renovation of a dormitory that housed 1,100 students, also directed by Walbridge. Both were adjacent to the university's executive office, a 10-story tower

MUNGER GRADUATE RESIDENCE HALL

Location
University of Michigan, Ann Arbor, Mich.

Project Type
Dormitory

Size
370,000 square feet

Cost
$110 million

Designer
Hartman-Cox, Washington, D.C., and
Integrated Design Solutions, Troy, Mich.

Owner
University of Michigan, Ann Arbor, Mich.

Structural Engineer
SDI Structures, Ann Arbor, Mich.

Contractor
Walbridge, Detroit, Mich.

PCI-Certified Precaster
Kerkstra Precast, Grandville, Mich.

Precast Components
356,000 square feet of hollow-core plank, 141,500 square feet of structural shear wall, and 65,000 square feet of exterior wall panels

The precast concrete system features architectural precast concrete wall panels, hollow-core floors, stairs, stair walls, interior demising walls, and other components.

where administrators could keep a close eye on the project. "We couldn't be idling trucks in front of the offices, both due to traffic concerns and because they'd be wondering what was going on," Corey says. "Coordination between the two projects was a key focus."

The two teams communicated to ensure the heavy equipment needed to erect the Munger dorm, including a tower crane, could work smoothly with the renovation work, which required dumpsters and equipment for removing debris as new plumbing, HVAC, roofing, and windows were delivered. "We needed to collaborate to ensure the crane had room to move and there was space for workers to safely move equipment and materials," Corey explains. The crews set up trailers in a shared parking lot for office space. Superintendents frequently met to coordinate equipment and review upcoming work.

Modular Bathrooms Installed

The modularized bathroom components provided a highly efficient, cost-effective design, but they also created unique challenges. This was especially true when Walbridge decided to build the modules themselves rather than purchase them from a supplier. "Several manufacturers make these units for hotel and hospital facilities," explains IDS' Stachowiak. "But we wanted more customized interiors with a higher quality design. Those elements along with shipping made their cost higher than we anticipated. So Walbridge decided to build them in-house."

Walbridge leased a warehouse in nearby Dexter, Mich., allowing university officials and others to visit frequently and monitor construction. Crews of tradespeople worked at the facility, including carpenters, laborers, tile setters, tile helpers, plumbers, and electricians. "We've built 120 similar units for a smaller project on campus, so we were familiar with the process but only on a limited scale," explains Corey. "It had gotten our feet wet and made us confident."

The contractor constructed 730 individual bathroom modules. That set a record for most modular bathroom units installed in a project, according to the Modular Building Institute. The next largest project used 270.

Five models were designed, including ADA-approved units. Each featured a fully tiled shower, toilet, sink, quartz countertops, cabinetry, light fixtures, medicine cabinet, and toilet. Prior to completion, each unit's floor was flooded with water that was retained for 24 hours to ensure no leakage occurred.

"One benefit of prefabrication was that tradespeople worked inside a controlled environment, where materials arrived premeasured and cut to order," says Corey. They were stacked in designated areas inside the plant. "Everything they needed was close at hand, and the majority of the work was completed with either feet on the floor or knees on the bench, eliminating having to climb ladders to complete work. The work was safer and quality was higher due to the standardization of material and work environment."

Fabricating the bathrooms while other work progressed at the site saved significant time and provided higher quality, but it created issues for the precasters. "One of the biggest challenges on the project was working out exactly where all the penetrations would be in the precast concrete while it was being designed and the bathroom modules were being built," says LaForest. "They had to be precise to avoid making any cuts on site, and the penetrations had to avoid the reinforcing strand in the concrete."

The hollow-core plank was cast 10 inches thick to provide an efficient thickness. "Shop drawings for the precast were being completed before we had finalized the MEP design," LaForest says. "We had to coordinate the size and location of plumbing chases to ensure that reinforcement wasn't cut."

"The penetrations through the floors and walls were critical aspects of the design," agrees Corey. "But there were only minor changes needed. It was all planned out very carefully. Kerkstra did a good job in communicating with us and working to make adjustments."

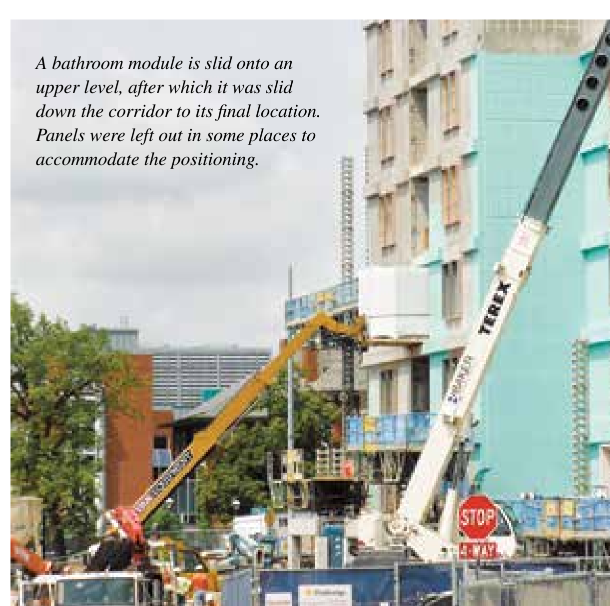
Precast Frame Adds Benefits

The precast concrete frame also added benefits to installing the bathrooms, Stachowiak notes. "It provided a strong base to secure the bathrooms, and the high level of control that we had over manufacturing both the precast and the bathrooms ensured we knew exactly where the blockouts were located and that they would match up. It all came out fantastic."

One of the key concerns, Kerkstra notes, was that the corridors were wide enough that the bathroom modules could be slid down the hallways to the appropriate room to be fitted into place. The building features seven bays divided by 8-inch shear walls, which provided an efficient thickness for structural support as well as access. The shear walls have penetrations so plumbing chases could cross-connect, minimizing the amount of plumbing required. Due to the duct sizes needed, the openings were reinforced and reinforcement bars were noted carefully to ensure no issues. "There wasn't much opportunity to move them once the bathrooms were in place," says LaForest.

With all the preplanning, the actual installation of the bathrooms went quickly. Corridor demising walls were

A bathroom module is slid onto an upper level, after which it was slid down the corridor to its final location. Panels were left out in some places to accommodate the positioning.



Because of the tight site with an adjacent project also underway, the precast concrete components were delivered on a just-in-time basis and erected through two shifts.

left out until the bathrooms were rolled into place through the open end bay. As each unit was pushed into place in each bedroom, the walls were installed and the rooms were finished off. "We rolled each one in and hooked it up by aligning it with the holes that were already cut," says LaForest. A test unit was tried in advance of the arrival of the others to ensure everything would work smoothly.

The system saved an estimated 4 to 6 months over conventional construction.

The system saved an estimated 4 to 6 months over conventional construction, Corey estimates. "The schedule was aggressive, but they beat it anyway," he says. "From engineering through production, delivery, and erection, it went very well." Another key advantage was the significant amount of waste material that was saved. "Suppliers cut materials to exact specifications and then shipped them to the plant," he explains. Waste leaving the plant was reduced by about 60%, varying by material. The result was an estimated savings of approximately 15% over building them on site.

J-I-T Delivery Used

Because of the tight site with an adjacent project underway, the precast concrete components were delivered on a just-in-time (J-I-T) basis and erected through two shifts, with an extra crane used on Saturdays. "We had no space at the site to store panels," says LaForest. "Kerkstra built up a significant inventory and stored them at the plant and then delivered them in the sequence we needed so they could be picked from the truck."

Trucks were staged about 1 mile away and were radioed in when each new delivery was needed. "It all moved like a finely tuned watch," Corey says. "It was a challenging schedule, but no problems arose due to our advanced planning."

On average, the cranes installed 60 pieces per day, Corey says. Each floor of the building, approximately 1 acre in size, was erected in approximately 2 weeks. As soon as the second floor was completed and components began to be erected on the third, trades entered the ground floor and began to work on finishes.

"Everyone loved working with the precast concrete, because of the speed and the ability to access higher levels immediately," notes Corey. "They dropped in the precast concrete stairs, and we could move between floors easily. It helped with life safety, construction speed, and accessibility."

The erectors had to work through the winter, with below-normal temperatures and 79 inches of snow accumulating. Even so, the precast concrete components were erected 2 months ahead of schedule. "A lot of concerns with the timetable went away when we completed the erection so quickly," says Kerkstra.

Brick Options Explored

The speed with which the precast walls were erected provided quicker access to masons and other tradesmen to install the insulation and brick on the exterior. "We explored the use of embedded thin brick," explains Stachowiak. "The precast fabrication was moving extremely quickly, and the university officials wanted to explore a variety of options for brick colors. That process took longer than we could afford to hold up the panels, so we cast the panels and laid-up the brick while interiors were being finished."

Fabricating the panels on a fast-track basis gave administrators time to select brick that matched nearby buildings and provide the laid-up masonry look they desired. The timing also worked, as the precast was erected through the harsh winter, allowing the insulation and brick installations to begin as spring arrived. The limestone and brick pieces were attached to the load-bearing wall system, which had punched windows cast into the panels. Interior walls were painted as other finishes were applied.

The project's design and construction were planned to meet LEED Silver certification, but the team's efforts pushed it to achieve Gold. "It's the first residence hall in the university's history to achieve that distinction," Corey notes. Walbridge's contributions included use of alternative transportation, low-emitting and fuel-efficient vehicles, management of indoor air quality, low VOC-emitting paints, protection and restoration of habitat, waste management, use of recycled content, regional materials, and other features. Precast concrete also aided with these points, by using local manufacture and use of local and recycled materials.

The project moved so smoothly and saved so much time that everyone came away noting the benefits of modularization. "You need repetition to make it work," says Stachowiak. "Assembly was fast and efficient, and a lot of materials were saved." Adds LaForest, "I'd definitely use this approach again. There were great advantages to all of the prefabrication. With the right combination of building type and modularization the building process can be very efficient." Walbridge's Corey agrees. "I think we'd use this modularization every chance we got," he says. "We always look to see what we can do with premanufactured and modularized components. It worked very well, and precast concrete fit right into the plan. If we hadn't prebuilt the bathrooms and used precast concrete, we never would have met the schedule."

Fabricating the panels on a fast-track basis through the winter gave administrators time to select brick that matched nearby buildings that could be installed in the spring.

Integrated Project Delivery Produces Advanced Hospital Design

Cook Children's Medical Center benefits from collaborative partnership created by IPD methods to build tower expansion featuring insulated architectural precast concrete panels

— Craig A. Shutt

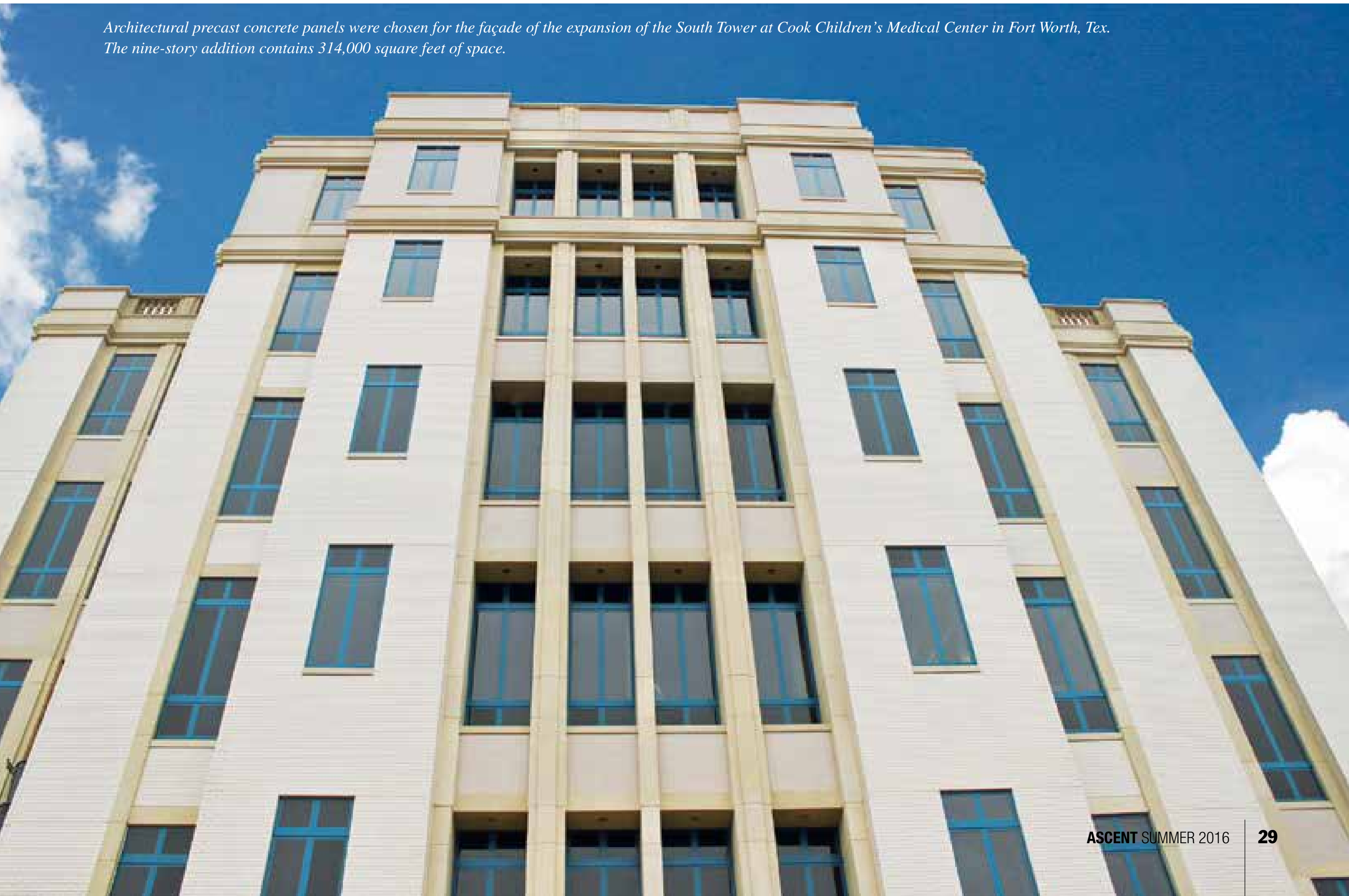
Integrated Project Delivery (IPD) methods have gained attention as an efficient way to design and build buildings quickly and cost effectively, while not minimizing aesthetic quality. The team that used IPD teamwork to construct the expansion of the South Tower at Cook Children's Medical Center in Fort Worth, Tex., points to its benefits as a key reason the project proved successful—but they also wouldn't recommend it for every project and every client.

The hospital expansion comprised 314,000 square feet of space in a nine-story addition (two below grade) to the hospital campus. The facility adds space for a new emergency department, 12 operating rooms, and a heart center. The upper floor was left unfinished to provide for future expansions as needs dictate.

The project was undertaken using the Integrated Project Delivery system, an approach described by the Lean Construction Institute as "a predictable and robust management system that benefits project or building owners and operators." It centers on a team-forming process that brings together the key participants as core partners from the design phase on, which ensures each company provides input that maximize efficiencies.

The team collaboration ensures each member's own techniques and contributions are considered and ramifications of each alteration are understood throughout the systems. Key subcontractors, including the precaster, are included in these discussions. Companies provide cost estimates or a Guaranteed Maximum Price (GMP) based on the design guidelines, updating them as the design develops. "With real-time cost knowledge, each solution set can be assessed against its impact to cost and schedule, as well as against a predefined set of Conditions of Satisfaction," the group explains.

Architectural precast concrete panels were chosen for the façade of the expansion of the South Tower at Cook Children's Medical Center in Fort Worth, Tex. The nine-story addition contains 314,000 square feet of space.



This partnered approach leads to an efficient design that takes all issues into account early, leading to a smoother construction process. "When a Lean/IPD project works properly," the group says, "customers, concerns, new possibilities, value, and waste are brought to the fore in new ways and replace standard practices, historical habits, and bureaucratic behaviors."

12 Companies Partner

Partnering in this way creates a level of buy-in that often doesn't occur with subcontractor relationships. With Cook, 12 companies signed the initial contract as partners in the IPD project. "We were all team members and part of one contract," says Dave Clark, project manager at Linbeck Group, the construction manager. "We worked collectively to find the best solution for each challenge from the beginning."

For the precast subcontractor, Gate Precast, that meant becoming heavily involved in the project on a design-assist capacity when design documents were 50% completed. Designers at the architectural firm David M. Schwarz Architects, which oversees façade projects at the hospital, were familiar with work Gate had done in Washington, D.C.,

'We worked collectively to find the best solution for each challenge from the beginning.'

the architects' home town. The design team visited the Gate Hillsboro facility and were impressed with the quality of the precast production process.

Once involved, Gate provided a GMP and assisted the design team, owner, and construction manager to complete the drawings. The project-management team tracked all of the changes that financially impacted the project in either direction to ensure the budget remained below the GMP.

"The IPD method essentially allows us to prepay for the bulk of our materials from subcontractors with assurances that those budget items will be met, while also assuring them that they can derive a profit from the project," Clark says.

The agreement provided incentives and disincentives based on the schedule. With all key players signed onto the same contract, they kept the big picture in mind. "Everyone

The facility, completed using the Integrated Project Delivery system, features a new emergency department, 12 operating rooms, and a heart center. The upper floor was left unfinished to provide for future expansions as needs dictate.

The BIM model helped to control the precast design process, creating a more fluid design and enhanced detailing.

is heavily invested in the same goal and coordinates activities to meet those targets," explains Jerod Rankin, project manager at Linbeck. "The profit distribution will impact everyone if the schedules aren't met."

CBA Results in Precast Being Selected

Precast concrete was selected for the project following a related IPD process, Choosing By Advantages (CBA), in which each factor in a material selection is weighted according to the project's needs and compared to find the best specification. "CBA works well when teams are assessing mutually exclusive alternatives," explains the Lean Construction Institute. "It also works well when prioritizing resource allocation." (For more information on IPD and CBA, see the sidebar.)

The initial application of CBA techniques led the team to the precast concrete façade over a typical masonry design or cast-in-place concrete on a steel frame, Clark says. The team used A3 forms suggested by Lean, which provide an analytical tool that helps condense challenges and compare various solutions to arrive at an action plan. The name derives from the ability to present the solutions on a single sheet of A3 (European) paper, approximately 11 by 17 inches.

"We used CBA to select precast concrete after evaluating and weighting such factors as cost, schedule, QA/QC, lintel and miscellaneous metal coordination, waterproofing, insulation, sound transmission, and available ceiling space," Clark says.

COOK CHILDREN'S MEDICAL CENTER

Location
Fort Worth, Tex.

Project Type
Medical facility

Size
314,000 square feet

Cost
$110 million

Architect of Record
CallisonRTKL Inc., Dallas, Tex.

Healthcare Planner
FKP Architects Inc., Dallas, Tex.

Design Architect
David M. Schwarz Architects, Washington, D.C.

Owner
Cook Children's Medical Center, Fort Worth, Tex.

Structural Engineer
CJG Engineers, Houston, Tex.

Construction Manager
Linbeck, Houston, Tex.

PCI-Certified Precaster
Gate Precast Co., Hillsboro, Tex.

PCI-Certified Erectorr
Precast Erectors, Hurst, Tex.

Precast Components
667 insulated architectural panels encompassing 76,000 square feet, with various finishes including embedded glazed bricks and limestone- and cast-stone-like appearances

Scheduling was a key factor, as the project had a tight deadline to completion, owing to the hospital's need for expanded space and additional services. "The obvious advantage that precast concrete gave us was speed of construction," says Clark. "It saved a tremendous amount of time, probably about 6 months. "In a typical evaluation, he notes, precast concrete might not have been selected, because it initially appeared to be more expensive than other alternatives. But once we factored in the time savings and how that rippled through the project in many ways, we found it actually was significantly cheaper."

The assembly activities that could be incorporated into the precast concrete fabrication, especially integrated insulation, were a key part of that savings, Clark notes. "We didn't require any brick layers or scaffolding, and we eliminated the need for insulation sheathing and other interior trades by incorporating all of those elements into the panels. Everything was contained within the precast concrete panels."

The precaster's team worked closely with structural engineer CJG Engineers, with both finishing designs simultaneously. "We didn't design the structure and then design the precast to fit onto it," explains Clark. "We worked as a team to create a design that fit both elements ideally."

'Precast's "kit of parts" approach provided great economies of scale and helped us develop a unique aesthetic design.'

A benefit of using precast concrete that arose at multiple points was its flexibility, says Sean Patrick Nohelty, managing director and principal at David M. Schwarz Architects. "It allowed us to standardize components and reuse molds. Precast's 'kit of parts' approach provided great economies of scale and helped us develop a unique aesthetic design. By working so closely with Gate, we were able to avoid a façade of repetitive, big pieces covering the building. We got an individualized look."

Realistic Finishes Needed

The architect's intent was to match the existing appearance of the hospital campus and achieve the look of natural limestone with concrete panels, explains Nohelty. But the designers wanted to go beyond the usual applications to achieve a unique appearance that emphasized the random coloring and graining of actual stone.

"The challenge with Gate's finishes was that they were too perfect," Clark explains. "The brick courses were too consistent, and the limestone had a uniform appearance, and we needed it to look more natural to match the existing building finishes."

Adds Nohelty, "Our goal was to emulate limestone and brick as closely as possible. Their use on nearby buildings would make comparisons apparent. We needed to match the traditional design appearance and materials with precast concrete. A lot of time and care went in to ensuring that could be done."

The precaster developed a pigmented technique that could provide the randomness the designer's sought. A special chemical retardant mix was applied to the molds first. When the concrete was added to each panel, it generated a chemical reaction with the base colors used in each segment that resulted in making the area lighter or darker than other areas.

"We did a very extensive color-by-number layout system on the entire façade that was incorporated into the shop drawings," says Nohelty. Adds Norm Presello, project manager at Gate, "We used BIM technology to control the design process. It allowed for a more fluid design and enhanced detailing."

Rather than inset traditional masonry brick, a glazed white thin brick was chosen from the same supplier that provided brick for other buildings on campus. It was embedded into panels erected on the middle levels of the design, creating a sleeker look that is offset by the darker, more rustic appearance of the base and top levels. The brick was embedded into the panels in the factory.

Cladding the façade required 667 panels encompassing 74,000 square feet. Panel sizes were designed for maximum efficiency in erection and to match existing sizes on the main building, ranging from 15 feet wide to 43 feet tall and weighing up to 53,000 pounds. The panel thickness, due

Gate used a new chemical process to create an appearance that emphasized the random coloring and veining of actual stone.

Because of the new veining technique used, a variety of mock-ups, from small samples to full-scale panels with windows installed, were created and approved.

to massive existing profiles, ranged from 4 inches thick in some areas to 19 inches thick in others.

To complete the aesthetic look, the precaster built approximately 50 molds including one "master" mold used to cast units used in six areas. To limit vertical joints at highly visible corners, Gate designed panels with 90-degree returns nearly 5 feet in length, exceeding the return lengths typically provided. Several special two-part hanging forms were built to meet this challenge.

The most challenging panels were those that incorporated both brick and limestone veining, says Presello. In some cases, casting in the glazed brick and applying the chemicals to achieve the variegated limestone finish could take as much as 7 hours for one panel.

To ensure the veining technique provided the limestone appearance the architects sought, a variety of mock-up iterations were created. "The casting process was unique, so we invested in mock-ups from small samples to full-scale panels," says Rankin. The BIM modeling system was used to design the panels and then expand on each mock-up sample as it was approved, adds Nohelty.

Eventually, a fully insulated, 30- by 20-foot mock-up with windows installed was created for the client to review. "We used BIM from the very beginning, and it worked very smoothly, with the client approving the final iteration," Nohelty says. The precaster's casting yard was only an hour from the site, Rankin notes, so it was easy to send teams to the plant to inspect new samples and review progress.

"Virtually every panel had eyes on it and full approvals before it left the plant," Nohelty says. "Any issues that arose were met well in advance. Gate was very proactive in ensuring the quality remained consistent and adjusting anything necessary."

Insulation Aids Efficiency

The panels' thermal efficiency was a key advantage both in minimizing trade congestion and time as well as for meeting energy goals. The panels feature 3 inches of XPS foam insulation sandwiched between two wythes of concrete.

"Healthcare facilities face critical temperature and moisture-management issues," explains Brad Nesset of Thermomass, which provided the insulation used in Gate's panels. "Patients and staff put added importance on interior air quality, proper daylight strategies, and exterior aesthetics.

Gate and Thermomass provided a series of isothermal and moisture analyses to assure long-term thermal resistance and eliminate concerns about condensation and mildew. The isothermal analysis calculated steady-state R-values based on the materials in the assembly. The precast panels had no thermal bridging, which boosted their score. The isothermal material R-value was R-16.41, twice that is required for the building's thermal zone and nearly twice the efficiency of a conventional brick/block assembly, Nesset says.

The dew-point analysis determines if water vapor will travel through the wall assembly or if condensation will accumulate on the exposed interior surface. A fully outfitted wall sample was tested in extreme winter and summer conditions and was found to block all condensation. "This is a key benefit to a barrier system like an insulated precast concrete wall assembly," Nesset points out. "There is no cavity, so any dew point occurs in the insulation or exterior wythe. There are no thermal bridges, so moisture has no path to follow."

As a result, the panels create a moisture barrier that prevents vapor diffusion and air infiltration while retaining heat and blocking cold air. The system was estimated to save more than 35% in annual BTUs when compared to a brick/block assembly.

> 'They drove in, the panel was picked, the truck drove off, and another one arrived. No precast panel ever touched the ground.'

Fast Erection

Special trailers and frames needing additional transit permits transported the large panels from the plant 55 miles away. The site was located in the heart of the medical district with limited availability for staging, so deliveries were completed on a just-in-time basis. Three cranes were used to speed the process and minimize disruption, consisting of a 200-ton lattice boom, a 600-ton hydraulic, and a contractor-supplied tower crane. Two cranes were in use at all times to erect the panels as quickly as possible. "It accelerated our schedule in a big way," says Rankin.

Erection could move so quickly, in fact, that Gate had to cast and store the pieces ahead of time. Once erection began, the panels went up much faster than they could be cast. "They had to store the pieces and then pull them out in the proper sequence to ensure each truck had the next one to go into place," Clark says. Adds Rankin, "They drove in, the panel was picked, the truck drove off, and another one arrived. No precast panel ever touched the ground." Even so, the deliveries went without a hitch.

The value of IPD expressed itself again with the delivery of windows, which arrived on site ahead of the delivery of each floor of precast panels. "We didn't need any temporary enclosures for the windows," Clark notes. "When the panels arrived, they were complete except for windows, which were installed right away."

"Gate and Precast Erectors did a great job," says Rankin. "They understood our needs and the limited space, and they made it work. The just-in-time delivery was paramount to our success. Sequencing the panels properly was a critical component for all 676 from the small 8- by 12-foot pieces to the 40-foot tall ones."

Approximately one-third of the panels had to be erected over an operating laboratory, Nohelty notes. "Safety at the site was paramount. Gate understood the limits of what could be done, and we communicated well with the client to provide updates on progress so they knew where we were when that work was being completed."

IPD Not For All

The project proved successful on all of its markers, and everyone agreed the IPD method aided that goal. "This was the first time we'd worked with it at this magnitude," Clark says. "We see it being used predominantly on healthcare facilities currently, due to their complexity. But it could be used for any type of project with a challenging schedule or budget." Adds Rankin, "We'll now be using IPD for all projects with this client."

Nohelty had not used IPD before, he says. "But I definitely would like to see it happen more with this client and these teammates. We worked very well together. Advanced technologies were specifically invented by Gate for this project to emulate the sophisticated appearance and detailing of the original hospital building."

But they also agreed they don't recommend it universally. "It takes the right mix of cultures and people," Nohelty says. "With other clients, there would be a huge education process to go through to help them understand what is needed. I'd be happy to lead it, but I wouldn't suggest it for everyone. It won't be the best approach for every client."

Rankin agrees. "IPD's success depends heavily on the owners and the partners involved. If they don't all buy in deeply, it won't work well. The right culture is required to be able to work together in the close, direct partnership that this requires. It can easily go wrong if some of the partners have the wrong attitude."

Gate's Presello agreed. "Working in collaboration with the owner, architect, erector, and construction manager, we were able to create details and finishes that exceeded the design intent while streamlining the schedule and saving money thermally for future generations."

An IPD project that succeeds can offer a whole greater than the sum of its parts, but those parts must all work toward the same goal. "It is one thing to have a vision," says Nohelty. "But it's something far greater when the reality exceeds all expectations."

The panels' thermal efficiency was a key advantage both in minimizing trade congestion and time as well as for meeting energy goals.

IPD & CBA

Integrated Project Delivery (IDP) "leverages early contributions of knowledge and expertise through the utilization of new technologies, allowing all team members to better realize their highest potentials while expanding the value they provide throughout the project life cycle," according to the American Institute of Architects.

A variety of forms and training programs are available through AIA and the Lean Construction Institute, among others, to help explain the benefits of IPD and help educate practitioners. AIA lists nine core sequential phases:

1. Conceptualization
2. Criteria Design
3. Detailed Design
4. Implementation Documents
5. Agency Review
6. Buyout
7. Construction
8. Closeout
9. Facilities Management

Choosing By Advantage (CBA) is a related process that factors key criteria into a solutions-based system to determine the best material choice. According to the Lean Construction Institute, CBA uses four principles:

1. Decision-making is based on determining the importance of differences between materials.

2. Decisions should be based on the importance of advantages, not by including disadvantages, such that an advantage is the difference between the attributes of the two alternatives.

3. Decisions are anchored to relevant facts.

4. The design team is composed of sound decision-makers who can learn and skillfully use sound methods of decision-making.

To learn more about these programs and download information and forms, visit **www.aia.org** and **www.leanconstruction.org**.

High-Tech Approach Revives Gothic Details

Laser-scanning, Revit, specialized concrete mixes help reconstruct decorative Collegiate Gothic style of Boston College's 1917 facility with precast concrete replacing cast stone

— Craig A. Shutt

After nearly 100 years of service, the cast-stone façade on St. Mary's Hall at Boston College had become worn, discolored, and unsightly. To revitalize the structure, built in 1917, designers replaced the existing decorative pieces with precast concrete pieces cast from sculpted molds of the originals. The traditional appearance was recreated using high-tech equipment and designs unavailable until recently.

In fact, cast stone was not yet a well understood or engineered product when Roxbury Pudding Stone and cast-stone decorations were used to build the facility. Designed by Maginnis & Walsh in an ornate Collegiate Gothic style, the façade on the four-story building had severely weathered and worn away. To revive it, more than 15,000 pieces were replicated in precast concrete duplicates of window traceries, window surrounds, bands, copings, water tables, and sculptural elements.

All Photos: Boston College.

'Very rarely is this quantity of artwork integrated into the architecture of a building.'

"Very rarely is this quantity of artwork integrated into the architecture of a building," says Wendall C. Kalsow, principal at McGinley Kalsow & Associates (MKA), the preservation architect that led the work. "The complex gothic vocabulary and details provide a visual richness rarely seen in modern architecture and construction." Replicating that look in precise detail and replacing the pieces took close attention to detail at every step.

Precast concrete was chosen for the project for a variety of reasons, he notes. "Precast concrete is very similar to caststone,

St. Mary's Hall at Boston College, Chestnut Hill, Mass., used more than 15,000 pieces of precast concrete to replicate the look of the cast stone originally used to clad the building, constructed in 1917.

and it could provide the historically accurate appearance we required. It also was an easy material to work with and provided an economical approach. It was definitely the right choice." Adds Robin Larouche, project manager at precaster BPDL Béton Préfabriqué, "The biggest advantage in using precast over other materials is the great plasticity of it, which allowed for a wide range of details, as well as the quality of the process itself."

ST. MARY'S HALL

Location Boston College, Chestnut Hill, Mass.
Project Type University building
Size 92,000 square feet
Cost N/A
Preservation Architect McGinley Kalsow & Associates Inc., Somerville, Mass.
Design Architect DiMella Shaffer, Boston, Mass.
Owner Boston College, Chestnut Hill, Mass.
Structural Engineer LeMessurier Consultants, Boston, Mass.
Contractor Shawmut Design & Construction, Boston, Mass.
PCI-Certified Precaster BPDL Béton Préfabriqué, Alma, QC, Canada
Masonry Contractor Grande Masonry, Providence, R.I.
Sculptor Skylight Studios, Boston, Mass.
Precast Specialty Engineer Building & Monument Conservation, Arlington, Mass.
Precast Components 15,000 cast-stone pieces encompassing 92,000 square feet

The entire building was laser-scanned to record digital benchmarks and to provide backup information during the reconstruction. Each of the 15,000 pieces then was removed individually and numbered, with its specific dimensions and location coded into an AutoDesk Revit file, explains Ryan Foster, project manager at MKA. "The program allowed us to model the building in three dimensions and coordinate the work on each piece." BPDL used separate software to create its fabrication drawings, but they were imported into Revit without difficulty.

"We typically do this numbering on projects, although few are this detailed," Foster notes. "The contractor found it helpful to have one tracking system established upfront. It helped the precaster with pricing and also allowed shop drawings and installation notes to be tracked and coded to each piece."

The best-surviving example of each type of unit was sent to the precaster, which made a mold of the piece for casting. BPDL used high-density liquids to create the molds, which

The original crucifix statue, shown in its heavily weathered state, had to be resculpted in clay (right) to create a mold so the piece could be recast in precast concrete.

The original main entrance (left) had weathered over 100 years, revealing the dark aggregates used in the cast stone. The new design (right) used lighter aggregates that will provide a uniform color even as it weathers.

provided the precision and finishing details required. "To compensate for the loss of detail due to weathering, original pieces had to be refinished by hand to simulate a natural stone tooling prior to making the molds," Kalsow explains. Severely weathered pieces and highly sculptural designs were sent initially to an artist's studio for modeling. They sculpted a clay replica that was sent to the precaster.

Each piece was molded, cured, unmolded, and treated with a light acid-etching to achieve its final appearance. Two concrete mixes were used, one to create a granite-like granolithic appearance for the building's base and a second to replicate limestone. "The original stones contained a black aggregate that was revealed over time by weathering, which caused them to look dirty," Kalsow says. "We used a light aggregate that will keep the stones appearing light over the next hundred years." A six-line striation pattern was cast into the pieces to provide for verisimilitude.

Many of the pieces were quite elaborate and required sculpting of a new piece that then was used to create molds for casting.

Each window tracery was recast as two back-to-back pieces rather than the 17 individual pieces in the originals. The traceries were installed and center mullions and surrounds were installed.

To improve durability and long-term performance, a stainless-steel anchoring system was used for the pieces, and some units were combined with false joints to make them larger and easier to secure. Plastic temporary lifting anchors were used to lift the pieces into position. About 400 molds were used to cast the 15,000 pieces, some for one unique piece.

The traceries posed a particular challenge. Each of the 30 units consisted of 17 individual pieces that were deemed too fragile and complex to recreate. Instead, each tracery was cast from a mold of the entire piece, in two halves. In that fashion, the pieces could be joined back to back and create a decorative piece on both sides.

"The biggest challenge came from the need to have the piece be symmetrical, since one piece would be turned over to be connected to the back of the other," Kalsow says. "The original could tolerate some dissymmetry, but ours had to be absolutely identical." The leaded-glass reglets also had to be maintained in as smooth of condition as possible to allow the stained glass to be fitted back into the pieces perfectly, Foster notes.

A series of statues and other sculpted pieces presented their own challenges. Four three-dimensional figures had to be resculpted following the original figures, Saint Mary, who was positioned in a niche, a crucifix, and two Archangels that flanked the crucifix. There also were 40 bas-relief sculptures in a similar fashion that were recreated.

On the cross, a Gaelic scroll was discovered only when the statues had been transported to the studio. "It had been so badly worn down that we didn't realize it was there until it could be closely examined in the studio," Kalsow says. The banner was recreated in a clay mold, from which forms were made for casting as with the other pieces.

The result of this close attention to detail and use of craftsmen to replicate the original pieces was a design that sparkles—and will do so for many years to come. "Something this complex was a real tribute to all of the companies involved," Kalsow says. "To successfully replicate these elements in precast concrete shows not only the versatility of the material but also demonstrates the high level of skill provided by the artists, precaster, mason, and general contractor. While precast is often thought of as a modern architectural material, it can also perform extremely well in historic restoration projects replicating either cast or natural stone."

Photo: GE Johnson.

Precast Concrete Meets the Freestanding ER Trend

Completed in 5.5 Months!

To meet the needs of a growing community, UCHealth added its new 18,000 square foot Harmony Emergency Department (ED) freestanding emergency room (ER) on Poudre Valley Health's 96-acre Harmony Road campus. The ED serves as UCHealth's anchor for the Poudre Valley Health hospital system. The rapid intake model of the ED ensures a convenient and smooth patient experience, with reduced wait times and easy access. Following the current free standing ED model trend, and with a focus on continued exceptional medical standards, UCHealth expanded services and technology to better serve the Ft. Collins area. This extension of the hospital offers 24/7 emergency access, and the identifiable UCHealth name, which is associated with the system's standard of high quality care.

Located in Ft. Collins, CO, UCHealth's new state-of-the-art, $12.3 million freestanding emergency facility features 12 private exam rooms, a major trauma room, two behavioral health rooms, isolation and decontamination rooms, advanced imaging, ultrasound and x-ray services, and a 24 hour lab and pharmacy. As shifting care patterns in the local area necessitated a need for greater access to emergency care, as well as diversification from the standard hospital emergency room setting, UCHealth developed the freestanding ED solution as an alternative to their standard of acute patient care.

The nation's latest trend in emergency patient care shows these EDs relieve congestion in hospital ER settings, reduce patient wait times, and add convenience to suburban and rural areas. There is currently a decrease in the number of hospitals operating onsite emergency rooms, and an increase in population, creating a demand for these stand-alone facilities. UCHealth's ED facility expands the hospital's reach in Colorado and offers easy access to a Poudre Valley Health alternative, providing a much needed asset to the Northern Colorado community.

After initial meetings with the project developer, precast was selected as the preferred material due to the ease of fabrication, an expedited erection schedule, and more economical pricing over conventional steel framing. Precast also provided an effective building envelope while meeting desired project architectural features; primarily, blending into the existing campus landscape. The precast ED footprint is designed to maximize efficiency and space, and to accommodate future expansions.

Precast concrete was also chosen for its versatility, fire resistance, rapid construction, and for the ease in creating a total precast structure with a single source supplier for the core and shell of the structure. The wall panels provide a low maintenance facade that will retain its pristine, factory built condition and attractive appearance throughout its life.

The Harmony project process began with an initial meeting to introduce precast as a viable project option. The General Contractor, GE Johnson, then contacted Stresscon, and a budget was presented, along with a scaled model and project sketches. A collaborative design-build team including UCHealth, S.A. Miro, Inc., H+L Architecture, GE Johnson, and Stresscon Corporation was then formed in late 2014. Precast production began in early 2015, with erection starting in April of 2015. Throughout the process, the project partners utilized Lean Construction's Last Planner System to identify strategies for achieving and meeting a fast-paced project schedule. The project team used 3D modeling throughout the project, benefitting both internal and external project coordination, as well as pre-planning the erection sequence to deliver the structure in only 11 days.

Typical construction technologies would have added twelve weeks to the build schedule. The team completed the entire project, from design phase through erection, in just over five and a half months, utilizing heavy collaborative and coordination efforts from all involved project partners. Stresscon was able to protect both the project budget and scope, and keep the precast price in place with the use of a unique precast framing design.

The Harmony facility incorporates 132 pieces of precast concrete, serving as both an architectural envelope design and structural support for the facility. The hospital project highlights the use of Stresscon's architectural precast products, featuring three colors of inlay bricks accented with brick banding. Stresscon accomplished a creative, innovative and aesthetic use of precast concrete and masonry to create the difficult brick banding in the panels.

Stresscon's precast/prestressed components included long-span double tees, inlay brick wall panels, beams, and columns. One very unique project feature is the precast sloped double tee roof system. The precast components are designed to meet specific natural disaster force protection criteria.

The precast exterior load-bearing horizontal panels were cast with block-outs as a complete wall system that encompasses needed fenestration to consolidate trade requirements and reduce required on-site installation time. All pieces were cast at Stresscon's Colorado Springs plant, shipped to the project site, and quickly erected. The significance of the hospital's mission required that new facilities be erected quickly to keep pace with the growing demand for services. The open floor design requires double tees spanning 72 to 78 feet, creating a roof system with no interior load bearing elements.

ED's are required to provide 24/7 emergency access to the community. The facilities are medical buildings, meeting code requirements, and built to withstand specific levels of force and seismic activity without disrupting services during natural disasters. Since the ED must have specific mechanical, electrical and plumbing lines and structures, there are several accommodations to be made in the design and build processes. The design process for Harmony included many challenges including layout, function, heavy mechanical structures, building requirements, electrical wiring, vacuum lines, oxygen tanks and lines, and disaster mode specifications.

As annual ER and ED visits continue to increase, and Colorado's population continues upward growth, patients will continue to seek more accessible and convenient ED options such as the new Harmony facility. Stresscon's participation in this free standing emergency room market positions precast as an ideal high-performance material, and reinforces the need and desire for precast concrete for convenience, speed of turnaround, high quality building materials, and specific federal requirements for existing ED and ER structures. These factors are key drivers to increased owner and patient satisfaction for the health system expansions, as well as for the provisions of alternatives to greater health care access.

For more information: www.enconunited.com

Problem Solving Skills Bring Precast Future to Light in Digital Technology Course

— Marty McIntyre

Looking at the student projects for the University of Michigan's *Capstone in Digitation Technologies: Investigations in Precast Concrete* is like starting up a time machine to look at the future of the precast industry. During the Winter 2016 term, eight students worked with Associate Professor of Architecture Glenn Wilcox to create new casting solutions and precast concrete shapes. These were influenced both by the cutting-edge technology available at the school and visits with local precasters. The students are part of the Masters in Digital Technology program that is housed in the school of architecture.

This program uses a technology lab with robotic automation that performs both subtractive and additive manufacturing that the university has christened the FABLab. The lab houses six industrial robots, organized into three cooperative work cells, providing the ability to work at a wide range of material scales. These work cells can be reconfigured rapidly, from sensor guided welding to automated bending, assembly, abrasive waterjet cutting, and composite fiber placement. In addition, the FABLab houses a wide range of large-scale Computer Numerical Control (CNC) machines, including (2) three-axis routers, (1) five-axis router, (1) three-axis vertical machining center for metals, (1) three-axis waterjet, (1) four-axis digital knife cutter, plus lasers, and 3D printers. One recent addition is a CNC industrial knitting machine that can create complex textile forms. Traditional metalworking tools and assembly areas support the new technology.

By the time a student gets to the capstone course for the masters program, they have spent nearly a year learning the ins and outs of the digital laboratory and are ready to put some of the equipment to use in precast design. But the ability to operate the equipment isn't enough, this program draws those who wish to learn how to use computations and create workflows in order to conduct investigative research on how the equipment can be used.

"The students coming out of this program are equipped for problem solving," says Wilcox. "Industry is looking for people like that. There is a unique strand of student that is coming out of the program and opening up some great doors."

One program student, Amogha Krishnaiah, says she sought out the University of Michigan program because of the perspective she gained as a working architect. Before she started at the University of Michigan, Krishnaiah had some experience with designing with precast, but had never had hands-on experience fabricating it. "This course gave me a different perspective because I learned how the materials react," says Krishnaiah. "I was working in a large multinational corporation doing architecture and construction.

"When I was working, we had to deal with a lot of production drawings and fabrication drawings and which fueled my interest in the making of these products. I wanted to be on the other side of the job, and know more about fabrication and production rather than just drawings."

Students Timothy Sutherland and Amogha Krishnaiah attended the PCI Convention as part of their work in the University of Michigan Masters In Digital Technology Program. They presented their work along with other students involved in PCI Foundation sponsored programs. Photo: Marty McIntyre.

This course met Krishnaiah's hopes for a new type of architectural learning in all the best ways, thanks in part to the teaching style of Wilcox. "Glenn's teaching is very hands-on. Doing it, and then getting to know more about what you can change," says Krishnaiah. "Not fanaticizing about the product, but jumping right in to it."

Partnership with local precasters

To achieve a high level of innovation and research, the course has been broken into three parts: studio work including research and field trips; guest lectures and critiques, from precasters and guest designers; and publication of the students' work in academic papers, industry conferences, and a final report.

The students were able to see current fabrication of precast products on a visit to Kerkstra Precast in Grandville, Mich. They also benefitted by hearing comments from employees of International Precast Solutions in River Rouge, Mich., during their mid-term and final reviews.

The plant visit also helped students understand the scale of precast pieces being fabricated. "One of the things that really struck the students was the sheer scale of the operation," says Wilcox. "How industrial the scale was, seeing the wall panel production lines, and the combination of machine-and hand-labor within the space. They were amazed by the additional components integrated in precast concrete panels such as the inset layers, the fittings for the insulation, and the various types of reinforcement including carbon fiber, steel, and prestress cables."

According to Wilcox, it was helpful to see the plant at the beginning of the semester, because it plays an important role in informing the direction of the students' projects. "I think we hit it at a good time because Kerkstra was producing a series of wall panels. The students walked down the line viewing different stages of production including setting the molds, laying in of infrastructure, pouring, and completion of the panels," says Wilcox. "For several days after their plant visit, the students were really struck by all the different layers of complexity within the operation. The plant tour was a useful exercise to conduct early in the term because it helped them think about scale of production, transportation, material development, and mold making."

For Greg Kerkstra of Kerkstra Prestress, he hopes the link between the industry and the university will yield early understanding of new technology. "Kerkstra made the commitment to the program for one main reason: to make a connection," says Kerkstra. "This connection creates a direct link for our industry and Kerkstra to be able to support students and professors. We want to educate our future designers, architects, and engineers about precast concrete. This real-time connection provides the students and professors with access to the ever-changing world of precast. "

Kerkstra sees this program benefitting both partners. "We receive real-time challenges and desires from the design community and are able to proactively work together to meet the needs of where design is going. Our long-term goal with our investment is to have many more professionals in the marketplace making educated decisions about where and when to use precast concrete."

Why Precast?

In choosing to pursue precast solutions as the capstone course, Wilcox feels he has found an interesting challenge for his students. It is not a typical architecture design studio. "All our students have architecture degrees, so we don't need to do a building design. We can look at components and production and look at the material," says Wilcox. "The really interesting thing about precast is that we can touch on so many elements of digital design and fabrication. It covers the range of what we have available to us in the lab. There are so many avenues we can take it to. That is an advantage of having it as a subject in this course."

Understanding and implementation of fabrication techniques and production methods in the development of the precast elements was key. The eight students developed five precast components that were fabricated using the technology available in the lab. With so much technology available and the creative minds of students at work, no two projects looked alike.

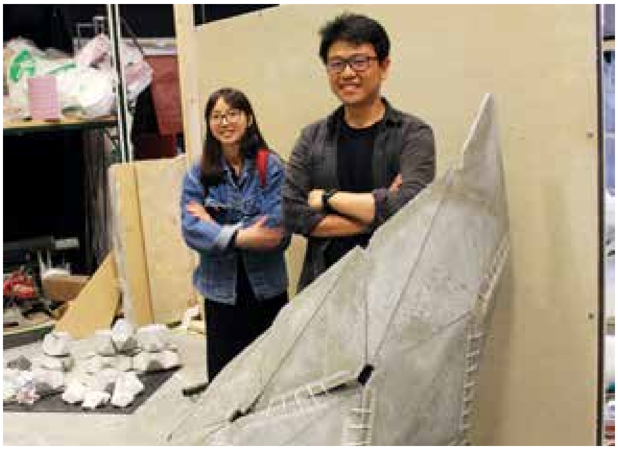
Folding Concrete

In one case, the students created a "folding concrete" where the piece might ship flat, but then be lifted into place and folded like origami to create a 3D effect. Candace Yang and Kurt Hong investigated technology that would help create voids in the concrete that would serve as seams; these explorations also led them to investigate concrete materials and reinforcement techniques.

Some of the material issues that Yang and Hong explored were the weight of the concrete, the joint design, and the reinforcement materials. After experimenting with regular concrete, the pair moved to a lighter weight glass-fiber-reinforced concrete (GFRC). For the joint design, they created a curved detail that not only allowed the concrete to fold on itself, but also left the joints less vulnerable to cracking.

The other issue that the students addressed was how to fold the concrete and ensure that it would be self-supporting. "When we lifted the piece in the center it folded by itself, so we started to develop the model and balance in that direction," says Hong. "We were interested in seeing how it could stand up by itself. We used our first models as our clue to generate our geometry.

Before moving to the large-scale concrete models, the team used a 3D printing machine to investigate how the pieces might function. "We did some analysis from different parameters with different results," adds Hong.



Candace Yang and Kurt Hong created a system of folding concrete that could be shipped flat and placed in upright as part of their work in the University of Michigan Digital Technology capstone course sponsored by the PCI Foundation. Photo: Marty McIntyre.

After all the experimentation, it was time to make the models using concrete. A few problems arose, which taught the students more about the material and led them to some new solutions. Where they originally tied the concrete together with mesh, they discovered that something strong and flexible would be needed. After more experimentation, Yang and Hong created a solution using voids cast in the concrete and then zip ties that went through them to hold the pieces together securely.

The end result was a model that was about 3 feet tall and stood solidly on its own after the pieces were lifted from their flat form. The ability to ship flat and stand on site may have interesting applications down the road.

Travel to PCI Convention

In addition to visiting with the local precasters, two UM students attended the PCI Convention in March 2016 in Nashville, Tenn. The students were able to share the work they had accomplished so far, and visit the Precast Show to further their understanding of the precast concrete industry and products that might help them in the future.

Krishnaiah, one of two students who attended the PCI Convention, used her time there not only to take part in the poster session, but also to make some personal connections. "I met a lot of different people from producers to associates. Some of the products I saw and perspectives I learned at convention helped me frame my capstone project. I thought about how precast is used and how it can be commoditized," says Krishnaiah.

Before the convention, she says that her focus was strongly on the making of the product. After attending the convention, she had a better idea of how the product she was designing with could be used.

Looking Forward

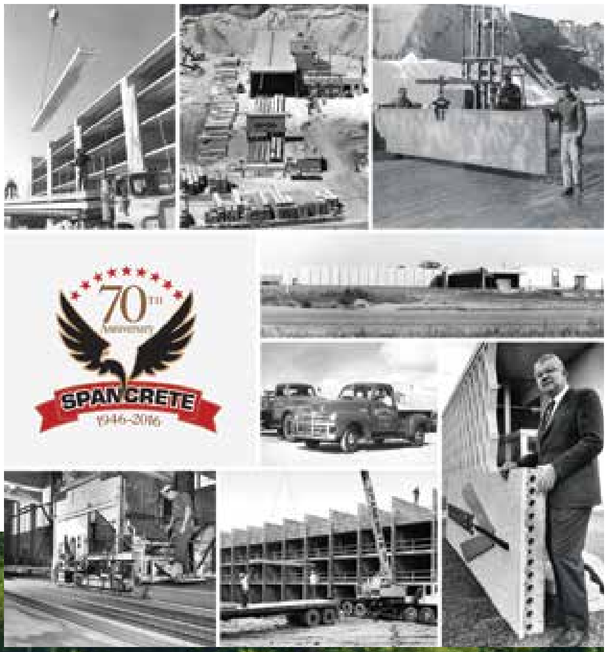
The Digital Technologies program at University of Michigan started in 2011. As the world of architecture changes, the program attracts more students every year. Next year there are 23 students who will join the 10-month masters program.

"In the discipline of architecture, people are beginning to receive more specialized degrees." says Wilcox. "Architects are thinking more about the different connections they can make to industry and production, and realizing they need people working for them that have this specialized knowledge."

When the students finish their degree, most will go back into practice, although some may pursue other areas such as lab technicians or becoming research assistants to get into a particular type of practice.

Providing Cutting Edge Precast Solutions Worldwide for over 70 Years

Beginning more than 70 years ago, Spancrete built a legacy of building concrete structures, perfecting production processes, and authoring the standards for research, design, production, installation and safety in the precast industry. And they're still building that same legacy. By partnering with customers and working to fully understand their vision, Spancrete turns dreams into amazing reality. Whether providing materials, full precast building systems or industry expertise, Spancrete offers important guidance throughout the entire construction process. Their goal is to help build innovative, durable structures where people work, live and thrive every day.



Founded in 1946 by Henry Nagy, Spancrete started when Nagy bought a hollowcore slipformer on a trip to Germany, bringing it back to his home in Wisconsin. Years of innovation, patents and hard work developed Spancrete into the company we know today – creating precast building solutions for commercial, residential, education, industrial and retail clients around the globe. Henry was one of the first recipients of the PCI Titan of the Industry award for his profound impact on the precast industry. Now in its third generation of family leadership, Henry's legacy and determination live on through his grandson, John Nagy. Spancrete now has 7 locations in the United States and over 30 licensees around the globe, all producing Spancrete products and services.

"My grandfather pioneered this industry, and we're proud and thankful to have reached this milestone," said Nagy. "We're just as excited about the future, too, as we keep innovating and supporting our customers and partners."

Over the past three years, Spancrete has introduced a number of new products and building solutions to the industry, most notably, *RePlenish*™ and *RibSlab Flooring System*™. *RePlenish* is the first precast pervious system in the industry that is effective in runoff reduction and filtration, while functioning as a sidewalk, alley, parking lot or other related application.

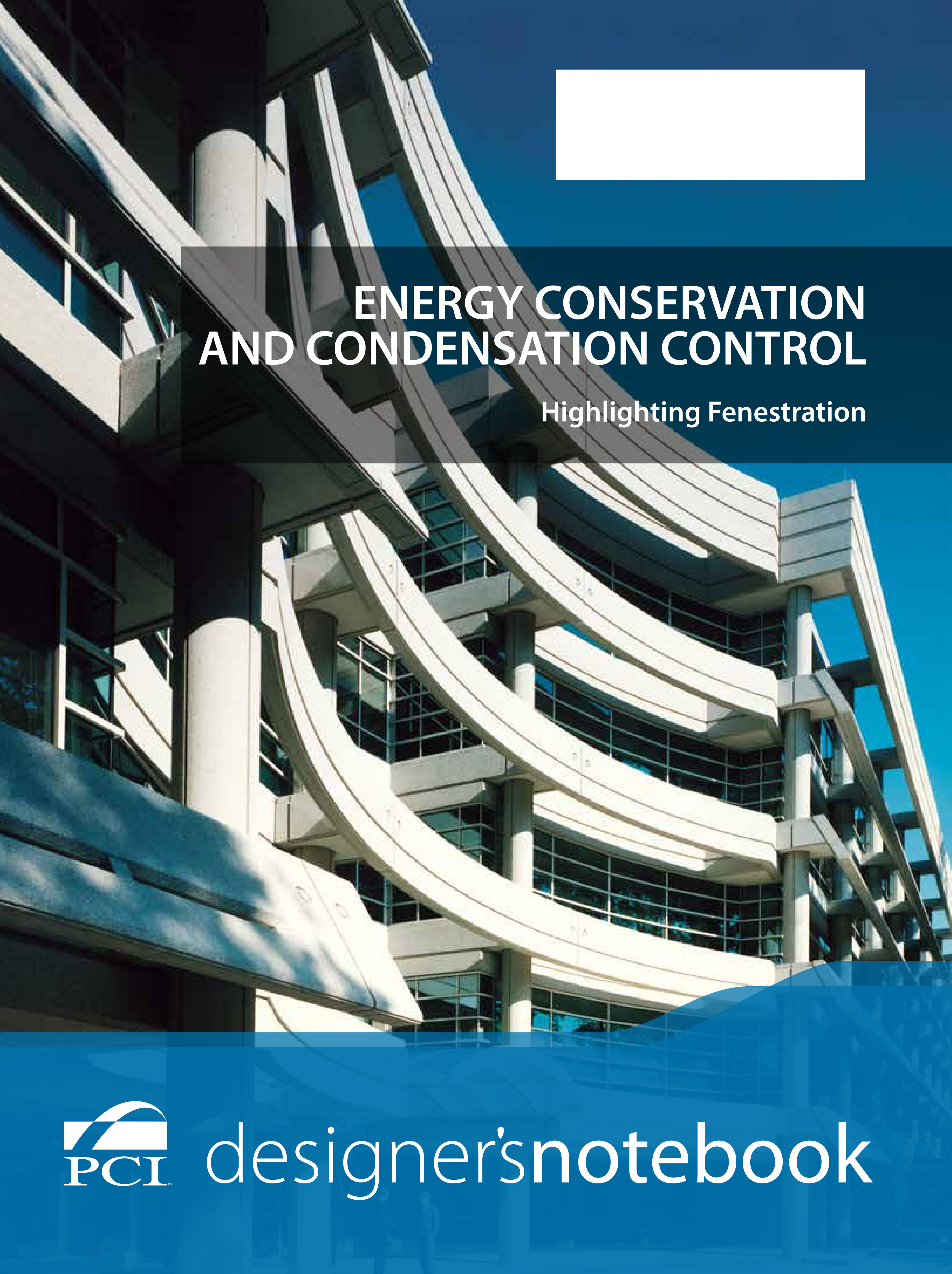
For years, customers around the globe have been asking for a durable precast concrete floor system that is not only lighter, stronger, and more energy efficient, but also can be manufactured in a variety of sizes; Spancrete answered with *RibSlab Flooring System*. This system offers a slim floor depth that is lightweight and robust all at the same time. The thin design reduces foundation and project costs; while also providing perfect placement options for a variety of mechanicals. The reduced floor thickness allows for more levels within the same building height.

Spancrete has built a global footprint through the constant pursuit of excellence in design and performance. The inspired structures created are a testament to Spancrete's clients' vision and their commitment to ensure function, efficiency and affordability are at the core of every project.

Spancrete pioneered the industry, and continues to strive every day to be the best in it.

Spancrete is an innovative precast manufacturer serving the US Midwest and Southeast states from three plants in Wisconsin, Georgia and Florida. Producing architectural and structural precast concrete solutions and providing precast production equipment and services around the globe for over 70 years, the company currently has over 450 employees.

For more information: www.spancrete.com



ENERGY CONSERVATION AND CONDENSATION CONTROL

Highlighting Fenestration

designer'snotebook

ENERGY CONSERVATION AND CONDENSATION CONTROL

Highlighting Fenestration

Three main components of a window are the glazing, the spacer, and the frame. Glazing is most-commonly glass, but it can be any transparent or semitransparent material such as plastic for skylights. Typically, a window is characterized by the number of panes of glazing such as single-glazed, double-glazed, triple-glazed, and so on. A spacer is used to separate two or more panes of glazing in a window to create a space between the panes. Spacers can be made from a variety of different materials and, depending on the conductivity of the spacer material, spacers can affect the overall window performance. This space can be filled with air, gas, or a combination of gases and sealed to improve the insulation value of the glazing unit. Glazing, spacer(s), and gases are all enclosed in a structure called the frame.

Glazing

Glazing for vertical fenestration is typically made of glass, which is an inorganic, amorphous substance. Other, lighter transparent materials may be used on the interior of triple- or quad-glazed windows to lessen the overall weight of the window.

Different gases can be used between panes of glass to improve the thermal performance of the window unit. Types of gases include Argon, Krypton, Xenon, and others, including proprietary formulations by different manufactures. These gases are chosen because they reduce convective heat transfer across the glazing cavity compared to normal air. Window seals have improved so that the likelihood of these beneficial gases escaping and being replaced with air has decreased. The life of a window is generally considered to be 30 years.

Window glass may also be coated to increase the energy efficiency of the window. The International Window Film Association (IWFA, www.iwfa.com) provides guidance on the various types of window films available and their properties. According to IWFA, the most common types of window films are:

- Solar control film—these films reduce the amount of heat that enters through windows.
- Spectrally selective film—these films block select wavelengths of radiation, typically to reduce heat gains while maintaining visible light transmittance.
- Decorative film—these films add aesthetic benefit.
- Safety/security film—these films help resist impact events, and are designed to hold glass together when broken.
- Low-E (low-emissivity) coating—lower the rate of heat gain/loss (compared to plain glass), which lowers the *U*-factor of the window unit.

Spacers and Sealants

An important part of the edge seal of windows is a spacer, which separates the glazing and provides a surface to which sealants can be applied. Spacers can be made of metallic materials, non-metallic materials, or a combination of both. The performance of the window can be greatly affected by the conductivity of the material used for the spacers. It must be emphasized that precast elements are only a part of the wall system. Where both joint sealant between precast elements and fenestrations are required it must be installed with quality materials per instructions from the manufacturers. In addition these installations should be properly inspected for conformance. A building maintenance inspection schedule should be established with records kept of those periodic inspections and any repairs or corrective actions performed as a result of those inspections be done in a timely manner. The sealant must also be replaced every 7 to 10 years.

Frames

Similar to the spacers, the material chosen for the frame of the window can greatly affect the performance of the window. Typical frame materials include wood, metal, and composite polymers. Because the frame is more-visible than the spacer, however, the choice of frame type is also influenced by style and maintenance needs. Wood and composite frames are generally more energy-efficient than metal frames. However, the strength of metal frames is often needed for commercial construction, especially high-rise construction.

Type of window systems

There are several types of window systems available. The choice of window type typically depends on several factors such as cost, aesthetics, energy efficiency, and others. Descriptions of some common window types are listed in the following.

Awning window: This type opens and projects outward from a hinge at the top of the window.

Casement window: This type opens and projects either inward or outward from a hinge at the side of the window.

Curtain wall: This type of window is so large that it is considered a wall, but one that carries no loads (the roof nor the floors) from the building and only the dead load of the wall itself. Typically, curtain walls are constructed entirely of glass and a metal frame. The glass is predominantly clear glass with portions that can be translucent or opaque.

Double-hung window: These windows have two sashes in a frame that are operable.

Single-hung window: For this type, only one of the two sashes in the frame is operable while the other is fixed.

Skylights: These window types are typically flat glass or domed composite panels that are placed on the roof in either a flat or angled position. They may be operable or fixed.

Storm window: This is actually an attachment that is mounted either inside or outside of a window to create an air space.

Transom window: These windows are inoperable, and are usually installed above a door or another window.

Performance

The energy efficiency of fenestration is largely determined by its *U*-factor and its SHGC. For most windows, these values include the effects of the glazing and the frame. Lower *U*-factors provide greater resistance to heat flow, which means they are better insulating. An example of typical *U*-factors are shown in Table 5, which were taken from the *ASHRAE Handbook: Fundamentals*, with typical values ranging from 0.20 to 1.20.

U-factors for operable windows are greater than those for the same window that is fixed (not operable). Operable windows are also generally more expensive. Some designers therefore specify fixed windows for their reduced cost. However, operable windows provide a benefit in passive ventilation and a connection to the outdoors for occupants, especially in schools and residential settings including residential healthcare facilities. Operable windows also serve a valuable role in resiliency when there are power outages due to storms.

SHGC values range from 0 to 1, with 0 meaning no heat gain and 1 meaning 100% heat gain. In commercial buildings, higher internal gains from lighting and equipment often mean air-conditioning loads for many months of the year even in colder climates. Therefore, ANSI/ASHRAE/IES Standard 90.1 and the IECC require an SHGC of 0.45 or less for northern climates and an SHGC of 0.25 or less in southern climates. North facing windows have less solar heat gains and higher SHGCs are often more energy-efficient and desirable. However, for ease of construction and to avoid differences in perceived window tinting on different sides of building, the same SHGC is usually specified for all four sides of a building. Permanent projections (horizontal overhangs) can be used to help meet the solar heat gain coefficient (SHGC) requirement when using ANSI/ASHRAE/IES Standard 90.1-2013 and the IECC.

Windows must have an NFRC label to meet the requirements of ANSI/ASHRAE/IES Standard 90.1, the IECC, or Energy Star. The label includes important performance characteristics of the window. The label is required to include the *U*-factor and SHGC values, as well as the Visible Transmittance (VT) value, which is a measure of the amount of light in the visible spectrum that comes through the product. VT values range from 0 to 1, with 1 corresponding to the most light available for daylighting.

Two optional performance ratings on the NFRC label are air leakage rate and condensation resistance. Air leakage rate of the product is a measure of the amount of outside air that can enter the building through the product. Typical air leakage values range from 0.1 to 0.3 cfm/ft^2. Condensation resistance factors (CRF) range from 0 to 100, with greater numbers meaning better resistance to condensation formation.

The principal potential moisture problems with windows are the following:

1. Poor sealing of the wall air barrier and vapor retarder at window joints with the wall.
2. Penetration of rainwater into the wall construction beneath the windows.

3. Condensation of moisture or frost formation on the inside of windows in cold weather and subsequent drainage of the water onto the sill and into the wall construction.

4. Excessive leakage of warm moist air into the building in summer weather to add to the air conditioning load.

Air barriers and vapor retarders must be carefully sealed at window openings to prevent air leakage into wall construction at the window frames. Likewise the design of window sills and the sealant techniques must be such that rainwater drainage is diverted to the outside without wetting the insulated construction beneath the windows. This requires that thermal insulation be held away from the collecting surface so moisture can proceed down to collection systems without wetting the insulation. Impaling pins allow this to be accomplished easily, and they are available with shoulders holding back-up discs and insulation away from the panel.

Double and triple glazed windows should be used in Climate Zones 4, 5, 6, and 7 where there are extended periods of cold weather to reduce surface condensation and drainage. An indoor relative humidity of 40% can be maintained without excessive condensation on double-glazed windows for outside temperatures down to 15°F (approximately the design temperature for Washington DC in Climate Zone 4). For Climate Zone 5 and colder zones the indoor relative humidity needs to be kept much lower – at 20% RH or lower – at design temperatures. At colder temperatures indoor RH levels are generally lower and but the potential for condensation still remains. Windows with argon fill allow for colder temperatures before condensate accumulates. The ***ASHRAE Handbook: Fundamentals*** provides more guidance on potential condensation. The drainage of window condensation should not be allowed to remain on the window sills or to run down the inside walls. Windows in hospitals and swimming pool areas as well as indoor spaces with additional moisture from humidification are exposed to higher than average indoor RH levels in cold climates and must be carefully designed to prevent condensation. Moisture-resistant or insulated window sills offer preventative solutions against sill damage; condensation generally does not cause damage to non-wood windows. Test Air leakage is required to not exceed 0.2 or 0.3 cfm/ft^2 according to ANSI/ASHRAE/IES Standard 90.1 and the IECC, depending on the test method. These values are available from the manufacturer.

The window-to-wall ratio (WWR) is the area of vertical fenestration divided by the total wall area. In general, a reduction in the WWR will save energy because of the much higher thermal resistance of most opaque walls compared to windows and the reduction in solar heat gains to indoor spaces, especially on the east- and west-facing sides of the building.

In warmer climates, typically defined as climate zones 1, 2, and 3, there are several design options related to windows to improve the energy efficiency of the building. They include:

- Providing overhangs to reduce solar heat gain for south-, east- , and west- facing windows;
- Providing vertical fins to reduce solar heat gain;
- Orienting and elongating the building in the east-west direction to maximize windows to the south, which can be easily shaded, and the north and minimize windows on the east and west faces; and
- Selecting windows with low SHGCs, especially for the east - and west-facing windows where solar heat gains are greatest.

In colder climates, typically defined as climate zones 5 through 8, there are several design options related to windows to improve the energy efficiency of the building. They include:

- Maximizing the south-facing windows by orienting and elongating the building in the east-west direction, and
- Using passive solar techniques and thermal mass, such as that in precast concrete, to absorb solar heat gain.

Glazing thermal performance is measured by thermal transmittance (*U*-factor), solar heat gain coefficient (SHGC), and visible transmittance (VT). A low SHGC will minimize solar heat gains and reduce cooling loads. Some products with low SHGC also have a low VT that will reduce daylighting benefits. Products with a low SHGC and high VT are often a good choice. More information is included in the section Considerations at Windows. Since glazing types have proliferated in recent years, refer to the ***ASHRAE Handbook: Fundamentals*** or the NFRC for more glazing and fenestration properties. **Table 1** provides some typical values.

Table 1 *U*-Factors for Various Fenestration Products, Btu/h ft^2 °F.

Product Type	Vertical Installation												
	Operable					Fixed					Curtain Wall		
Frame Type	Aluminum without Thermal Break	Aluminum with Thermal Break	Reinforced Vinyl/ Aluminum Clad Wood	Wood/ Vinyl	Insulated Fiberglass/ Vinyl	Aluminum without Thermal Break	Aluminum with Thermal Break	Reinforced Vinyl/ Aluminum Clad Wood	Wood/ Vinyl	Insulated Fiberglass/ Vinyl	Aluminum without Thermal Break	Aluminum with Thermal Break	Structural Glazing
Glazing Type													
Single Glazing													
1/8 in. glass	1.23	1.07	0.93	0.91	0.85	1.12	1.07	0.98	0.98	1.04	1.21	1.10	1.10
1/4 in. acrylic/ polycarbonate	1.10	0.94	0.81	0.80	0.74	0.98	0.92	0.84	0.84	0.88	1.06	0.96	0.96
1/8 in. acrylic/ polycarbonate	1.17	1.01	0.87	0.86	0.79	1.05	0.99	0.91	0.91	0.96	1.13	1.03	1.03
Double Glazing													
¼ in. air space	0.81	0.64	0.57	0.55	0.50	0.68	0.62	0.56	0.56	0.55	0.77	0.67	0.63
½ in. air space	0.76	0.58	0.52	0.50	0.45	0.62	0.56	0.50	0.50	0.48	0.71	0.61	0.57
¼ in. argon space	0.78	0.61	0.54	0.52	0.47	0.65	0.59	0.53	0.52	0.51	0.74	0.63	0.59
½ in. argon space	0.73	0.56	0.50	0.48	0.43	0.60	0.53	0.48	0.47	0.45	0.68	0.58	0.54

Double Glazing, e = 0.6 on surface 2 or 3													
¼ in. air space	0.79	0.61	0.55	0.53	0.48	0.66	0.59	0.54	0.53	0.52	0.74	0.64	0.60
½ in. air space	0.72	0.55	0.49	0.48	0.43	0.59	0.53	0.47	0.47	0.44	0.68	0.57	0.53
¼ in. argon space	0.75	0.57	0.51	0.50	0.45	0.61	0.55	0.49	0.49	0.47	0.70	0.60	0.56
½ in. argon space	0.70	0.53	0.47	0.45	0.41	0.56	0.50	0.44	0.44	0.41	0.65	0.55	0.51
Double Glazing, e = 0.2 on surface 2 or 3													
¼ in. air space	0.73	0.56	0.50	0.48	0.43	0.60	0.53	0.48	0.47	0.45	0.68	0.58	0.54
½ in. air space	0.65	0.48	0.43	0.41	0.37	0.51	0.45	0.39	0.39	0.35	0.60	0.50	0.45
¼ in. argon space	0.68	0.51	0.45	0.43	0.39	0.54	0.47	0.42	0.42	0.38	0.62	0.52	0.48
½ in. argon space	0.61	0.45	0.39	0.38	0.33	0.47	0.41	0.35	0.35	0.30	0.55	0.45	0.41
Triple Glazing													
¼ in. air spaces	0.67	0.49	0.43	0.43	0.38	0.53	0.47	0.42	0.42	0.38	0.61	0.51	0.46
½ in. air spaces	0.61	0.44	0.38	0.38	0.34	0.47	0.41	0.36	0.36	0.31	0.55	0.45	0.40
¼ in. argon spaces	0.63	0.46	0.41	0.40	0.36	0.50	0.44	0.38	0.38	0.34	0.58	0.48	0.43
½ in. argon spaces	0.59	0.42	0.37	0.36	0.32	0.45	0.40	0.34	0.34	0.29	0.53	0.43	0.38

Source: *ASHRAE Handbook: Fundamentals*.

About AIA Learning Units

Please visit **www.pci.org/elearning** to read the complete article, as well as to take the test to qualify for 1.0 HSW Learning Unit.

The Precast/Prestressed Concrete Institute (PCI) is a Registered Provider with both the American Institute of Architects (AIA) and the National Council of Examiners for Engineers and Surveyors (NCEES). Continuing education credit is reported to both agencies.

All certificates of completion, for architects and for engineers, will be available from the Registered Continuing Education Provider (RCEP) web site at www.rcep.net. PCI reports data twice per month so you should see your credits appear (and your certificate will be ready) within 30 days of our receiving your completed quiz.

If you are new to the Registered Continuing Education Provider system, www.rcep.net will email you a welcome email when PCI uploads your data. That email will contain your account password. Your login name at www.rcep.net will be your email address, so you must include it when submitting your completed quiz.

Instructions

Review the learning objectives below.

Read the AIA Learning Units article. Note: The complete article is available at www.pci.org/elearning.

Complete the online test. You will need to answer at least 80% of the questions correctly to receive the 1.0 HSW Learning Units associated with this educational program.

Learning Objectives:

After reading this article, readers will be able to:

1. Discover the components of a fenestration system.
2. Understand the *U*-factors for various fenestration products.
3. Develop a deeper understanding of the role of emittance values and air-space gases on the thermal performance of windows.
4. Learn how to choose the correct fenestration system for the climate zone in which a project is located.

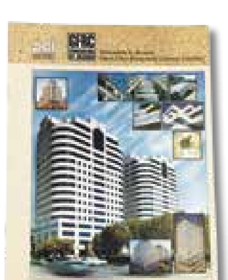
Questions: contact Education Dept. - Alex Morales, (312) 786-0300, Email amorales@pci.org

Precast/Prestressed Concrete Design Resources

PCI develops, maintains, and disseminates the Body of Knowledge for designing, fabricating, and constructing precast concrete structures and systems. It is from this Body of Knowledge that buildings codes, design guides, education, and certification programs are derived. **Please visit www.pci.org for all of these design resources and more.**

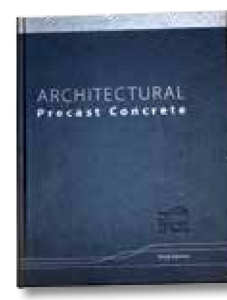
Architectural Precast Concrete Color and Texture Selection Guide, 2nd Edition - (CTG-10)

The "Architectural P recast Concrete - Color and Texture Selection Guide" has been reprinted with 12 new color and texture pages, plus identification pages with mix designs. This includes nine new color pages with two new colors per page, two pages of new form liners, and one page of new clay brick-faced precast. The numbers in the guide have not been changed, so that there is no confusion with the old and the new versions. A visual guide to assist architects in the initial selection of color and texture for architectural precast concrete. The guide is an extension of the information included in the architect-oriented Architectural Precast Concrete manual (MNL-122), illustrating more than 500 colors and textures for enhancing the aesthetic quality of precast concrete panels. Cements, pigments, coarse and fine aggregates, and texture or surface finish with various depths of exposure were considered in creating the 287 6.75-by-11.00-inch color plates, the majority of which display two finishes on the same sample. The materials used to produce the samples are identified in the back of the guide for handy reference. Three-ring binder with removable inserts.



Innovation by Design: Glass Fiber Reinforced Concrete Cladding - (GFRC-3)

Four-color publication discusses what is GFRC, production techniques and available choices of color, form and texture. Applications and advantages of GFRC, along with its use in rehabilitation and renovation projects are also presented. The brochure presents guidelines for effective use of GFRC.



Architectural Precast Concrete, 3rd Edition - (MNL-122)

This fully revised edition includes new sections on sustainability, condensation control, and blast resistance. You'll get extensive updates in the areas of color, texture, finishes, weather, tolerances, connections, and windows, along with detailed specifications to meet today's construction needs. Includes full-color photographs and a bonus DVD.

Designers' Notebooks-Free

The PCI Designer's Notebooks provide detailed, in-depth information on precast concrete relevant to specific design topics, such as acoustics, mold and sustainability.

Top Photo: Éric Painchaud, architecte.

PCI Continuing Education

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 International Code Council (ICC). 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

July 26 and July 28, 2016 "Precasat Concrete Off-Site Construction: Techniques & Case Studies" –Webinar attendees will be provided with an overview of the most common systems of precast concrete products, cover basic design criteria and capabilities, and explore case studies showing how precast was used to solve diverse design and construction challenges with off-site construction.

August 23 and August 25, 2016 "Total Precast School Systems."

September 20 and September 22, 2016 "Enclosure Design - Panelization and Joints/R-Value Calculation."

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 resource at **www.pci.org/elearning**.

In-Person Learning Opportunities

Seminars and Workshops

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

* High Performance Precast Concrete Building Enclosures Seminars

September 14, 2016 Denver Marriott Tech Center, Denver, Co.

September 15, 2016, Salt Lake City Marriott City Center, Salt Lake City, Utah.

Upcoming Seminars and Workshops:

Quality Control Schools

Level I/II

July 18-20: Denver,CO.
August 31–September 2, 2016: Chicago, IL

Level III

August 30–September 2, 2016: Chicago, IL

CONTINUING EDUCATION AIA

Visit www.pci.org/schools or www.pci.org/events for more information and to register.

Lunch-and-Learns

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

PCI-Certified Plants

(as of June 2016)

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, C4, C4A
Forterra Building Products (Pelham Prestress), Pelham (205) 663-4681 ____ B4, C4

ARIZONA

Coreslab Structures (ARIZ) Inc., Phoenix (602) 237-3875 ____ A1, B4, C4, C4A
Green Fuel Technologies LLC dba Royden Precast, Phoenix (602) 484-0028 ____ B4
Stringer Bridge & Iron, Coolidge (520) 723-5383 ____ B4
Tpac, An EnCon Company, Phoenix (602) 262-1360 ____ A1, B4, C4, C4A

ARKANSAS

Coreslab Structures (ARK) Inc., Conway (501) 329-3763 ____ C4, C4A

CALIFORNIA

Bethlehem Construction, Inc., Wasco (661) 391-9704 ____ C3, C3A
Clark Pacific, Fontana (909) 823-1433 ____ A1, C3, C3A, G
Clark Pacific, Irwindale (626) 962-8751 ____ C4A
Clark Pacific, West Sacramento (916) 371-0305 ____ A1, C3, C3A
Clark Pacific, Woodland (530) 207-4100 ____ A1, B3, C4, C4A
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, C4, C4A
KIE-CON, Inc., Antioch (925) 754-9494 ____ B4, C3
Mid-State Precast, L.P., Corcoran (559) 992-8180 ____ A1, C3, C3A
Oldcastle Precast, Inc., Perris (951) 657-6093 ____ B4, B4A, C2, C2A
Oldcastle Precast Inc., Stockton (209) 466-4215 ____ C2
Precast Concrete Technology dba CTU Precast, Olivehurst (530) 749-6501 A1, C3, C3A
StructureCast, Bakersfield (661) 833-4490 ____ A1, B3, C3, C3A
Universal Precast Concrete, Inc., Redding (530) 243-6477 ____ A1, B1, C1
Walters & Wolf Precast, Fremont (510) 226-9800 ____ A1, G
Willis Construction Co., Inc., Hollister (831) 623-2900 ____ A1, C1
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, C3, C3A
Rocky Mountain Prestress LLC, Architectural Plant Denver (303) 480-1111 A1, C3, C3A
Rocky Mountain Prestress LLC, Structural Plant, Denver (303) 480-1111 ____ B4, C4
Rocla Concrete Tie, Inc., Pueblo (303) 296-3500 ____ C2
Stresscon Corporation, Colorado Springs (719) 390-5041 ____ A1, B4, B4A, C4, C4A

CONNECTICUT

Blakeslee Prestress Inc., Branford (203) 481-5306 ____ A1, B4, C4, C4A
Coreslab Structures (CONN) Inc., Thomaston (860) 283-8281 ____ A1, B1, C1
Oldcastle Precast, Avon (860) 673-3291 ____ B2, C1, C1A
United Concrete Products, Inc., Yalesville (203) 269-3119 ____ B3, C3

DELAWARE

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

FLORIDA

Cement Industries, Inc., Fort Myers (800) 332-1440 ____ B3, C3
Colonial Construction, Concrete, Precast, LLC, Placida (941) 698-4180 ____ C2
Coreslab Structures (MIAMI) Inc., Medley (305) 823-8950 ____ A1, C4, C4A
Coreslab Structures (ORLANDO) Inc., Orlando (407) 855-3190 ____ C2
Coreslab Structures (TAMPA) Inc., Tampa (813) 626-1141 ____ A1, B3, C3, C3A
Dura-Stress, Inc., Leesburg (352) 787-1422 ____ A1, B4, B4A, C4, C4A
Finfrock Industries, Inc., Apopka (407) 293-4000 ____ A1, C3
Gate Precast Company, Jacksonville (904) 757-0860 ____ A1, B4, C3, C3A
Gate Precast Company, Kissimmee (407) 847-5285 ____ A1, C3
International Casting Corporation, Miami Lakes (305) 558-3515 ____ C4
Metromont Corporation, Bartow (863) 440-5400 ____ A1, C3, C3A
Pre-Cast Specialties Inc., Pompano Beach (954) 781-4040 ____ C4
Spancrete Southeast Inc., 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 ____ C4, C4A
Coreslab Structures (ATLANTA) Inc., Jonesboro (770) 471-1150 ____ C2
Metromont Corporation, Hiram (770) 943-8688 ____ A1, C4, C4A
Spancrete, Newnan (770) 252-8944 ____ C2
Standard Concrete Products, Inc., Atlanta (404) 792-1600 ____ B4
Standard Concrete Products, Inc., Savannah (912) 233-8263 ____ B4, C4
Tindall Corporation, Georgia Division, Conley (404) 366-6270 ____ C4, C4A

HAWAII

GPRM Prestress, LLC, Honolulu (808) 682-6000 ____ A1, B4, C4

IDAHO

Forterra Structural Precast, Caldwell (208) 454-8116 ____ A1, B4, C4
Teton Prestress Concrete, LLC., Idaho Falls (208) 522-6606 ____ B4, C3

ILLINOIS

ATMI Precast, Aurora (630) 896-4679 ____ A1, C3, 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, C3A
Dukane Precast, Inc., Naperville (630) 355-8118 ____ A1, B3, B3-IL, C3, C3A
Dukane Precast, Inc., Plainfield, (815) 230-4760 ____ C3
ICCI Illini Concrete, LLC, Tremont (309) 925-2376 ____ B3, B3-IL
Illini Precast, LLC, Marseilles (815) 795-6161 ____ B4, B4-IL, C3
KW Precast LLC, Westchester (708) 562-7770 ____ B4, B4-IL, C4
Lombard Architectural Precast Products Co., Alsip (708) 389-1060 ____ A1, C2, C2A
Mid-States Concrete Industries, South Beloit (815) 389-2277 ____ A1, B3, B3-IL, C3, C3A
St. Louis Prestress, Inc., Glen Carbon (618) 656-8934 ____ B3, B3-IL, C3
Utility Concrete Products, LLC, Morris (815) 416-1000 ____ B1, B1A, C1, C1A

INDIANA

ATMI Indy, LLC, Greenfield (317) 891-6280 ____ A1, C2, C2A
Coreslab Structures (INDIANAPOLIS) Inc., Indianapolis (317) 353-2118 ____ A1, C4, C4A
Hoosier Precast LLC, Salem (815) 459-4545 ____ B3, C1, C1A
Precast, LLC dba Precast Specialties, Monroeville (260) 623-6131 ____ A1, B1
Prestress Services Industries LLC, Decatur (260) 724-7117 ____ B4, B4-IL, C4, C4A
StresCore, Inc., South Bend (574) 233-1117 ____ C2

IOWA

Advanced Precast Co., Farley (563) 744-3909 ____ A1, C1, C1A
Forterra Building Products, Iowa Falls (641) 648-2579 ____ A1, B4, B4-IL, C4, C4A
MPC Enterprises, Inc., Mount Pleasant (319) 986-2226 ____ A1, C3, C3A
PDM Precast, Inc., Des Moines (515) 243-5118 ____ A1, C3, C3A

KANSAS

Coreslab Structures (KANSAS) Inc., Kansas City (913) 287-5725 ____ B4, C4
Crossland Prefab LLC, Columbus (620) 249-1414 ____ C1
Fabcom Precast, LLC, Pleasanton (913) 937-3021 ____ C3, C3A
Prestressed Concrete, Inc., Columbus (620) 249-1414 ____ C1
Stress-Cast, Inc., Assaria (785) 667-3905 ____ C3, C3A

KENTUCKY

Bristol Group, Inc., Lexington (859) 233-9050 ____ A1, B3, B3A, C3, C3A
de AM - RON Building Systems LLC, Owensboro (270) 684-6226 ____ B3, C3, C3A
Gate Precast Company, Winchester (859) 744-9481 ____ A1, C3, C3A
Prestress Services Industries LLC, Lexington (601) 856-4135 ____ A1, B4, C4, C4A
Prestress Services Industries LLC, Melbourne (859) 441-0068 ____ B4, C3

LOUISIANA

Atlantic Metrocast, Inc., New Orleans (504) 941-3152 ____ C2

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

Boykin Brothers, Inc./Louisiana Concrete, Baton Rouge (225) 753-8722 **A1, B4, C3, C3A**
F-S Prestress, LLC, Princeton (318) 949-2444 **B4, C3**
Fibrebond Corporation, Minden (318) 377-1030 **A1, C1, C1A**

MAINE

Superior Concrete, LLC, Auburn (207) 784-1388 **B2, C1**

MARYLAND

Larry E. Knight, Inc., Glyndon (410) 833-7800 **C2**
Oldcastle Precast Building Systems Div., Edgewood (800) 523-3747 **A1, C3, C3A**

MASSACHUSETTS

Oldcastle Precast, Inc., Rehoboth (508) 336-7600 **B4, C3**
Precast Specialties Corp., Abington (781) 878-7220 **A1**
Unistress Corporation, Pittsfield (413) 629-2039 **A1, B4, C4, C4A**
Vynorius Prestress, Inc., Salisbury (978) 462-7765 **B3, C2**

MICHIGAN

International Precast Solutions, LLC, River Rouge (313) 843-0073 **A1, B3, C3, C3A**
Kerkstra Precast Inc., Grandville (616) 224-6176 **A1, B3, C3, C3A**
Nucon–Stress-Con Industries, Inc., Kalamazoo (269) 381-1550 **A1, B4, C3, C3A**
Peninsula Prestress Company, Grand Rapids (517) 206-4775 **B4, C1**
Stress-Con Industries, Inc., Saginaw (989) 755-4348 **B4, C3**

MINNESOTA

Crest Precast, Inc., La Crescent (800) 658-9045 **B3, B3A, C3, C3A**
Forterra Building Products, Elk River (763) 441-2124 **B4, C2**
Fabcon Precast, LLC, Savage (952) 890-4444 **A1, B1, C3, C3A**
Molin Concrete Products Co., Lino Lakes (651) 786-7722 **C3, C3A**
Molin Concrete Products, Ramsey (651) 786-7722 **A1, C1A**
Wells Concrete, Albany (320) 845-2299 **A1, C3, C3A**
Wells Concrete, Wells (800) 658-7049 **A1, C4, C4A**
Wells Concrete–Maple Grove, Osseo (763) 425-5555 **A1, C4, 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, C2, C2A**
Tindall Corporation, Moss Point (228) 246-0800 **A1, C4, C4A**

MISSOURI

Coreslab Structures (MISSOURI) Inc., Marshall (660) 886-3306 **A1, B4, C4, C4A**
County Materials Corporation, Bonne Terre (636) 432-0225 **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) 869-7350 **A1, C3, C3A**

MONTANA

BC Concrete, Inc. dba Missoula Concrete Construction,
Missoula (406) 549-9682 **A1, B3, C3, C3A**
Forterra Building Products, Billings (406) 656-1601 **B4, C3**
Forterra Building Products, Montana City (406) 442-6503 **B4**

NEBRASKA

American Concrete Products Co., Omaha (402) 331-5775 **B1, B1A, C1, C1A**
Concrete Industries, Inc., Lincoln (402) 434-1800 **B4, C4, C4A**
Coreslab Structures (OMAHA) Inc., Bellevue (402) 291-0733 **A1, B4, C4, C4A**
Enterprise Precast Concrete, Inc., Omaha (402) 895-3848 **A1, C2, C2A**

NEVADA

Precast Management Corporation, Sloan (702) 370-5217 **B4, C2**

NEW HAMPSHIRE

Newstress Inc., Epsom (603) 736-9000 **B3, C3**

NEW JERSEY

Boccella Precast LLC, Berlin (856) 767-3861 **C2**
Jersey Precast, Hamilton (609) 689-3700 **B4, C4**
Northeast Precast, Millville (856) 765-9088 **A1, B3, C3, 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, C4, C4A**
Ferreri Concrete Structures Inc., Albuquerque (505) 344-8823 **A1, C4, C4A**

NEW YORK

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

NORTH CAROLINA

Coastal Precast Systems , LLC, Wilmington (910) 604-2249 **B2, C2**
Gate Precast Company, Oxford (919) 603-1633 **A1, C2**
Metromont Corporation, Charlotte (704) 372-1080 **A1, C3, C3A**
Prestress of the Carolinas, Pineville (704) 587-4273 **B4, C4**
Utility Precast, Inc., Concord (704) 721-0106 **B3, B3A**

NORTH DAKOTA

Wells Concrete, Grand Forks (701) 772-6687 **C4, C4A**

OHIO

DBS Prestress of Ohio, Huber Heights (937) 878-8232 **C3**
Fabcon Precast, LLC, Grove City (952) 890-4444 **A1, C3, C3A**
High Concrete Group LLC, Springboro (937) 748-2412 **A1, C3, C3A**
Mack Industries, Inc., Valley City (330) 483-3111 **C3**
Prestress Services Industries of Ohio, LLC, (I-Beam),
Mt. Vernon (800) 366-8740 **A1, B4, C3**
Prestress Services Industries of Ohio, LLC,, (Box Beam),
Mt. Vernon (740) 393-1121 **B3, C3**
Rocla Concrete Tie, Inc., Sciotoville (740) 776-3238 **C2**
Sidley Precast, Thompson (440) 298-3232 **A1, C4, C4A**

OKLAHOMA

Arrowhead Precast, LLC, Broken Arrow (918) 995-2227 **A1, C3, C3A**
Coreslab Structures (OKLA) Inc. (Plant No.1),
Oklahoma City (405) 632-4944 **A1, C4, 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, C4A**
R.B. Johnson Co., McMinnville (503) 472-2430 **B4, C3**

PENNSYLVANIA

Architectural Precast Innovations, Inc., Middleburg (570) 837-1774 **A1, C3, C3A**
Brayman Precast, LLC, Saxonburg (724) 352-5600 **B1, C1**
Brayman Precast, LLC, Speers Plant, Belle Vernon (724) 352-5600 **B1, C1**
Concrete Safety Systems, LLC, Bethel (717) 933-4107 **A1, B1, B1A, C1, C1A**
Conewago Precast Building Systems, Hanover (717) 632-7722 **A1, C3,C3A**
Dutchland, Inc., Gap (717) 442-8282 **C3**
Fabcon Precast, LLC, Mahanoy City (952) 890-4444 **A1, B1, B1A, C3, C3A**
High Concrete Group LLC, Denver (717) 336-9300 **A1, B3, C3, C3A**
J & R Slaw, Inc., Lehighton (610) 852-2020 **A1, B4, C3, C3A**
Nitterhouse Concrete Products, Inc., Chambersburg (717) 267-4505 **A1, C4, C4A**
Northeast Prestressed Products, LLC, Cressona (570) 385-2352 **B4, C3**
PENNSTRESS, Roaring Spring (814) 224-2121 **A1, B4, C4**
Say-Core, Inc., Portage (814) 736-8018 **C2**
Sidley Precast, Youngwood (724) 755-0205 **C3**
Universal Concrete Products Corporation, Stowe (610) 323-0700 **A1, C3, C3A**

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US Concrete Precast Group Mid-Atlantic, Middleburg (570) 837-1774 ____ **A1, C3, C3A**

RHODE ISLAND

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

SOUTH CAROLINA

Florence Concrete Products, Inc., Sumter (803) 775-4372 ____ **B4, C3, C3A**
Metromont Corporation, Greenville (864) 605-5000 ____ **A1, C4, C4A**
Tekna Corporation, Charleston (843) 853-9118 ____ **B3, C3**
Tindall Corporation, Spartanburg (864) 576-3230 ____ **A1, C4, C4A**

SOUTH DAKOTA

Gage Brothers, Sioux Falls (605) 336-1180 ____ **A1, B4, C4, C4A**

TENNESSEE

Construction Products, Inc. of Tennessee, Jackson (731) 668-7305 ____ **B4, C4**
Gate Precast Company, Ashland City (615) 792-7608 ____ **A1, C3, C3A**
Mid South Prestress, LLC, Pleasant View (615) 746-6606 ____ **C3**
Ross Prestressed Concrete, Inc., Bristol (423) 323-1777 ____ **B4, C3**
Ross Prestressed Concrete, Inc., Knoxville (865) 524-1485 ____ **B4, C4**

TEXAS

Coreslab Structures (TEXAS) Inc., Cedar Park (512) 250-0755 ____ **A1, C4, C4A**
CXT, Inc., Hillsboro (254) 580-9100 ____ **B1, B1A, C1, C1A**
East Texas Precast Co., LTD., Waller (281) 463-0654 ____ **C4, 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, C1, C1A**
Gate Precast Company, Pearland (281) 485-3273 ____ **C2**
GFRC Cladding Systems, LLC, Garland (972) 494-9000 ____ **G**
Heldenfels Enterprises, Inc., Corpus Christi (361) 883-9334 ____ **B4, C4**
Heldenfels Enterprises, Inc., San Marcos (512) 396-2376 ____ **B4, C4**
Legacy Precast, LLC, Brookshire (281) 375-2050 ____ **C4, C4A**
Lowe Precast, Inc., Waco (254) 776-9690 ____ **A1, C3, C3A**
Manco Structures, Ltd., Schertz (210) 690-1705 ____ **C4, C4A**
NAPCO PRECAST, LLC, San Antonio (210) 509-9100 ____ **A1, C4, C4A**
Rocla Concrete Tie, Inc., Amarillo (806) 383-7071 ____ **C2**
Texas Concrete Partners, LP, Elm Mott (254) 822-1351 ____ **B4, C4**
Texas Concrete Partners, LP, Victoria (361) 573-9145 ____ **B4, C4**
Tindall Corporation, San Antonio (210) 248-2345 ____ **A1, C3, C3A**
Valley Prestressed Products, Inc., Houston (713) 455-6098 ____ **B2**
Valley Prestress Products Inc., Eagle Lake (979) 234-7899 ____ **B4**

UTAH

Forterra Structural Precast, Salt Lake City (801) 966-1060 ____ **A1, B4, C4, C4A, G**
Granite Construction Company, Salt Lake City (801) 526-6000 ____ **B1**
Harper Precast, Salt Lake City (801) 326-1016 ____ **B2, C1**
Olympus Precast, LLC, Sandy (801) 571-5041 ____ **A1, B3, B3A, C3, C3A**

VERMONT

J. P. Carrara & Sons, Inc., Middlebury (802) 388-6363 ____ **A1, B4, B4A, C3, C3A**
S.D. Ireland Companies, Williston (802) 863-6222 ____ **A1, B1, C1**
William E. Dailey Precast, LLC, Shaftsbury (802) 442-4418 ____ **A1, B4, B4A, C4, C4A**

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) 545-5215 ____ **B4, C3**
Coastal Precast Systems, LLC, Chesapeake (757) 545-5215 ____ **A1, B4, C3**
Faddis Concrete Products, King George (540) 775-4546 ____ **B2, C2**
Metromont Corporation, Richmond (804) 665-1300 ____ **A1, C3, C3A**
Rockingham Precast, Harrisonburg (540) 433-8282 ____ **B4**
Smith-Midland, Midland (540) 439-3266 ____ **A1, B2, C2, C2A**
The Shockey Precast Group, Winchester (540) 667-7700 ____ **A1, C4, C4A**
Tindall Corporation, Petersburg (804) 861-8447 ____ **A1, C4, C4A**

WASHINGTON

Bellingham Marine Industries, Inc., Ferndale (360) 380-2142 ____ **B3, C2**
Bethlehem Construction, Inc., Cashmere (509) 782-1001 ____ **B1, C3, C3A**
Concrete Technology Corporation, Tacoma (253) 383-3545 ____ **B4, C4**
CXT, Inc., Precast Division, Spokane (509) 921-8766 ____ **B1, C1, C1A**
CXT, Inc., Rail Division, Spokane (509) 921-7878 ____ **C2**
EnCon Northwest, LLC, Camas (360) 834-3459 ____ **B1, B1A**
EnCon Washington, LLC, Puyallup (253) 846-2774 ____ **B1, B1A, C2, C2A**
Oldcastle Precast, Inc., Spokane, Spokane Valley (509) 536-3300 ____ **A1, B4, C4**
Wilbert Precast, Inc., Yakima (509) 325-4573 ____ **B3, C3**

WEST VIRGINIA

Carr Concrete a division of CXT Inc., Waverly (304) 464-4441 ____ **B4, C3**
Eastern Vault Company, Inc., Princeton (304) 425-8955 ____ **B3, C3**

WISCONSIN

County Materials Corporation, Janesville (608) 373-0950 ____ **B4, B4-IL**
County Materials Corporation, Roberts (800) 426-1126 ____ **B4, C3**
International Concrete Products, Inc., Germantown (262) 242-7840 ____ **A1, C1**
MidCon Products, Inc., Hortonville (920) 779-4032 ____ **A1, C1**
Spancrete, Valders (920) 775-4121 ____ **A1, B4, C3, C3A**
Stonecast Products, Inc., Germantown (262) 253-6600 ____ **A1, C1**
Wausau Tile Inc., Wausau (715) 359-3121 ____ **AT**

WYOMING

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

MEXICO

PRETECSA, S.A. DE C.V., Atizapan De Zaragoza 52 (555) 077-0071 ____ **A1, G**
Willis De Mexico S.A. de C.V., Tecate 52 (665) 655-2222 ____ **A1, C1, G**

CANADA

BRITISH COLUMBIA

APS Architectural Precast Structures LTD, Langley (604) 888-1968 ____ **A1, B4, C3, C3A**
Armtec Limited Partnership, Richmond (604) 214-3243 ____ **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, C4A**

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 Trans. Canada Inc.,
St. Eugene De Grantham (819) 396-2624 ____ **A1, B4, C3, C3A**
Bombadier, Alma ____ **A1, C2**
Papeterie, Alma ____ **A1, C3, C3A, G**
Prefab de Beauce Inc., Alma (418) 668-6161 ____ **A1, C3**

UAE

Arabian Profile Company Limited, Sharjah 971(6) 5432624 ____ **G**

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PCI Certified Erectors

(as of June 2016)

When it comes to quality, why take chances? When you need precast or precast, prestressed concrete products, choose a PCI 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 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 Certified Erector is the first step toward getting the job done right the first time, thus keeping labor costs down.
- PCI 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 certified by the Precast/Prestressed Concrete Institute (PCI) prior to the beginning of any work at the jobsite. The precast concrete erector shall be 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.

ARIZONA

Coreslab Structures (ARIZ), Inc., Phoenix (602) 237-3875 ____ S2
RJC Contracting, Inc., Mesa (480) 357-0868 ____ A, S2
Tpac, An EnCon Company, Phoenix (602) 262-1360 ____ A, S2

CALIFORNIA

Walters & Wolf Precast, Fremont (510) 226-5166 ____ A

COLORADO

EnCon Field Services, LLC, Denver (303) 287-4312 ____ A, S2
Gibbons Erectors Inc., Englewood (303) 841-0457 ____ A, S2
Rocky Mountain Prestress,LLC, Denver (303) 480-1111 ____ A, S2

CONNECTICUT

Blakeslee Prestress, Inc., Branford (203) 481-5306 ____ A, S2

FLORIDA

Concrete Erectors, Inc., Altamonte Springs (407) 862-7100 ____ A, S2
Florida Builders Group, Inc., Miami (305) 278-0098 ____ S2
Jacob Erecting & Construction, LLC, Jupiter (561) 741-1818 ____ A, S2
James Toffoli Construction Company, Inc., Fort Myers (239) 479-5100 ____ S2
Pre-Con Construction, Inc., Lakeland (813) 626-2545 ____ A, S2
Prestressed Contractors Inc., West Palm Beach (561) 741-4369 ____ S2
Solar Erectors U.S. Inc., Medley (305) 825-2514 ____ A, S2
Spancrete Southeast, Sebring (863) 655-1515 ____ S1
Specialty Concrete Services, Inc., Umatilla (352) 669-8888 ____ A, S2
W.W. Gay Mechanical Contractor, Inc., Jacksonville (904) 388-2696 ____ S2

GEORGIA

Bass Precast Erecting, Inc., Cleveland (706) 809-2718 ____ S1
Jack Stevens Welding LLP, Murrayville (770) 534-3809 ____ S2
Precision Stone Setting Co., Inc., Hiram (770) 439-1068 ____ A, S2
Rutledge & Sons, Inc., Canton (770) 592-0380 ____ S2
Southeastern Precast Erectors Inc. (SPE Inc.), Roswell (770) 722-9212 ____ A

IDAHO

Precision Precast Erectors LLC, Post Falls (208) 981-0060 ____ A, S2

ILLINOIS

Area Erectors, Inc., Rochelle (815) 562-4000 ____ A, S2
Creative Erectors, LLC, Rockford (815) 229-8303 ____ A, S2
Mid-States Concrete Industries, South Beloit (815) 389-2277 ____ S2

IOWA

Cedar Valley Steel, Cedar Rapids (319) 373-0291 ____ A, S2
Industrial Steel Erectors, Davenport (563) 355-7202 ____ A, S1
Northwest Steel Erection, Inc., Grimes (515) 986-0380 ____ A, S2
US Erectors, Inc., Des Moines (515) 243-8450 ____ S2

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KANSAS

Carl Harris Co., Inc., Wichita (316) 267-8700 ______ A, S2
Crossland Construction Company, Inc., Columbus (620) 442-1414 ______ S2

MARYLAND

DLM Contractors, LLC, Cheltenham (301) 877-0000 ______ A, S2
E & B Erectors, Inc., Elkridge (410) 360-7800 ______ A, S2
E.E. Marr Erectors, Inc., Baltimore (410) 837-1641 ______ A, S2
L.R. Willson & Sons, Inc., Gambrills (410) 987-5414 ______ A, S2

MASSACHUSETTS

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

MICHIGAN

Assemblers Precast & Steel Services, Inc., Saline (734) 368-6147 ______ A, S2
Devon Contracting, Inc., Detroit (313) 221-1550 ______ S2
G2 Inc., Cedar Springs (616) 696-9581 ______ A, S2
Pioneer Construction Inc., Grand Rapids (616) 247-6966 ______ A, S2

MINNESOTA

Amerect, Inc., Newport (651) 459-9909 ______ A
Fabcon Precast, LLC, Savage (952) 890-4444 ______ S2
Landwehr Construction Inc., St. Cloud (320) 252-1494 ______ A, S2
Molin Concrete Products Company, Lino Lakes (651) 786-7722 ______ A, S2
Wells Concrete, Maple Grove (800) 658-7049 ______ A, S2

MISSISSIPPI

Bracken Construction Company, Ridgeland (601) 922-8413 ______ A, S2

MISSOURI

JE Dunn Construction, Kansas City (816) 292-8762 ______ A, S2
Prestressed Casting Co., Springfield (417) 869-7350 ______ A, S2

NEBRASKA

Structural Enterprises Inc., Lincoln (402) 423-3469 ______ S2
Topping Out Inc. dba Davis Erection–Omaha, Omaha (402)731-7484 ______ A, S2

NEW HAMPSHIRE

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

NEW JERSEY

CRV Precast Construction LLC, Eastampton (609) 261-7325 ______ S1
J. L. Erectors, Inc., Blackwood (856) 232-9400 ______ A, S2
JEMCO-Erectors, Inc., Shamong (609) 268-0332 ______ S2
Jonasz Precast, Inc., Westville (856) 456-7788 ______ A, S2

NEW YORK

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

NORTH DAKOTA

PKG Contracting, Inc., Fargo (701) 232-3878 ______ S2

OHIO

Precast Services, Inc., Twinsburg (330) 425-2880 ______ A, S2
Sidley Precast Group, A Division of R.W. Sidley, Inc., Thompson (440) 298-3232 ______ S2

OKLAHOMA

Allied Steel Construction Co., LLC, Oklahoma City (405) 232-7531 ______ S2

PENNSYLVANIA

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

SOUTH CAROLINA

Davis Erecting & Finishing, Inc., Greenville (864) 220-0490 ______ A, S2
Florence Concrete Products, Inc., Florence (843) 662-2549 ______ S2
Steel Clad Inc., Greenville, (864) 246-8132 ______ A, S2
Tindall Corporation, Spartanburg (864) 576-3230 ______ A, S2

SOUTH DAKOTA

Henry Carlson Company, Sioux Falls (605) 336-2410 ______ A, S2

TENNESSEE

Mid South Prestress, LLC, Pleasant View (615) 746-6606 ______ S1

TEXAS

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

UTAH

Forterra Structural Precast, Salt Lake City (801) 966-1060 ______ A, S2
IMS Masonry, Lindon (801) 796-8420 ______ A
OutWest C & E Inc., Bluffdale (801) 446-5673 ______ A, S2

VERMONT

CCS Constructors Inc., Morrisville (802) 888-7701 ______ A, S2

VIRGINIA

The Shockey Precast Group, Winchester (540) 667-7700 ______ S2

WISCONSIN

J.P. Cullen, Janesville (608) 754-6601 ______ A, S1
Miron Construction Co., Inc., Neenah (920) 969-7000 ______ A, S2
Spancrete, Valders (920) 775-4121 ______ A, S2
The Boldt Company, Appleton (920) 225-6212 ______ A, S2

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