AESTHETIC VERSATILITY ISSUE

WINTER 2013

ASCENT

DESIGNING WITH PRECAST

CONTINUING EDUCATION

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Precast Concrete and High Performance

Brian Miller, P.E., LEED AP
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We didn't disappear before the new year began, as certain ancient civilizations predicted—at least not yet. But no one can deny that it's been a challenging and changing year. We have experienced some devastating disasters, weather patterns seem to be changing erratically, energy costs continue to increase, and our economy continues to hang on a "cliff" despite many efforts to alleviate that.

Many of these changes have prompted new approaches to how we design, construct, and operate buildings—some good, and some bad. On the good side, there is more focus on sustainable practices and materials as well as an emphasis on reducing energy consumption. This is a great start, but there is still more to do. Unfortunately, many are satisfied with a few positive attributes or a scorecard they can market, regardless of the building's actual long-term performance. Building codes and society have reduced efforts to the lowest common denominator. As a result, we have less durable construction and, in some cases, poor overall building performance.

The idea of high-performance buildings provides an overarching concept that includes sustainability, as well as many other important attributes. High-performance buildings are defined as buildings that integrate and optimize several high performance attributes on a life-cycle basis.

This is somewhat different from the way most of us typically think of high performance. Often, high performance is considered better than "standard." For example, high-performance concrete (HPC) would provide higher compressive strength, less permeability, etc. This part of the definition still applies to high performance buildings since, in most cases, these buildings exceed code requirements. However, the definition includes the ability to provide multiple benefits simultaneously, based on long-term performance. For example, a high performance building must be sustainable, energy efficient, and hurricane-resistant.

High-performance buildings are putting us back on track to build more versatile, efficient, resilient, and safe structures. To accomplish this, we will need to use high-performance materials and systems, such as precast concrete. That is the theme of this year's *Ascent* magazine. Each issue will address one of the broad groupings of high performance attributes, starting with versatility.

How is versatility a high-performance attribute? When discussing race cars, it may not be. But when optimizing systems and structures for the long-term, it's a critical issue.

Why use two separate systems or many different materials when one will do? Why not reduce total material usage, joints, detailing, professional liability, and coordination? Precast concrete provides incredible versatility in aesthetics, structural capacity, envelope design, and promotes desconstructability and adaptive reuse.

The articles in this issue focus on various aspects of precast concrete's versatility. When a material can reach from one end of the aesthetic spectrum to the other, serve as the envelope and structural system simultaneously, and truly optimize all of these benefits, that's versatility in a high-performance system. This issue, and the others this year, will help you *Discover High Performance Precast!*

ASCENT

On the cover: recast helps the Perot Museum in Dallas, Tex make an architectural statement. (see page 44)

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- **POSTMASTER:** Send address changes to *Ascent*, 200 W. Adams St., Suite 2100, Chicago, IL 60606.
  Periodical postage paid at Chicago, IL and additional mailing offices.
- *Ascent* (Vol. 23, No. 1, ISSN 10796983) is published quarterly by the Precast/Prestressed Concrete Institute, 200 W. Adams St., Suite 2100, Chicago, IL 60606.

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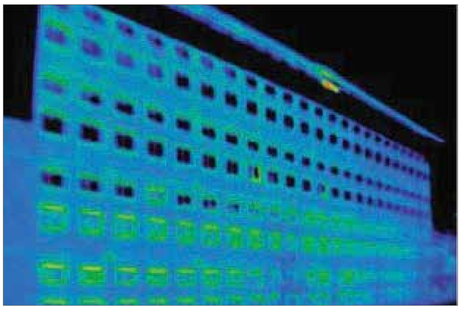

The above graphic is a thermographic image taken at NREL RSF to demonstrate the thermal efficiency of the building envelope with our continuous insulation system.

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Façade Tectonics Conference to Be Held February 22

LOS ANGELES

The University of Southern California's School of Architecture will host the first of its façade tectonics conferences, devoted specifically to precast concrete, on February 22, 2013. This event is part of the university's Executive Education and Professional Development curriculum.

The half-day conference will coincide with the publication of the *Façade Tectonics Journal: Precast Concrete*. This bound, color publication will focus on new information that advances the state of the art in the area of precast concrete used for façades and building envelopes. Top researchers and select industry experts in the precast concrete field have contributed original papers to the *Façade Tectonics Journal* and the authors will present the results of their work at the conference.

An optional pre-conference architectural precast plant tour is scheduled for the morning of February 22. Clark Pacific will host the tour at its plant in Fontana, Calif.

Visit the following link for more information: https://www.uscarchitecture.com/facades.

There is no cost to attend this event. Four CES/AIA Learning Units will be provided.

For more information, contact Edward D. Losch, P.E., S.E., Architect, LEED AP, University of Southern California School of Architecture, at 323-592-3299 or Losch@USC.edu.

Submit your headline news for consideration in a future issue of *Ascent* to Whitney Stephens at wstephens@pci.org.

Congratulations to the Winners of PCI's High Performance Precast Tour at DBIA

NEW ORLEANS

Recently, PCI joined nine member companies in exhibiting at the **Design-Build Institute of America's** (DBIA) Design-Build Annual Conference and Expo and united everyone with a common message — Discover High Performance Precast. At the heart of the excitement was a High Performance Precast Tour contest encouraging all attendees to visit PCI member booths for a chance to win $500.

Congratulations to the winners of our drawing, **Sandra Gitlin of STV** and **Anne Farrell of HGA**. Gitlin was the first place winner and awarded a $500 Visa gift card. Farrell was the runner up and awarded a $200 Visa gift card.

The following PCI member companies participated in the 2012 event: Bekaert, Bentley Systems, Carolina Stalite, Gate Precast, Oldcastle, Shockey Precast, Tekla, Thermomass, and Tindall.

PCI Design Awards Submission Site Opens January 21

CHICAGO

The **2013 PCI Design Awards** submission site will open on January 21. The PCI Design Awards program recognizes design excellence and construction quality using precast concrete. All winning projects will be showcased at the PCI Convention and National Bridge Conference and be included in a summary article that appears in *PCI Journal*, *Aspire* and *Ascent* magazines. Together, these publications reach over 65,000 industry stakeholders. Visit www.pci.org and click on the Design Awards icon for more details and to make a submission. Submissions are due by May 20. To view the 2012 winners, visit www.pci.org/2012designawards.

Stresscon Completes Erection of Precast Concrete for Bass Pro Shop CS

DENVER

Stresscon Corp. has finished erecting the precast concrete structure for the 119,640-square foot Bass Pro Shop in Colorado Springs, Colo. The exterior of the store features 113 pieces of 8 in. (200 mm) thick precast/prestressed concrete wall panels. These load-bearing wall panels serve as exterior cladding and provide the lateral resistance for the building. The building was completed in 54 days from the award of contract to completion of the precast concrete structure at the site. Erection of the precast concrete wall panels was accelerated and took just seven days to complete.

Stresscon Completes Architectural Precast Erection for RTD Parking Structure

DENVER

Stresscon Corp. in Colorado Springs, Colo., has completed erection of the architectural precast concrete for the Regional Transportation District West Rail Line at Wadsworth Boulevard. This is a four-level parking structure serving RTD passengers in Lakewood, Colo. The precast concrete spandrels and column covers enhance the appearance of the structure by providing two colors: tan and dark gray. As designed by Gensler Architects, the tan panels form a large multibay and multistory picture frame effect surrounding the gray elements. This color-defined frame effect is emphasized by a 3 in. (75 mm) projecting gray bullnose that is cast into the tan panels.

In addition to the frame and bullnose concept, many of the gray spandrels were cast on a horizontally ribbed formliner. The ribs, in combination with shadow lines created by the steps in the face of concrete, add a significant amount of architectural interest to the building.

There are 187 pieces of architectural precast concrete, all cast on a fiberglass form. Most of these pieces contain either the tan or the gray color in a given element. However, many of the tan elements contain the gray bullnose. Casting two colors in the same piece required a great deal of care to keep the colors properly separated. All of the elements are given an acid-etched finish that simulates the look of natural stone but at a significant savings in cost.

The spandrels are tall enough to provide for the code-required 42 in. (1.07 m) of personal fall protection, and at 8 in. (200 mm) thick, both the spandrels and column covers also resist accidental vehicular impact.

Five Holcim (US) Plants Receive 2012 Energy Star

Five **Holcim (US) Inc.** plants have earned the U.S. Environmental Protection Agency's (EPA's) Energy Star.

The following five Holcim plants were named: Theodore in Theodore, Ala.; Ste. Genevieve in Bloomsdale, Mo.; Holly Hill in Holly Hill, S.C.; Portland in Florence, Colo.; and Devil's Slide in Morgan, Utah. This year's award is the second for the Portland plant, the third for both the Holly Hill and Ste. Genevieve plants, and the fifth consecutive year for the Devil's Slide plant.

The Energy Star is the national symbol for protecting the environment through superior energy performance.

Free Exhibits-Only Registration to the World of Concrete

LAS VEGAS

PCI is offering free exhibits-only registration for the **2013 World of Concrete**, taking place February 4–8 in Las Vegas. The World of Concrete is an annual international event dedicated to the commercial concrete and masonry construction industries. Use the code A34 when registering online for free registration compliments of PCI. Additionally, make sure to stop by our booth, #N337, while at the event.

Concrete Joint Sustainability Initiative Sponsors Resilient Buildings Workshop

WASHINGTON

Sponsored by the Concrete Joint Sustainability Initiative and hosted by the Department of Homeland Security, National Institute of Building Sciences, and the National Building Museum, the interactive Resilient Buildings Workshop featured presentations and discussions focused on creating and maintaining resilient, high performance buildings. Visit www.sustainableconcrete.org to view presentations from this October 2012 event.

FEMA Launches a Business Continuity Suite for Disaster Preparedness

WASHINGTON

The **Federal Emergency Management Agency** (FEMA) has launched an online suite of tools to help businesses assess their disaster preparedness and the resiliency of their facilities, and to improve their ability to return to operation more quickly following a natural or man-made disaster.

The suite is scalable for optimal use by organizations of any size and consists of business continuity plan (BCP) training, automated BCP and disaster recovery plan (DRP) generators, and a self-directed exercise for testing an implemented BCP. Businesses can utilize this solution to maintain normal operations and provide resilience during a disruption.

View the tools at www.ready.gov/business-continuity-planning-suite.

PCI Co-Sponsors International Concrete Sustainability Conference

SAN FRANCISCO

The **2013 International Concrete Sustainability Conference** will be held on May 6-8 in San Francisco at the Sofitel San Francisco Bay hotel. The 8th annual conference will provide learning and networking opportunities on the latest advances, technical knowledge, continuing research, tools and solutions for sustainable concrete manufacturing and construction. PCI is a co-sponsor of the conference. For more information on the event, visit http://www.concretesustainabilityconference.org/.

PCI and ICC Issue Updated Fire Resistance Manual

CHICAGO

PCI/ICC's ***Design for Fire Resistance of Precast/Prestressed Concrete,*** **Third Edition** (MNL 124-11) is available as an ePub at www.pci.org/epubs. This manual has been used by designers for almost 30 years, and much of it has been reproduced or referenced in the model building codes and the International Building Code. Since the second printing in 1989, much has been experienced and learned, resulting in the need for updating the manual to its current status. Several parts have been rewritten to clarify the text and some new material has been added, but nothing has been changed that would affect the character of the manual. This manual is the first PCI publication to be cobranded with the International Code Council (ICC). In addition, it has been issued an evaluation report (ESR-1997) through the ICC Evaluation Service. This manual can be used as an alternative method to what is specified in IBC section 703.3.

Cohrs Elected Chairman of the Portland Cement Association

WASHINGTON

The **Portland Cement Association** (PCA) Board of Directors elected Cary O. Cohrs as chairman during the association's fall board meeting in Washington, D.C. Cohrs succeeds Aris Papadopoulos of Titan America. John Stull, president and CEO of Lafarge North America Inc., was elected vice chairman.

Finfrock Starts Construction of University of Central Florida Housing Project

APOPKA

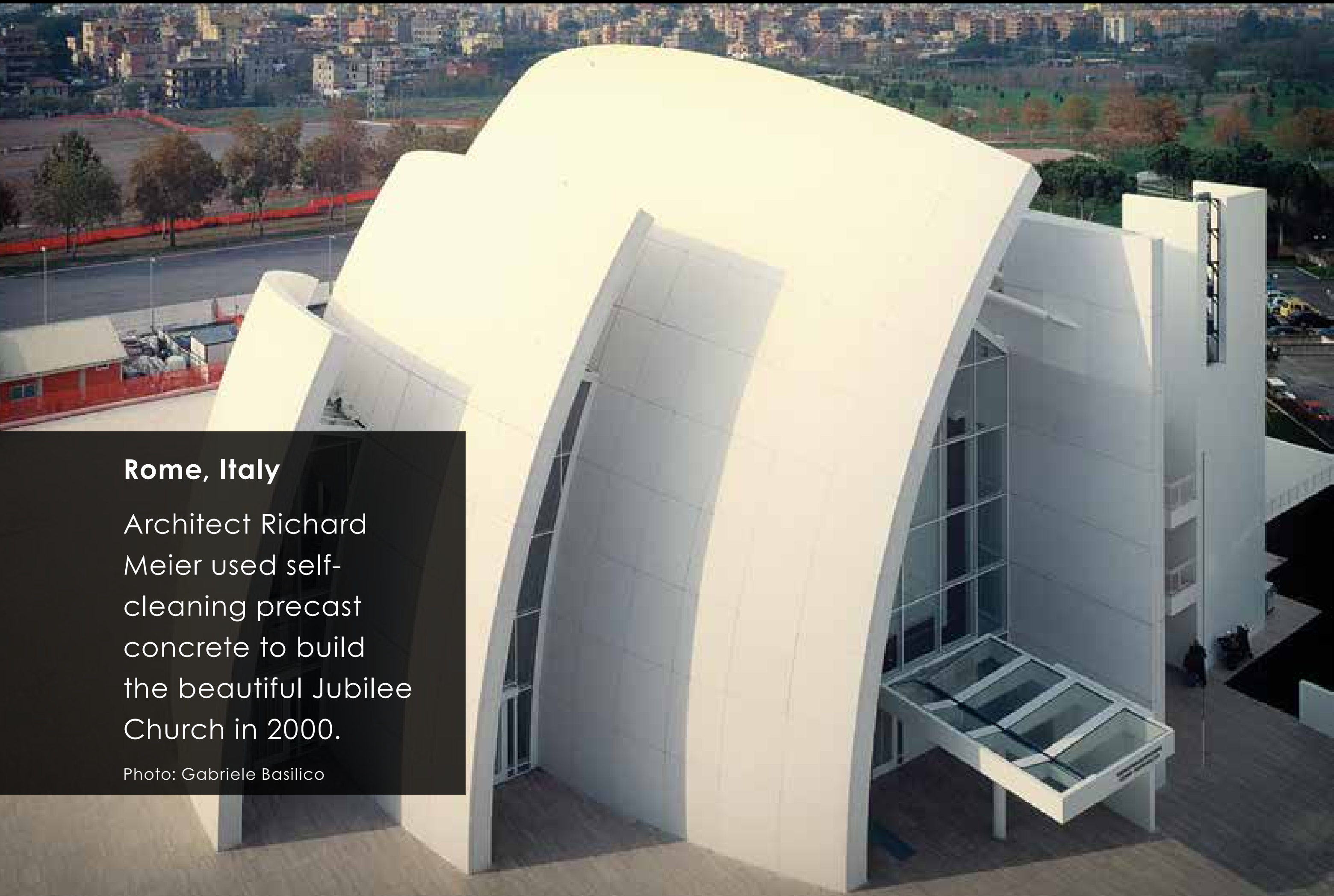
Finfrock has completed the design and begun the construction of a $60 million design-build student housing project at the University of Central Florida (UCF) in Orlando. The 600-bed project is comprised of 30 two-story townhouse units with living rooms open to the second level, 90 four-bedroom and 60 two-bedroom flats, and parking for 775 cars. The buildings are seven stories tall stepping down to five stories bordering the streets. The community will offer a parking garage, swimming pool, rooftop sun deck, club room, fitness center, and 40,000 square feet of program space. Students will have direct access to all living unit levels from the parking garage. Once open, the project will be one of the closest student housing options available for UCF students that is not located on campus. The total precast concrete building will be open in August 2013.

Wilmette, IL

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

Photo: This file is licensed under the Creative Commons

WHAT DO THESE BUILDINGS HAVE IN COMMON?



Rome, Italy

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

Photo: Gabriele Basilico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New Architecture Program Mainstreams Sustainable Design Thinking

— Dennis A. Andrejko, FAIA

The built environment often showcases the development and advancement of cultures and civilizations, and today, more than ever, architecture is observed as influencing our everyday patterns of growth and opportunity. It is widely understood that, as designers, architects have a profound influence in shaping the environment around us, and at the same time, that very environment has a profound influence in shaping us.

The Best of Times – The journey into the 21st century of design thought is an exciting time. Practice is consistently exposed to an ever-expanding array of tools and methods, to expand the way design projects are conceived of and processed, while novel materials and methods of construction are developing at an ever-rapid pace. Combined, these new approaches suggest building forms, spaces, settings, and places that are unlike many previously experienced.

The Worst of Times – Yet at the same time, the downturn of the economy, natural disasters occurring at an ever increasing rate and in elevated fashion, climate change and rising temperatures, water in overabundance in some regions, and significant drought in others, put into question our very future and survivability. At a global scale, continued population growth, disease and health, famine, food scarcity, and increased energy demand tied to diminishing natural resources, remind us daily of the fragility of the "spaceship earth" we inhabit.

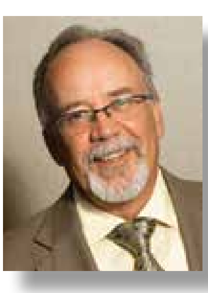
Challenges and Opportunities – The profession of architecture is in a time of great transition. Challenges continue to mount and responsibilities grow. We are compelled to forge ahead by accepting both traditional roles along with new opportunities as these roles expand and diversify. By asserting our position as leaders in shaping the built environment, architects must become more equipped for, and adroit in synthesizing, the myriad elements that make up client needs and expectations.

Change is Constant – As the profession evolves, our next generation of design leaders are compelled to elevate their discernment around the diversity and complexity of an ever-changing landscape, and architecture schools have a responsibility to address this future head-on. At Rochester Institute of Technology a new program has commenced providing a unique setting for an architectural curriculum in an innovative way. The Master of Architecture program is now in its second year, and housed in the Golisano Institute for Sustainability where Ph.D. and Master of Science programs presently exist, and aligned with the College of Imaging Arts and Sciences. In a holistic fashion, the program has a core focus around four key themes, becoming an essential foundation and framework to increase the understanding, awareness and ability to manage and assimilate information. By mainstreaming sustainable design thought throughout the curriculum, these four themes become the primary agendas to educate emerging professionals in various aspects around issues that affect building design, operation, and use:

Technology – Mastering and understanding the value and significance of technology is fundamental to advancing the built environment and improving both the design process and product. Tempering technology with an elevated sense of recognizing its implications in design is also essential.

Urbanism – The challenges facing our cities and urban settings are profound, and throughout the globe urban settlements continue to increase in size and scope. Focusing on and paying attention to urban principles and practices as they affect the social, economic, cultural, and environmental fabric of a city must be an interwoven discussion with any building proposal. Our communities must serve as an active learning environment.

Integration – Integrating learning and practice are key elements for a successful design profession. The amalgamation of various disciplines and stakeholders, combining both the art and science of design to be mutually informative, and understanding the value of diversity and inclusiveness, can leverage and solidify collective intelligence in a team environment to the benefit of the communities in which structures are built. Cross-dis-



– Dennis Andrejko, FAIA, is chairman of the master of architecture program in the Golisano Institute for Sustainability at the Rochester Institute of Technology in Rochester, N.Y. He also serves as principal of Andrejko + Associates in Buffalo, N.Y. Andrejko and was the vice president of the National Board of the American Institute of Architects for 2011-2012.

ciplinary and cross-professional alliances are fast becoming an essential theme in architectural practice.

Sustainability – Chief among these themes, and unifying their holistic intent is the sustainability imperative. Energy efficiency and high performance buildings, leading toward net-zero and carbon-neutral buildings can only be realized by a well-balanced understanding of several areas including sustainability science, ecological literacy, material and product selection and analysis, life cycle assessment, embodied energy and water, and commissioning and operational effectiveness. In addition, climate, culture, regional fit, and human factors play key and fundamental roles in a well-designed environment.

The Master of Architecture program holds sustainability—entwined with investigations around integration, urbanism, and technological advancement—as non-negotiable cornerstones and key ingredients of its curriculum. The program begins with a four-year, non-architecture related baccalaureate, followed by three years of focused study with sustainability as the foundation of future design inquiry. Students bring with them an interest in architecture with broad frames of reference, diverse and synergistic disciplinary perspectives, and intellectual maturity. The program integrates core course requirements with the Ph.D. and Master of Science students to greater assure deliberate, collaborative and connected discussions are brought to the table when conceptualizing design projects.

The new Golisano Institute for Sustainability building, scheduled to open in early 2013, is a living, learning laboratory where research, design, and knowledge sharing are fused together. Current and developing methods, materials and systems that make up and shape the built environment will be tested, explored and developed to advance the fabric around which future buildings are built and their surrounding context and settings are planned. The Master of Architecture program provides unique, relevant, and essential partnering among the academy and profession, with business and industry, and throughout the community and public as a whole—centering the profession with its collaborators as a nucleus of innovative thought.

The new Golisano Institute for Sustainability, scheduled to open in early 2013, is a living, learning laboratory where research, design, and knowledge sharing are fused together. *Photos: courtesy of Rochester Institute of Technology*

All designs hold the potential for elevated outcomes if we nourish our curiosity in sensible and practical, yet creative and evocative ways—expanding and catapulting us into design possibilities that enrich and advance the physical environment for our clients and communities overall. The design profession should look forward to opportunities to share ideas and contribute collaboratively in this quest for a more vibrant, healthy, productive, resilient, and yes, sustainable future for us to share and celebrate.■

For more information on the Golisano Institute for Sustainability, visit www.pci.org. for more information on precast concrete and sustainability, visit www.rit.edu/gis/

Precast Concrete Offers Aesthetic Versatility

Designers turn to precast concrete to meet owners' demands for signature designs or to blend in with a community, and precasters respond

— Craig A. Shutt

Aesthetic requirements for buildings are expanding, as owners battle to attract tenants and create a distinctive appearance. That encompasses every aesthetic option—from making a signature statement with a contemporary, dramatic look to blending seamlessly into a campus environment or historic neighborhood. A desire for more detailing also has grown, as designers look to add visual interest and depth to façades.

In many cases, designers are turning to precast concrete to meet these needs. Precast concrete is a high performance building material and system. Its excellent aesthetic versatility allows for finishes from one end of the spectrum to the other. Its plasticity provides depth and geometric shapes that create an arresting style. It also can replicate the look of brick, stone, metal panels, and other materials, or incorporate these materials into precast panels, in faster, more economical and more sustainable ways. Precast concrete can also incorporate multiple finishes, shapes, and colors in one component, or panel. This facilitates faster construction, eliminating trades, reducing joints, detailing, and risks, and makes for a more efficient schedule while improving building performance. These attributes combine to help designers deliver economical, quickly constructed, and aesthetically pleasing projects.

The following projects highlight some of the techniques being used throughout North America by precasters to meet the growing needs of owners, designers, and building users.

Thin Brick Helps Campus Housing Blend In

Following an extensive assessment of its Newing College residential community, administrators at Binghamton University in Vestal, N.Y., decided to build eight new residential halls to replace and expand the existing facilities. The project, for which four dormitories are still under construction, took a phased approach to create space for the new facilities and shift students from old to new dormitories in a smooth and controlled pace.

'Precast concrete panels provided the right blend of speed, structural shear capacity, and versatile interior space.'

The design and construction of these facilities, which expand bed spaces overall by 50% to 3,000 beds, took careful consideration of the complex's impact. The university also wanted the projects to set the tone for future construction on the campus by achieving Silver LEED certification. Architectural precast concrete panels, many embedded with thin brick, helped to achieve the university's goals.

The eight facilities, at an average of 120,000 square feet apiece, posed key challenges just in terms of their scale, says Christopher Miller, project manager at architectural firm Stantec. "The owners wanted a residential feel for these buildings, despite their massive size. They also wanted them to fit into the scale of other campus architecture, especially with so many buildings in the group." With five above-ground stories, the buildings were about twice the size of most other campus structures, requiring an aesthetic approach that could reduce their formidable appearance.

Speed also was a critical factor in determining an aesthetic approach to the façades, he notes. "We needed to keep as many beds on line as possible as new dormitories were built." The owners also wanted to avoid inevitable escalations in cost that would occur as time went by before later projects could be completed.

An initial dormitory was built, with students shifted into it, after which two dorms were demolished to make room for three new facilities. Once those were completed, two remaining halls were demolished to accommodate the final four buildings. Some of the remaining residential halls will remain and may be converted to administration offices and other uses.

Designers chose architectural precast concrete wall panels to clad all of the buildings. Precast concrete was chosen over a range of other systems, including cast-in-place concrete, steel with hand-laid brick cavity wall, light-gauge metal, and plank on grout-filled masonry.

"We decided that the precast concrete panels would provide the right blend of speed, structural shear capacity, and versatile interior space," says

Photos courtesy of High Concrete Group LLC

Minimizing scale and projecting a residential image were key reasons that architectural precast concrete panels with embedded thin brick were chosen to clad eight new dormitories at Newing College at Binghamton University in Vestal, N.Y. Precast concrete's speed of erection also was a key factor, as the dorms had to come on line quickly to accommodate student needs.

PROJECT SPOTLIGHT

Newing College Residence Halls at Binghamton University

Location: *Vestal, N.Y.*

Project Type: *Dormitories*

Size: *1.05 million square feet in three dorms*

Cost: *$300 million*

Designer: *Stantec Architecture Inc., Philadelphia*

Owner: *Binghamton University, Vestal, N.Y.*

Engineer: *David Chou & Associates, Blue Bell, Pa.*

Contractor: *LeChase Construction Services Inc., Binghamton, N.Y.*

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

Precast Components: *922 pieces, including spandrels, wall panels, insulated wall panels, column covers, solid slabs, and stairs with landings*

Miller. "Architectural precast concrete allowed a more flexible footprint, minimized structure, and could be constructed during cold weather so we could meet an aggressive timeline."

Thin Brick Speeds Construction

Administrators wanted the brick appearance to blend with surrounding academic buildings, Miller notes. One of the reasons the thin-brick design was chosen was due to the long New York winters, which would have minimized the time in which brick could be laid. It also would have required renting temporary heating units for long periods, raising costs. Miller estimates that the precast panels went up about six times faster than hand-laid brick, in 30 working days versus about six months for masonry. "Precast was definitely the best bet to meet the schedule."

Choosing the proper brick color also posed challenges, to ensure the mix met administrators' goals. "The campus has a mixture of brick colors, due to the various time periods in which they were built, and many are fairly dark," Miller says. "We wanted a redder, brighter color than most others had."

A main field of red brick with bands of dark-brown accent bricks was specified. Buff-colored brick at the top floor further reduces the scale. The custom-colored precast is similar to the buff bricks and provides a solid base to the building's hierarchy. High Concrete Group LLC in Denver, Pa., provided the precast concrete components for this second phase of the project, which included three buildings.

Fireproof steel provides the primary building structure, with cast-in-place concrete supporting the architectural precast concrete panels. The panels consist of horizontal load-bearing panels that span column-to-column, providing shear resistance and minimizing the need for interior cross bracing. Flooring consists of 12-inch-thick precast concrete hollowcore planks with a nonstructural topping.

"The design provided the most efficient use of materials," says Miller. "Load-bearing masonry and cast-in-place concrete would have required more material. We could eliminate the spandrel beams between the column lines, allowing the hollowcore planks to carry the load and the needed diaphragm action."

The panels were furred out on the interior with $3^{5}/_{8}$ -inch studs over $2^{1}/_{2}$ inches of semi-rigid mineral-wool insulation. Including R-13 batt insulation and gypsum board, the assembly delivers a composite R-25 for the walls.

Stair towers feature freestanding insulated wall panels with a steel-trowel finish inside. With a 3-inch thickness of XPS insulation sandwiched between the two concrete wythes, the stairwell panels offer an R-16 rating. Hip roofs on the stair towers and gables along the sides further help reduce the scale and create a relatable feel.

The site posed significant challenges for this second phase of the three-phase project. The tight space afforded by the surrounding buildings made locating cranes difficult and left no room for staging precast concrete components nearby. A staging area was created about one mile away and pieces were trucked to the site as they were needed in sequence.

Cranes were located in several secure locations and often had to reach across the building to set panels, requiring the operator to be working blind. Walkie-talkie communication and careful handling ensured the panels were set smoothly. Miller says the operation moved so efficiently that he made a video that he uses in presentations to show how quickly precast concrete panels can be erected.

The use of hollowcore plank and cross-bracing frame allowed open interiors that will provide great flexibility for future changes, Miller notes. "The existing dorms will be challenging to convert to other uses due to the structural layouts. But these new ones that utilized precast concrete have open floor plans that can accommodate any changes in the future. They provide a flexible design that will keep up with the university's needs."

GFRC Raises the Bar for Citrus Tower

A variety of complications arose for the design of Citrus Tower Corporate Plaza in Riverside, Calif. The large office building stands on a high-profile corner location near a major highway. As a result, the owner's goal for the aesthetic design was to "create a memorable architectural statement that was a friendly neighbor to the community, with 'traditional' quality architecture to which no one would be

PROJECT SPOTLIGHT

Citrus Tower Corporate Plaza

Location: *Riverside, Calif.*

Project Type: *Mixed-use building (retail, office, parking)*

Size: *140,000 square feet (plus 153,360 square feet of parking on four subterranean levels)*

Cost: *$36 million*

Designer: *Nadel Architects Inc., Los Angeles*

Owner: *Regional Properties Inc., Riverside, Calif.*

Engineer (Below-Grade Parking): *Seneca Structural Engineering, Laguna Hills, Calif.*

Engineer (Above-Grade Building): *BP Consulting Engineers, Los Angeles*

Contractor: *McCormick Construction Co., Burbank, Calif.*

PCI-Certified Precaster: *Willis Construction Co. Inc., San Juan Bautista, Calif.*

Precast Components: *525 pieces of GFRC spandrels, crowns, arches, and granite-covered column covers*

Citrus Tower Corporate Plaza sets a new standard for aesthetic design in Riverside, Calif. It features GFRC panels on its façade in three colors. GFRC was chosen because of its ability to create the complex appearance desired, including multiple colors in one panel. Its light weight saved on framing costs and made the pieces easier to handle.

Photos courtesy of Willis Construction Inc.

GFRC was chosen due to its capabilities in achieving multiple colors and its light weight.

indifferent," says Herb Nadel, principal at Nadel Architects.

The architectural design expressed a rich and grand visual for the entire building, which was clad with glass-fiber reinforced concrete (GFRC) panels, some of which were embedded with granite veneers. Each bay opening features a two-colored arched spandrel with multifaceted granite-clad GFRC column covers at each structure column.

GFRC consists of portland cement, fine aggregates, acrylic co-polymers, and glass fibers that provide reinforcement similar to the steel reinforcement in concrete. The small fibers provide flexibility and versatility in creating components, allowing the mixture to be sprayed onto forms to create unusual shapes. The light weight and consistency of the glass fibers reduce the weight of the components, making them considerably lighter than traditional precast concrete components with much the same durability and appearance.

Along its base, the building features tall arched windows and a larger arched entry, which draws the eye up and breaks the procession of square windows one story up. Above this are vertical expanses of glass surrounded by precast concrete columns in two tones, a rose hue and a buff color. They lead to a setback penthouse level that serves as a roof crown, which also was clad in GFRC.

GFRC was chosen for the project due to its capabilities in achieving the multi-hued look that was desired and its light weight. The building's foundations are set above a four-story subterranean parking structure on a post-tensioned slab, which required the above-ground structure to be as light as possible. But the designers also wanted to use precast concrete materials to maximize longevity and durability.

Several other options were considered, including stone, 4-inch-thick precast concrete panels, and exterior cement plaster. All were intended to provide a stone-like appearance to meet the owner's requirements, Nadel explains. Evaluations showed that GFRC would meet all of the needs, providing a similar appearance to what precast concrete could provide while eliminating some of the weight. The GFRC's light weight also allowed a reduction in some of the structural steel framing, saving costs.

The ability for the GFRC components to cast multiple colors in one panel also provided budget savings. Using the various colors required close pre-planning with the precaster to ensure clear transitions between colors. The first mix design was sprayed with the form being masked. The masking then was removed, and the mix was allowed to stiffen but not completely set up. That allowed the first pour to be secure when the second mix-design color was sprayed in.

In all, three mix designs were created, with some panels including all three. Two finishes, light and heavy sandblasting, provided textural variety. Attaching the granite to the panels was achieved by spraying a thickened GFRC back-up skin to the back side of each granite piece. Additional GFRC was consolidated to cover metal clips attached to the granite. Willis Construction Co. Inc. created the GFRC components.

The building's most dramatic feature is the rounded tower on the corner, which extends past the roofline. Its canopy consists of compound-radius GFRC panels, with granite cladding the topmost band.

The design reflects a similar project that was to be designed by Nadel in Riverside. "We showed this idea to the client, and we thought the city might be receptive to this idiom of architecture because it blended so well with other structures throughout the city," Nadel says. "The curved corner becomes a beacon and a very identifiable form, giving the building distinctive characteristics along with natural colors that reflect the general built environment."

The designers worked closely with the precaster to find the proper mix of colors and textures. Full-size mockups of the panels were created to confirm the choices. "Those crystallized our selections, and the process of creating them was very successful," he says.

Working with the GFRC panels was seamless, he notes. "Its flexibility created forms and shapes as needed and worked well with the window system. The needed shapes were easily achieved. Detailing the panels also was a simple process, since the material can be configured in virtually any shape or form because of its plasticity."

The design process for the dome required complex calculations, he adds, due to the costs, weight, and the limited resources available to build such a complicated structure. "The cost factor played a major role in how it was ultimately constructed," he says. "There are virtually no straight pieces, since the entire dome and all of its supports are curvilinear."

Cranes were set into one lane of traffic to allow erection, and the process moved smoothly. "Delivering and erecting the GFRC components was a straight-forward and simple process," he says. "There were no complications."

The GFRC offered a great option for this project, he says. "As far as I'm concerned, working with GFRC, or precast concrete, is a fairly simple design process. We have used it innumerable times. I would highly recommend the use of this material because of the design excellence that can be achieved at a very economical price."

The community agrees that the project fits well into the neighborhood and provides a dramatic, signature style. "We have been repeatedly told that the building is a beautiful addition to the city," he says. "It is compatible, memorable, and has an excellent standard of quality. It has raised the bar for architectural excellence within this community."

Precast Mimics Metal Panel Façade at Place de l'Escarpement

The first phase of the Place de l'Escarpement project features a seven-story commercial building at the intersection of two major streets in Quebec. The 142,000-square-foot facility serves as the home to several major corporations. To project the proper image for the tenants, owners wanted to create a bold, contemporary look that was economical and quick to construct. To achieve this, designers selected architectural precast concrete panels in complex shapes.

To provide a dramatic contrast, some façades of the building feature architectural precast concrete panels cast with an undulating wave pattern across their face. The waves were created with formliners and follow a similar pattern due to repetition in the forms, producing a rhythmic style. The architect worked closely with an artist to create the design that best reflected the wave he was seeking.

Gray concrete with black pigment and a light sandblast was used to emphasize the pattern and draw attention to these faces. Large joints were designed to add a vertical element that is complemented by columns of windows rising up with only thin mullions separating them at each level.

These façades contrast with more traditional architectural panels with a buff-colored finish and multiple reveals that butt against the wavy facings. These faces feature groups of horizontally placed punched windows that are emphasized by the reveal patterns. All of the panels were connected to the cast-in-place frame using hot-dip galvanized anchors.

The gray, wavy panels clad two parallel faces with a large expanse of glass covering the perpendicular fa-

The Place de L'Escarpement commercial building in Quebec provides a bold, contemporary look that was economical and quick to construct thanks to the use of architectural precast concrete panels. Waves in the panels, designed by an artist working with the architect and precasters, were created with formliners, and a gray concrete created with black pigment.

PROJECT SPOTLIGHT

Place de l'Escarpement

Location: *Quebec, QC, Canada*

Project Type: *Office building*

Size: *295,600 square feet*

Cost: *$35 million*

Owner: *Immostar, Quebec, QC, Canada*

Architect: *Pierre Martin Architecte, Quebec, QC, Canada*

Engineer: *Cime Consultants, Quebec, QC, Canada*

Contractor: *Ogesco Construction, Quebec, QC, Canada*

Artist: *Florent Cousineau, Quebec, QC, Canada*

PCI-Certified Precaster: *Bétons Préfabriqués du Lac, Alma, QC, Canada*

Precast Components: *90 flat or L-shaped panels*

Photos courtesy of BPDL

çade between them. The buff-colored panels clad a six-story perpendicular rectangular. The seven-story section seems to wrap over and around the other portion, with the gray panels seemingly overlapping the buff panels on the far side.

"The project presents a modern aesthetic and complex shapes with repetition," says Pierre Martin, president of Pierre Martin Architecte. "The use of gray concrete with black pigments and light sandblasting prove that traditional gray concrete can translate into something modern and unusual. A total of 94 precast concrete panels were supplied by Bétons Préfabriqués Du Lac.

Gold LEED Certification

Complicating the design was the owner's desire to achieve LEED Gold certification. Geothermic technology was used for the heating system, and a green roof was also used. Precast concrete added to achieving certification in a variety of ways, including local manufacturing, use of recycled materials, energy efficiency, and elimination of construction wastes. About 85% of all construction waste was recycled, representing 440 metric tons.

Design and production of the precast concrete panels took about $2^1/_2$ months, after which the erection was accomplished in less than three weeks.

The building also was designed to enhance the productivity of users by including large expanses of windows and providing such amenities as a daycare center, fitness gym, and restaurant. "The design should bring more productivity, less absenteeism, and more personnel retention," Martin says.

The project won the ENERGIA award from the Institute of Urban Development and was the first commercial building to qualify as LEED Gold in Quebec City. The first energy-consumption reports indicated the building uses about half of the energy of a conventional building.

"The building's final impact wouldn't have been the same without the precast concrete panels," says Martin. "We would not have been able to replicate this appearance any other way. Precast concrete also helped obtain the LEED credits. The project ran easily and without problems thanks to good teamwork and close coordination between architect, contractor, and precaster. The final result is just stunning."

> 'The project presents a modern aesthetic and complex shapes with repetition.'

Paseo Altozano – Precast Replicates Stone

The massive Paseo Altozano (Altozano Walkway) shopping center in Morelia, Michoacan, Mexico, was designed to showcase the blend of traditional Mexican construction techniques in a modern environment. Designers worked with the precast fabricator to create stone-like architectural precast concrete panels, using natural stone as models. The panels replicate stone in a variety of colors and finishes, including simulated slate, to create an eye-catching design.

The project covers 33.3 acres and hosts 21 acres of commercial and entertainment facilities. A variety of approaches were considered for the project, says Fidel Lopez, engineering and erection director at precaster PRETECSA. The company worked with a team of designers at architectural firm Taller Único de Arquitectos, headed by Alonso Ruiz de Velasco, owner and director.

"The project owner's first choice was to clad the building in natural sandstone imported from Costa Rica in different colors, from black to polychromatic, including black, gray, red, yellow, and brown," Lopez explains. But after mockups were made and sites were investigated, it was determined that it would take three years to ship the needed amounts of stone and install it.

"With architectural precast concrete panels, the façade was completed in 13 months, including design, drafting, molding, production, shipping, and erection," says Lopez.

The owner and architect worked with the precaster to choose stones that would serve as the model for the styles to be replicated by the precast concrete. "These pieces were chosen individually based on color and texture to serve as samples for each elevation," explains de Velasco. "The contrasts of the various ready-made textures give the building a distinctive image, meeting the essential interests of the project."

To achieve the proper appearance for each type of material, the precaster used a variety of formliners, finishes and colors. Rubber molds were made of specific stones, with molds varying due to the uniqueness of the stone pieces selected. Additional stone-like pieces were cast from molds made from old and damaged concrete flowing at the precaster's plant.

"Those created a very interesting texture," says Gervacio Kim, operations director at PRETECSA. "A large number of unique molds had to be made to achieve the special shapes needed to get the final real-stone look."

Among the finishes used on the panels were acid etching, chiseled-hammering and polishing. Panels were hand-stained with any of five oxide stains and a penetrating acid stain that helped create the proper patina for the stone colors.

The panels were cast in 350-block patterns that were alternated and shifted to avoid creating a repetitious pattern, so as to better generate a nature stone look. More than 2500 precast concrete pieces, ranging in size from 86 to 140 square feet, were created for the project, totaling 376,736 square feet.

> With architectural precast concrete panels, the façade was completed in 13 months.

"The desired slate finishes were achieved with an impressive degree of accuracy and a natural look," Kim says. "The use of precast concrete panels represented considerable savings in terms of substitution of natural materials in the required size, variety, volume, and time."

Large Joints Eliminated

Designers worked with the precaster to create panels in different sizes and shape to eliminate conspicuous joint lines. "It was like working a puzzle to fit the panels together to avoid vertical joints," he says. "That helped us achieve the look of natural stones that had been installed one by one."

A multitude of stone appearances were created from architectural precast concrete to add a distinctive style to the massive Paseo Altozano (Altozano Walkway) shopping center in Morelia, Michoacan, Mexico. Rubber molds made from actual stones, including slate, ensured the accuracy of the precast concrete appearances. A variety of finishes added texture.

PROJECT SPOTLIGHT

Paseo Altozano

Location: *Morelia, Michoacán, Mexico*

Project type: *Retail facility*

Size: *1.45 million square feet*

Cost: *$150 million*

Owner: *Grupo FAME, Morelia, Michoacán, Mexico*

Architect: *Taller Único de Arquitectos, Mexico City, Mexico*

Engineer: *Postensados y Diseños Estructuras, Álvaro Obregón, Mexico City, Mexico*

Contractor: *Grupo Altozano, Morelia, Michoacán, Mexico*

PCI-Certified Precaster: *PRETECSA, Atizapán de Zaragoza, Estado de México*

Precast Components: *2,500 panels.*

Photos courtesy of Fotosenconcreto.com

The stone appearance is convincing, he notes. "In large extended surfaces, the installed precast concrete façade elements create different architectural styles, which were achieved by alternating several finishes and geometries. We were able to take advantage of the architectural properties of the concrete to create visually attractive and original appearances within the complex."

A key challenge was to ship the correct panels to the site in sequence, ensuring the panels fit together as designed, while working on seven elevations simultaneously, Lopez says. The precaster ensured the project was supplied with a continuous inventory of 60 panels per day, with the proper sequence of lifts orchestrated. The textures on the panels' faces were protected with plastic pads and foam during transport.

Six continuous months of intensive work, allowing 210 panels to be erected each week, were required to erect the panels onto the steel framing. The main erection challenge came when the steel installation fell behind and became a bottleneck. To make up that time, eight three-member crews worked to install the panels once the framing was completed, working through the weekends to keep the project on schedule.

"Cement consumption by developers in this area is very low because of a widely held idea that concrete is a gray and dull element," Lopez says. "By combining a wide variety of manufacturing techniques, several architectural styles were magnificently achieved in different buildings within the complex. It showed that concrete can work as a high-quality, multicolored architectural finish that gives life to this massive construction."

Visitors to the center have been impressed. "Initially, people think that it is real stone glued to a steel frame," he says. "On opening day, people were touching the panels trying to figure out if it was real or fake stone because it was constructed so quickly."

These projects give a sampling of the innovative approaches designers are using to make a dramatic statement for their buildings. Precast concrete is the only high-performance building material that offers this expansive aesthetic versatility. Precast concrete and precasters continue to help designers raise the bar to achieve even more distinctive and aesthetically pleasing designs. ■

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

Preserving the Past, Planning the Future

Ratio Architects founder Bill Browne has a respect for the past and an entrepreneurial spirit that keeps the company growing

— Craig A. Shutt

Bill Browne, FAIA, LEED AP

Bill Browne wasted little time opening his own architectural firm, Ratio Architects, after gaining his Master's degree in architecture. Starting as a renovation specialist, the firm today, 30 years later, has grown to become a key Midwestern player in a variety of building categories. Its success has grown because Browne wasn't afraid to ask the question, "What's the worst that can happen?"

"I was an impatient 26-year-old kid," he explains. "All of us are impatient and want to control our own destinies at that age. I was willing to risk everything to go out on my own, but really, being so young, there wasn't much to risk. After all, what's the worst that can happen? If I failed, I'd just have to get a job somewhere."

Born and raised in Indianapolis, Browne graduated from the University of Illinois and attended a postgraduate program at the Preservation Institute in Nantucket, Mass. That program, affiliated with the University of Florida, led him to Gainesville for his Master's work. He returned to Indianapolis and joined the Ehrenkrantz Group.

Two years later, he, his sister (an interior designer), two architectural classmates and an assistant opened their own development and architectural firm, leveraging renovation tax credits to generate project commissions. In 1985, Browne split off the architectural business, changing the name to Ratio Architects in 1987.

Past Informs the Future

Browne immediately gravitated toward renovation work. "I took every architectural history course I could in school, and I grew to have a great affinity for urban areas," he says. "I believe it's important for projects to have a connection to the past. The past informs the future. Contrasting a city's past with its current style is what makes a city interesting."

He leveraged that interest by specializing in renovation projects, then designing "contextual additions" to historic buildings. The firm then began doing projects in which it stripped a building to its framework and rebuilt it. That led to commissions on new projects.

Frequently, Ratio served as associate architect to a larger, national firm on major projects. "We gained knowledge by partnering with others rather than working at large firms," he explains. "That allowed us to come out of the box doing fairly large projects."

Thriving On Complexity

Large, complex projects are his favorites, he notes. "I love complicated, robust construction projects," he says. "I love urban, campus-type projects surrounded by buildings, with a lot of restraints that require a lot of thinking and complex designs. I thrive

The Ivy Tech Community College campus in Elkhart, Ind., was designed by the design-build team of Ratio Architects and the Hagerman Group. The $16.8-million academic building and community center, which is clad in architectural precast concrete panels, achieved Silver LEED certification. Photos courtesy of MV2 Photography

Ratio Architects created a north end-zone addition to the venerable Memorial Stadium on the Bloomington campus of Indiana University using precast concrete panels to create a Gothic style that blended with the limestone-clad buildings throughout the campus. Grandstand bleacher seating also was replaced with permanent precast concrete seating.

on the projects that are in the public eye, with a lot of scrutiny and a lot of constituents to please."

Those aren't everyone's idea of a fun time, he acknowledges. "It sounds insane, and it can be," he laughs. "But I enjoy finding ways to please a variety of people and creating solutions that work on political, economic, and design levels. Those are complicated puzzles, and that's what I love being a part of. It requires a team of people to play that game and win it."

Browne's early work with larger companies made him aware of the value of creating strong alliances. "Once I opened my office in Indianapolis, I realized that it wasn't just about what you knew, it was about who you knew," he says. "Having a network is critical, especially if you want to build a national practice."

Those alliances began with Hugh Hochberg, principal at the Coxe Group, a Seattle-based architecture and engineering consulting firm. "We've developed a wonderful business and personal relationship. Without that involvement, we would not have been able to do what we've done today," he says. But he hasn't tried to replicate that company's success, he notes. "Rather than model ourselves on anyone, we learn from all our associations and take ideas that work."

That effort is aided by a corporate roundtable program in which Browne participates. The 15 noncompetitive design firms around the country gather twice a year to share balance sheets and "horror stories," he says. "Those associations are about learning new ideas rather than trying to replicate their approach."

Browne also participates in local organizations, particularly the Indianapolis Historic Preservation Commission, where he has served for 20 years as the mayoral-appointed president. "I take preservation very seriously," he says. "And it's important to me overall to give back to the community that has been so good to me. It takes a lot of people to make a city vibrant, and I like to tap into other people's passions. That vitality is not all driven by the work we do as architects, even though we like to think it is. Participating keeps us from getting into our own little world and thinking we are

The new Residence Hall at Rose-Hulman Institute of Technology in Terre Haute, Ind., completed in 2012, features architectural precast concrete insulated panels embedded with thin brick. The 70,000-square-foot, 240-bed facility was the first facility on campus to achieve Silver LEED certification.

driving everything."

His passion for preservation also makes him a strong believer in sustainable design. "It's a natural outgrowth of preservation," he says. "It's an incredibly important concept, since 75% of all energy is used by buildings. I'm pleased to see that our profession has embraced sustainability and I hope we continue that to a large degree. It's no longer a matter of choice or a topic of conversation; it's just expected that we will do as much as we can. I'm hoping that it leads us to net-zero buildings in the near future."

Project Variety

Higher-education and community-college projects are two types that often encourage sustainable design and seek high LEED certifications. Ratio made those categories a key focus in anticipation of other markets declining in the late 1980s. That led to work in categories such as life sciences, office buildings, residential, and cultural centers.

"Our diversity has given us a wonderful variety of work," he says. "Each provides different challenges but has important implications for the communities and people they serve. That dichotomy and richness fuels our organization. If we only did one type of project, we wouldn't be able to attract and keep the high-quality talent we do."

That variety has led the firm to specify precast concrete on a range of building types. They include the high-tech façade for the Ivy Tech Community College in Elkhart, Ind., the gothic-style façade on the end-zone addition at Indiana University's Memorial Stadium in Bloomington, Ind., and a thin-brick-clad residence hall at Rose-Hulman Institute of Technology in Terre Haute, Ind.

"Precast concrete has come a long way, and it's made architects think differently about façades." Replicating limestone can be a tough sell in a major limestone-quarrying area such as Indiana, he notes, but limestone doesn't offer the speed, flexibility, and durability of precast concrete. "Precast has become an incredibly exciting material, because it's so plastic and affordable. Designers can achieve so much more with it today. There are still challenges in reproducing stone's variegated patinas, but the advancements have been amazing."

Opportunistic Expansion

Ratio's diversity and openness to new ideas has led to expansions in recent years, in opportunistic but controlled ways. "We've been successful in Indiana, but there's only so much business to go around," he explains. "The only way to grow is to increase the pool." That led to new offices in Champaign, Ill., in 2004, Raleigh, N.C., in 2010, and a strategic alliance with Chicago-based SMDP in 2011. Gaining a foothold in Chicago was a key move. "We needed a presence in a top-tier city to be considered a national firm."

It also gave the company entry into Asian markets, through SMDP's projects in China and Korea. Ratio has strengthened those ties through an agreement with Zhejiang University Design Institute in Hangzhou, China. "I look at the top 50 firms, and 35% or more of their business comes from international markets," he says. "I had to ask what I could with that information."

His goal, he says, is to create a company that's substantial and successful enough to maintain its viability without his participation. "I want to build this business so it can buy me out and continue to have a life of its own. I want Ratio to have a legacy as a business that can carry on for its people as much as design buildings that will outlive us."

Expanding into Chicago and looking overseas are risky ventures in this economy, he admits. "I'd been thinking about it for awhile, but these opportunities suddenly arose, and I took them."

His entrepreneurial spirit makes such risks worth trying. "After all," he says, "what's the worst that can happen?"

Precast's Aesthetic Versatility Allows Parking Structures To Evolve

Precasters help designers meet challenging aesthetic requirements by creating innovative solutions.

— Craig A. Shutt

Parking structures offer unique challenges for designers, as they require long, open bays often vulnerable to weather. Today, those durability and accessibility needs are being complicated by demands for more creative aesthetic designs. Precast concrete's aesthetic versatility allows designers to create the required appearance—whether that means fitting into a campus design, creating a contemporary statement, or blending with an historic neighborhood and hiding the structure's function.

"Aesthetics are definitely more important to parking-structure owners today," says Joseph Mastropaolo, an architect in Tampa, Fla. "Many don't want their structures to look like a parking garage, particularly if it's in a historic urban environment."

Adds Anthony Caputo, senior project manager with Perkins + Will in New York, "Owners definitely are paying more attention to the details of their parking structure's look and the overall aesthetics. They want the buildings to blend into the campus environment and not stand out just because they're designed for parking."

"Generally, we're seeing owners want to go beyond the typical spandrel-like parking structure and add as much aesthetic value as they can," says Frank Fox, president of Greenfield Architects in Lancaster, Pa. "In part, I think that's because owners can see what's being accomplished with materials like precast concrete, and they realize they can demand more from their project. We're seeing more decorative looks and the use of panels rather than spandrels, with more projections, louvers, and screens on façades."

The following parking structures from around the country give an idea of what designers are achieving with precast concrete, meeting a variety of challenges in addition to providing an aesthetically pleasing appearance:

Precast Sets the Standard for the Future of Hartford Hospital

Administrators at the Hartford Hospital in Hartford, Conn., presented designers from Perkins+Will with a daunting challenge. After the firm completed a 30-year master plan for the hospital campus, administrators asked the team to "set the language and design approach for all future work" with a new building: a nine-story, 1250-car parking structure.

"Using this project as the foundation for the tone of future work made it an important assignment," says Anthony Caputo, senior project designer. "But parking structures are a very different type of building due to their function, mechanical requirements, spanning needs, etc." At the same time, the designers were working with the Hartford city officials, who wanted to ensure new projects acknowledged the historic relevance of buildings near the campus's edge.

"We had to evolve to provide a new language for the hospital campus that took these various needs into account and express them with the parking structure such that it could serve as a base for future projects," he explains. "We had to create a very interesting blend to bring all of that together."

The result was a precast concrete structural system that features a typical design of double tees, beams, columns, shear walls, and spandrel panels. To meet the aesthetic needs, the façade consists of a series of three-

"Generally, we're seeing owners want to go beyond the typical spandrel-like parking structure and add as much aesthetic value as they can."

At the Hartford Hospital in Hartford, Conn., designers used an all-precast concrete structural system and a façade design that features three-dimensional "folded" panels stacked across the façade. The design was the first in a 30-year master plan and sets the foundation for later buildings.

PROJECT SPOTLIGHT

Hartford Hospital Parking Structure

Location: *Hartford, Conn.*

Designer: *Perkins+Will, New York*

Owner: *Hartford Hospital, Hartford, Conn.*

Engineer: *Desman Associates, Rocky Hill, Conn.*

Contractor: *Downes Construction Company, LLC, New Britain, Conn.*

PCI-Certified Precaster: *Unistress Corp., Pittsfield, Mass.*

Precast Components: *Double tees, columns, beams, shear walls, stair towers, and spandrel panels.*

Photos courtesy of Unistress

dimensional "folded" panels stacked across the façade. The panels have symmetrically placed "warps" that curve out similar to small eyebrow windows.

"Conceptually, we started with the idea of alluding to overlapping cedar-shake roofs, which over time age and warp somewhat to create shadow lines. We used that image to extrapolate out to create a sense of shadow play. Our goal was to allow the building to reflect light in different ways at different times of the day while creating a modular system that would be easy to erect, ensuring it was economical."

The panel designs were produced on CAD files and given to the precaster to create shop drawings. "This approach allowed us to validate the design ideas quickly," he says. A variety of "interactive" meetings were held with the precaster, Unistress Corp., which allowed the team to mark up changes as needed quickly. Only a handful of panel types had to be created, allowing forms to be efficiently changed and adjusted as needed for a particular panel shape. The small number enhanced casting speed.

> 'Using this project as the foundation for the tone of future work made it an important assignment.'

Identical Waves

The wave projections were designed to be identical, with a projection of 2 in. off the 8 in. panel. Formliners were used to create the projections. "We were concerned about the weight and economy, as well as projecting off the vertical panels in some locations, so we kept to one size," he says. Caputo visited the plant to discuss the designs and then reviewed them on-site during the erection.

The white wavy panels contrast with vertical column sections finished in charcoal gray. "We wanted to create a vertical effect that would offset the very horizontal design of the parking structure." Vertical fluting was added to the panels to emphasize this, created with stock formliners. The vertical panels received a light sandblast to slightly expose the aggregate, but not to create too textural of a surface.

Designers paid attention to aesthetics inside the structure as well. At the ramps, a two-part spandrel panel was created, with separate finished faces on both interior and exterior sides. Along the interior, the panels follow the slope of the ramp, while the exterior panels remain horizontal. "We didn't want to express the slope of the ramp for users on the floors, so this double system of panels allowed us to meet all of the needs."

Two types of metal treatments also were applied to the exterior to achieve different aesthetic goals. One type consists of perforated metal with variations in colors that match nearby brick buildings. The second is a stainless-steel mesh that diffused light from inside, minimizing light pollution for nearby areas.

Administrators also had asked for some commercial space on the first floor to emphasize the pedestrian scale and interaction with the facility. A 5000-square-foot fitness center was created along the street side of the first floor. This allowed parking to be set back away from the street.

"This project offered some unique challenges, but the result was a dramatic structure," says Caputo. "It now will set the design standard for all projects going forward at the hospital."

Historic Lancaster, Pennsylvania

At the other end of the spectrum, the new 151,200-square-foot Central West Garage built in the downtown area of Lancaster, Pa., blends into its historic neighborhood while providing a 21st-century facility. The 405-car garage features a precast concrete structural system and a façade of architectural precast concrete panels with embedded thin brick and buff-colored accents, including a cut-stone appearance at the base, columns, and accent areas.

"The owners wanted an aesthetically pleasing design that fit with the area," explains Frank Fox, president of Greenfield Architects. The site is located on the edge of the city's historic district, which includes buildings dating to the early 1700s. When the owners applied for a zoning variance for height, city officials made it clear

A traditional tripartite design with faux windows and elaborate details, including embedded thin brick in the architectural precast concrete panels, help the façade of the Central West Garage in Lancaster, Pa. fit in with its neighbors. The all-precast concrete structural system was connected on each level with an existing adjacent parking structure.

Photos courtesy of High Concrete Group LLC

PROJECT SPOTLIGHT

Lancaster Central West Garage

Location: *Lancaster, Pa.*

Size: *151,222 square feet*

Cost: *$11.1 million*

Designer: *Greenfield Architects Ltd., Lancaster, Pa.*

Owner: *Lancaster Newspapers, Inc., Lancaster, Pa.*

Engineer: *Providence Engineering Corporation, Lancaster, Pa.*

Contractor: *High Construction Company, Lancaster, Pa.*

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

Precast Components: *Load-bearing spandrels, nonload-bearing spandrels, double tees, lite walls, beams, girders, L-beams, shear walls, wall panels, and stairs with landings.*

that they didn't want the building "to look like a parking structure," Fox says. "We got the message clearly."

A detailed study was done prior to design work to ensure the economics of the precast concrete panels with embedded thin brick. Designers also considered load-bearing panels as well as panels with laid-up brick

'From every angle—aesthetics, schedule, efficiency, cost, etc.—the precast concrete panels made the most sense.'

installed after erection. "From every angle—aesthetics, schedule, efficiency, cost, etc.—the precast concrete panels with embedded thin brick and attached limestone projections made the most sense." High Concrete LLC supplied the precast concrete components.

Adding to the complexity was the building's location abutting three-story row houses on one side and an existing parking structure on another. The new parking structure had to connect to an existing one, which was owned by the same company. "This project was going to essentially provide an addition to the existing building, but it had to reflect more of the history of the area." To accomplish that, designers created an appearance on the visible sides of the building that reflects to proportions of the row houses but at a scale to match its seven-story height."

The building features a traditional tripartite design of base, center, and cornice. The base features precast concrete panels cast with formliners to resemble cut stone, a popular design for some of the older, larger buildings in the area, Fox explains. These were enhanced with limestone accents that project out from the façade. They were added after the panels were erected, fitting into recesses with anchors.

"The projections for some of these pieces were fairly large, up to 8 inches, and we calculated that it would be more economical and attractive to set them in rather than try to cast them into the panels," he says. "These were high-profile pieces at eye level, where we wanted to focus our budget." The panels feature large window openings that mimic the look of retail storefronts. These were covered with dark aluminum panels and mesh to hide the interior while allowing the building to remain open.

Brick Veneer Blends

In the center section, a 40-40-20 mixture of red brick shades along with black ironspot stippling mimics the faces of the nearby buildings. Designers reviewed a variety of thin-brick options before deciding on the combination that provided the rich, near-orange tint they desired. Belt courses and accent bands in buff-colored precast concrete mimic the stone appearance used on the base.

Punched window openings were created on a regular pattern and filled with an aluminum grid that replicates the look of mullioned windows. Beneath these two windows per bay are three square windows with a decorative grille of concentric circles. The aluminum pieces were installed in the openings at the precaster's plant prior to shipping. Other portions of the center section feature the cut-stone appearance of the lower level.The cornice level features precast concrete panels with alternating bands of embedded thin brick and buff-colored, limestone-like textures. The combination provides a dark, textured look to the building's roofline.

The detailed mixture of brick and limestone appearances continue about 30 ft around each corner, where the design shifts to a more traditional spandrel-like open appearance for sides away from public view. "This approach allowed us to represent the historic detail on the public faces of the building while allowing the majority of the structure to remain open," he explains. In some of the enclosed areas, vents, louvers, mechanical systems, and sprinklers were installed to meet code requirements for enclosed parking structures.

The garage's driving surface comprises double tees reinforced with carbon fiber, which makes them corrosion-resistant. The carbon reinforcing also allowed the precaster to reduce concrete cover ordinarily used to protect welded wire-mesh reinforcement. As a result, the tees are $3^1/_2$ in. thick on most floors, a half-inch less than usual, which allowed a weight reduction of 8%. On the first floor, where a two-hour fire rating was required, flanges were $4^3/_4$ in. thick. Each double tee is 15 ft wide and spans 60 ft long.

Constructing the building was complicated by its location, which formerly had been a surface parking lot. The structure connects to the parking structure next to it on each level and abuts the historic row houses beside it. In addition, the site sloped in both directions, dropping 4 to 5 ft in one direction and 6 to 10 ft in the other. The precast panels could accommodate the slope as well as the interior ramping to keep the building looking parallel to the street on all of its levels.

The use of embedded thin brick eliminated the need for masonry scaffolding at the congested site. The precast concrete components were staged nearby and erected by a crane set on the site. Lanes of traffic were blocked toward the end of the erection as the crane worked out to the edge of the tight site. "Using precast concrete shortened the site-construction phase by about two months," says Fox. That helps the building owner save money and generate revenues faster.

"We've done a good deal of work with structural precast concrete, and we find that it makes good sense to go with this system," says Fox. "It's less expensive than other systems in both initial and life-cycle costs, and it provides aesthetic options that can meet owners' growing desires these days to avoid a typical, utilitarian look to their parking structures."

Colorful Winter Haven, Florida

City officials in Winter Haven, Fla., had two goals for their new large parking structure at a prominent downtown intersection: they wanted to avoid having it look like a garage, and they wanted it to blend with the adjacent retail corridor. They achieved these goals with the use of a total precast system.

'Precast is less expensive than other systems in both initial and life-cycle costs.'

Decorative touches, ranging from brick and tile to awnings, cornices, and colorful paint, create the look of retail storefronts for a new precast concrete parking structure in downtown Winter Haven, Fla. Panels were overlapped to create a varying rhythm to the façade, and a variety of lighting fixtures minimize light overflow and mimic retail appearances. Photo courtesy of Mike Potthast, Potthast Studios

Photos courtesy of Lori Ballard, Photographer

Photos courtesy of Everett Whitehead & Son, Inc.

PROJECT SPOTLIGHT

Winter Haven Downtown Parking Garage

Location: *Winter Haven, Fla.*

Size: *97,608 square feet*

Parking Stalls: *261*

Cost: *$3.2 million*

Architect: *Collman & Karsky Architects, Winter Haven, Fla., and Tampa, Fla.*

Owner: *City of Winter Haven, Winter Haven, Fla.*

Structural Engineer: *McCarthy & Associates, Inc., Clearwater, Fla.*

MEP Engineer: *I. C. Thomasson Associates, Inc., Tampa, Fla.*

Contractor: *Everett Whitehead & Son, Inc., Winter Haven, Fla.*

PCI-Certified Precaster: *Coreslab Structures (Tampa) Inc., Tampa, Fla.*

Precast Specialty Engineer: *Pfeil Design LLC, Tampa, Fla.*

Precast Components: *Double tees, columns, lite walls, frame walls, spandrels, wall panels, beams, cornice caps, flat slabs, and stairs with landings.*

"A lot of forethought went into creating a façade that hid the building's true function," explains architect Joseph Mastropaolo. He served as the project architect for architectural firm Collman & Karsky Architects, which designed the structure. The three-level, 97,608-square-foot project in the city's downtown retail district is flanked by historic buildings dating to the early 1900s. The city manager and commissioners wanted to increase parking for retailers in this area, but they didn't want a large structure to dominate storefronts or look out of place.

A precast concrete panel system approach was specified rather than a spandrel system. The precast concrete wall panels allowed a variety of "doors" and fenestration patterns to be cast into them, creating a variety of appearances along the façades. Cost evaluations by the precaster and contractor showed the two systems were comparable once the different foundation needs were taken into account. Precaster Coreslab Structures (Tampa) supplied the precast concrete components.

"The key challenge was to design a different fenestration pattern at each storefront and maintain the required open area so the parking structure would not have to be mechanically ventilated," Mastropaolo explains. "Working with the precaster during the design development phase of the project made this a reality."

‘We decided to use precast concrete cornices both for the high quality of the appearance and the durability they would offer from vandalism.’

The precast concrete wall panels essentially served as a blank canvas onto which the architect was able to place color, materials, and ornamentation to complement the structure in its historic context. “The design-build format allowed us to continue to examine more economical approaches to those aesthetic designs while not interrupting the flow of the casting and erecting of the building,” he says. “Holding off on selecting the final materials gave us time to find the optimal material to fit the budget and provide the best aesthetics.” As a result, brick and tile was added in several locations when the budget proved sufficient to accommodate them.

Sections of the wall panels were offset and overlaid on top of adjacent panels to accentuate alternating storefronts, creating a three-dimensional rhythm. These protruding storefronts were finished in richer colors and received tile or brick to enhance their design. Special accent colors were selected for trim. In contrast, the receding storefronts feature neutral colors and had less ornamentation and no brick or tile.

Most of the precast concrete was cast with a standard form finish, with reveals and recesses incorporated during casting. This allowed for the design team to easily add a variety of ornamentation and treatments after installation. During erection, it was noted that the precaster provided a high quality product. The architect exploited this to further enhance the façade by incorporating smooth areas into the fields of texture.

Faux windows were used along the street facades, varying with each storefront. They were fabricated with aluminum tubes in the shop and installed after the panels were erected. To further blend the storefronts with the local architecture, stucco headers and trim were installed at selected windows and doors along with several designs and colors of fabric awnings and metal canopies. Sections of Mission-style tile roof accents were also attached to the panels at two storefronts to continue the retail corridor.

Black-out glass panels were considered for window openings along with inoperable doors to hide the building’s true function along the retail corridor. Instead, perforated metal panels were installed on the backside of the faux windows and doors. They make it difficult to see into the building during the day while allowing those inside to see out. The perforated panels also reduce interior light from escaping at night and provide natural ventilation.

The window and door cutouts were cast with wood forms as well as magnet-adjusted steel forms to allow quick changes among the blockouts needed to create the openings. The designs allowed for little repetition, requiring a variety of forms. The adaptability of the forms ensured the panels could be cast quickly to keep the project on schedule.

Custom Cornices Top Structure

Storefronts featuring a cornice had unique designs, which initially were planned to be created with EIFS. However, concerns arose about its long-term durability, especially as the cornices would be within easy reach of visitors on the top level. “We decided to use precast concrete cornices both for the high quality of the appearance and the durability they would offer from vandalism,” Mastropaolo says.

The cornices were cast in custom shapes and then connected to the top of the panels at the site. The fabrication process produced such high-quality pieces that the architect decided to leave them smooth and paint them a palette of colors that would complement the specific storefront.

The stair/elevator tower on the corner features a system of precast concrete frames on the perimeter and precast concrete shear walls at the elevator core. The design includes a Mission tile roof complementing the roof treatments found in the downtown, while its wide open spaces on each level offer panoramic views for garage users.

Exterior lighting also was given careful consideration. The electrical engineer and the architect investigated lighting options to wash the façade, to minimize light emanating through the fenestration at night while highlighting architectural details. They used light fixtures with both LED and fluorescent lamps to reduce the impact of the interior lighting on the sidewalk outside.

“We did mockups of the lighting installations with the precast concrete façades to determine how to maximize the impact and ensure we achieved the desired effect,” Mastropaolo says. Even the height of the lamp poles on the third level were scrutinized, to provide the minimal height while maintaining the required foot-candles. This reduced pedestrian and vehicle site lines and limited illumination spilling beyond the structure.

Early in the programming phase of the project, the city considered adding retail spaces along the structure’s main street front to continue the retail corridor and add activity, but ultimately decided against it. “The goal was to create accessible parking and encourage people to visit retailers and restaurants in the downtown, and the city decided it didn’t want to generate additional leasable space that would compete with the landlords downtown.”

Historic Traverse City, Michigan

The Old Town Parking Deck in Traverse City, Mich. also had to fit into a historic area, but this time the history reflected a northern Michigan resort area that was undergoing rejuvenation. The facility was designed to handle parking for a large national insurance company as well as focus tourist parking into one location rather than have them spread throughout the neighborhood looking for a spaces. But neighbors also wanted to ensure the parking structure didn’t dominate the otherwise low-key, historic buildings.

To meet these challenges, designers created a 177,226-square-foot, four-story parking structure with a precast concrete structural system. To help it fit in with its surroundings, structural precast concrete wall panels were embedded with a historic thin brick that had previously been used to face several other buildings in the area with full bricks many years earlier.

“The neighbors wanted us to maximize parking in the structure while creating a low-profile style and appearance that respected the context of the adjacent traditional two-story development,” explains Matthew Jo-

Photo courtesy of Todd Zawistowski

A thin brick in a "Chicago common" style was embedded into the precast concrete panels on this all-precast concrete parking structure, mimicking the look of the historic area in which the facility is located in Traverse City, Mich. Charcoal-gray spandrels were chosen to contrast with the brick appearance in other locations.

Photo courtesy of Matt Jobin, Rich & Associates

PROJECT SPOTLIGHT

Old Town Parking Deck

Location: *Traverse City, Mich.*

Size: *177,226 square feet*

Cost: *$7.9 million*

Designer/Engineer: *Rich & Associates, Southfield, Mich.*

Consulting Architect: *Environment Architects (formerly CWS Architects), Traverse City, Mich.*

Owner: *City of Traverse City, Traverse City, Mich.*

Contractor: *Colasanti, Detroit*

PCI-Certified Precaster: *M.E.G.A. Precast (formerly National Precast), Roseville, Mich.*

Precast Specialty Engineer: *Integrated Engineering Solutions, Tecumseh, Ontario*

Precast Components: *559 pieces, including double tees, columns, inverted T-beams, lite walls, stair walls, risers, embedded-brick panels, acid-wash panels.*

Photo courtesy of Todd Zawistowski

Photo courtesy of Todd Zawistowski

Photo courtsey of Matt Jobin, Rich & Associates

bin, project manager for Rich & Associates. The structure was placed mid-block, with development areas to the north and south to be completed later. "We wanted to tuck the parking into the neighborhood. But the neighbors made it clear that they also didn't want a vanilla box."

To achieve this, designers worked with local architectural firm CWS Architects to find a style that would blend well while reaching other goals. They found a thin brick that replicated the look of "Chicago common brick," which was used on several other projects nearby. The brick had become commonplace in the area in the late 1800s as ships took lumber to Chicago. To ensure enough ballast on the return trip, ships filled up with the brick, which was abandoned upon reaching Traverse City again. Locals began using the available brick on their projects.

The brick features a range of yellow-tan colors, intermixed to achieve the warm patina of other buildings, Jobin says. Renderings followed by mockups of the brick panels were created to ensure the proper look was achieved. The bricks were set into the forms and then the panels were cast over them, ensuring a secure connection between the concrete and the brick. Both spandrel and wall panels were used to break up the massing of the building.

Brick Contrasts With Spandrels

The entrance features charcoal-gray spandrels spanning the opening and connecting to a stair/elevator tower on the end that features more brick adjacent to a taller precast concrete tower with charcoal-gray spandrels framing large windows. The precast concrete structure consists of a simple beam-and-column grid pattern with precast concrete stairs.

Blockouts were created in the façade panels to replicate windows, and aluminum framing units and spacer panels, minus the glass, were installed at the precaster's plant prior to shipping the panels to the site. The windows were left open both to lower maintenance costs and to ensure the structure met requirements for an open facility. Large 12-foot window-like openings were placed on the ground floor to mimic the look of nearby retail spaces and provide a base for the facility.

The first-floor panels were cast in

a vertical position 12 ft wide to match the width of the precast concrete double tees, allowing for large architectural openings at the base. The upper floors were erected in a horizontal position based on a 36-foot-wide bay. Each grouping of wall panels is topped with a cornice treatment that includes precast concrete patterned with friezes or ornamental medallions and architectural metal parapet trim. M.E.G.A. Precast of Roseville, Mich., formerly National Precast, provided the precast concrete components.

"The controlled environment afforded in production of the precast components greatly increased the level of quality control in the final product's appearance, with a level likely unable to be matched by other construction methods within the project budget," says Jobin.

Precast concrete did a lot more than just achieve the aesthetic goals. Due to the limited length of the building, the structure slopes on both sides to allow for ramping. "The precast concrete panels allowed us to keep the façade appearing horizontal and to avoid having it appear to slope," he says. The panels are structural and act as shear walls to support the double tees, which were pretopped in all areas except on the top floor where the snow-melt system was installed.

A precast concrete roof structure, consisting of wall panels, end spandrels, and double tees, was located over the floor slope from the third to the fourth level. The roof, along with a snow-melt system embedded in the sloped floor, helps maintain operation of the garage in any winter weather.

Construction moved smoothly and without site restraints, with 559 pieces erected in 50 days. That was a key element of the project, Jobin notes, as the community wanted to ensure that disruptions to the area were minimized. The precaster delivered 60 ft double tees from its plant four hours from the site—much of it along two-lane roads—without difficulty. The components were staged in an empty lot near the site, with $1^1/_2$ to 2 days' worth of pieces available to erect at all times.

The project features a green roof with 200 photovoltaic arrays to help power the facility. It also includes electric-charging stations and other sustainable-design features. Combined with the attributes provided by the precast concrete, including local manufacturing, minimized construction waste, recycled materials, and others, the project qualified for LEED Silver certification.

"We came up one point short of Gold certification, but the owner wasn't interested in changing or adding anything to achieve it," Jobin says. "He was aiming for LEED certification, and we achieved Silver without altering our plans."

> 'The goal was to create the image of movement from one set of louvers to the next.'

The precast concrete design ensured the project could meet all of its goals, he notes. "The notable advantages of precast concrete, such as lower project costs, speed of erection, long-term durability, ease of maintenance, use of recycled material content, and year-round construction, made it the ideal choice at the onset of the design process."

Prominent Medical Center

Designers faced the opposite challenge in creating the seven-level, 400,000-square-foot parking structure at the front of the UC Davis Medical Center facility in Sacramento, Calif. Administrators wanted to make the structure highly visible—but they also wanted it to blend with the existing campus. The facility features a precast concrete structural system and an off-white precast concrete spandrel façade covered in many areas with metal mesh, canopies, and an intricate louver system.

"The parking structure is at the 'front door' of the hospital complex by design," explains Peter Saucerman, partner in charge of sustainable planning at Dreyfuss & Blackford. "Parking structures often are treated as a utilitarian building and are stuck in the back somewhere. But people arriving at a hospital, either as a patient or visitor, often are confused and aren't sure where to go. The master plan for this hospital placed the parking up front so people would know where to go first."

At the same time, the building needed to fit in with the campus and provide a "strong, professional appearance" befitting a hospital, he notes. It is located along two heavily trafficked streets that intersect at an acute angle, creating a pentagonal-shaped footprint. "The design had to flow from one façade to another and tie in with the new hospital tower that was just built, so people could easily find it but keep it in sympathy with the rest of the hospital style."

Designers chose a precast concrete structural solution to meet their needs for the 1,200-car structure. "We always look at a range of options for design possibilities and economy," Saucerman says. "But past experience with precast concrete led us to believe that it would provide the best solution, and it did." Clark Pacific provided the precast concrete components.

The design uses a precast concrete hybrid moment frame for seismic resistance, which was critical in this high-seismic area. "Seismic requirements are always a challenge on projects in this area, but we've worked with Clark Pacific and other precasters in the area, and they know the needs and can produce designs that work."

The hybrid moment-frame system eliminated the need for shear walls, which helped create more wide-open interiors, aiding layout and security concerns. The beams and columns feature an architectural finish on exposed elements to heighten the quality of their appearance, with other areas receiving a standard gray color and finish. The resulting system is not only cost-effective, but it adds to the safety and overall experience of visitors.

The building's exterior features an integrally colored white architectural finish. "We were able to match the precast concrete's color to that of the hospital finishes, so they worked together." Reveals were added to the spandrels along with thin, horizontal "window" openings along one side to emphasize the horizontal nature of the structure.

Metal panels and mesh were placed over these horizontal elements, creating a vertical element that also blocked light from emanating out of the facility. The street-side façades also were faced with finished-aluminum louvers attached to steel substructures. Each set of louvers were set at a different angle, mathematically calculated to provide the best intersection with lighting around it and from the streets.

"The goal was to create the image of movement from one set of louvers to the next, rather than have a set cornice with one angle or shadow all

The high-profile parking structure at the UC Davis Medical Center in Sacramento features aluminum louvers and other metal decorations attached to the precast concrete spandrel panels. Each set of louvers is angled slightly differently, to cast different shadows through the day and imply movement.

PROJECT SPOTLIGHT

UC Davis Medical Center Parking Structure

Location: *Sacramento, Calif.*

Size: *400,000 square feet*

Cost: *$20 million*

Architect of Record/Engineer: *Watry Design, San Jose, Calif.*

Design Architect: *Dreyfuss & Blackford Architects, Sacramento, Calif.*

Owner: *UC Davis Medical Center*

Contractor: *McCarthy Building Companies, Inc., Sacramento, Calif.*

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

Precast Components: *Columns, beams, elevator shafts, and spandrel panels.*

day," he explains. "They all are fixed in place, but some of them look like they could be flipped open or shut." They also were designed with considerations for street traffic, so the louvers in each section can pick up headlights at night as they move past the facility.

The louver's metal substructure attached to the precast concrete façade with stainless-steel fasteners. Making the connections posed no unusual challenge, he notes. "The beauty of working with precast concrete is the precision you can specify. We can plan the dimensions as tightly as we need and you know things will fit together." The metal louvers cover the south and west façades, along the streets, while the east and north sides feature traditional precast concrete panels.

The structure's roof includes a solar photovoltaic array that generates electricity to run the parking deck and generate power for the hospital building next door. "It's hot in this part of the country, making rooftop parking less desirable," he explains. The PV panels double as carports, shading the top deck.

The project fulfills the University of California Policy on Sustainable Practices and incorporates energy efficiency and sustainable features, such as electric-vehicle charging stations. "We didn't pursue LEED certification, but we certainly have those requirements in the back of our mind, and we try to provide as many techniques as we can, even if that isn't the goal," he explains. "The precast concrete definitely helped us with that, as it was manufactured within 50 miles of the site and used recycled materials."

These projects show some of the range that precast concrete parking structures can achieve. Whether the facility must blend with its neighbors or create a dramatic contemporary statement, precast concrete's aesthetic versatility can provide a solution as well as offer additional benefits in accelerated construction, sustainable design, layout ease, and cost efficiency. ■

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

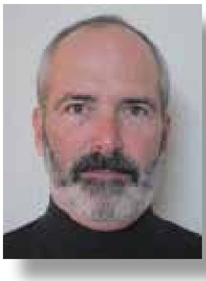
High Performance Precast: Integrating Structural and Envelope Systems

— By Degan Hambacher, P.E.

Maximizing the value of high-performance Total Precast Systems starts with understanding how to best organize the design and optimization process.

High-performance structures integrate and optimize several attributes on a life-cycle basis. This often requires the use of high-performance materials and systems. Precast concrete serves as a high-performance material and system for many reasons, especially due to its ability to serve both structural and architectural purposes at the same time. This provides a host of benefits, including reductions in materials, time, and costs while increasing usable interior floor space. Additional precast concrete attributes include fire, storm, and blast resistance; ability to resist earthquakes; and increased thermal performance, durability, and versatility in aesthetic and structural design.

Precast concrete structural systems, sometimes referred to as Total Precast Systems (TPS), have been successfully used over the past 50 years in almost every project type, from offices and retail centers to multi-family and institutional structures.



– Degan Hambacher, P.E., is president of FDG, Inc. in Arvada, Colorado, a specialty engineering firm servicing the precast/prestressed concrete industry since 1991. He has more than 30 years experience in engineering and project management including being the precast design engineer for the MGM Grand hotel and casino in Las Vegas, which is a total precast structure.

Tucker High School, in Tucker, Georgia, used a total precast system including columns, beams, double-tees, stairs, and insulated wall panels to complete this 340,000 sq. ft. project. Photo credit: Photo courtesy of George Spence, Metromont

Basically, a TPS integrates the structural and envelope systems, sometimes referred to as core and shell, hence integrating architecture and structure. Structurally, precast concrete not only resists self-weight and lateral loads but also transfers and resists primary vertical loads, such as roof and floor loads. Architecturally, it offers versatility in aesthetic design options while also providing thermal performance and resiliency for the building's façade.

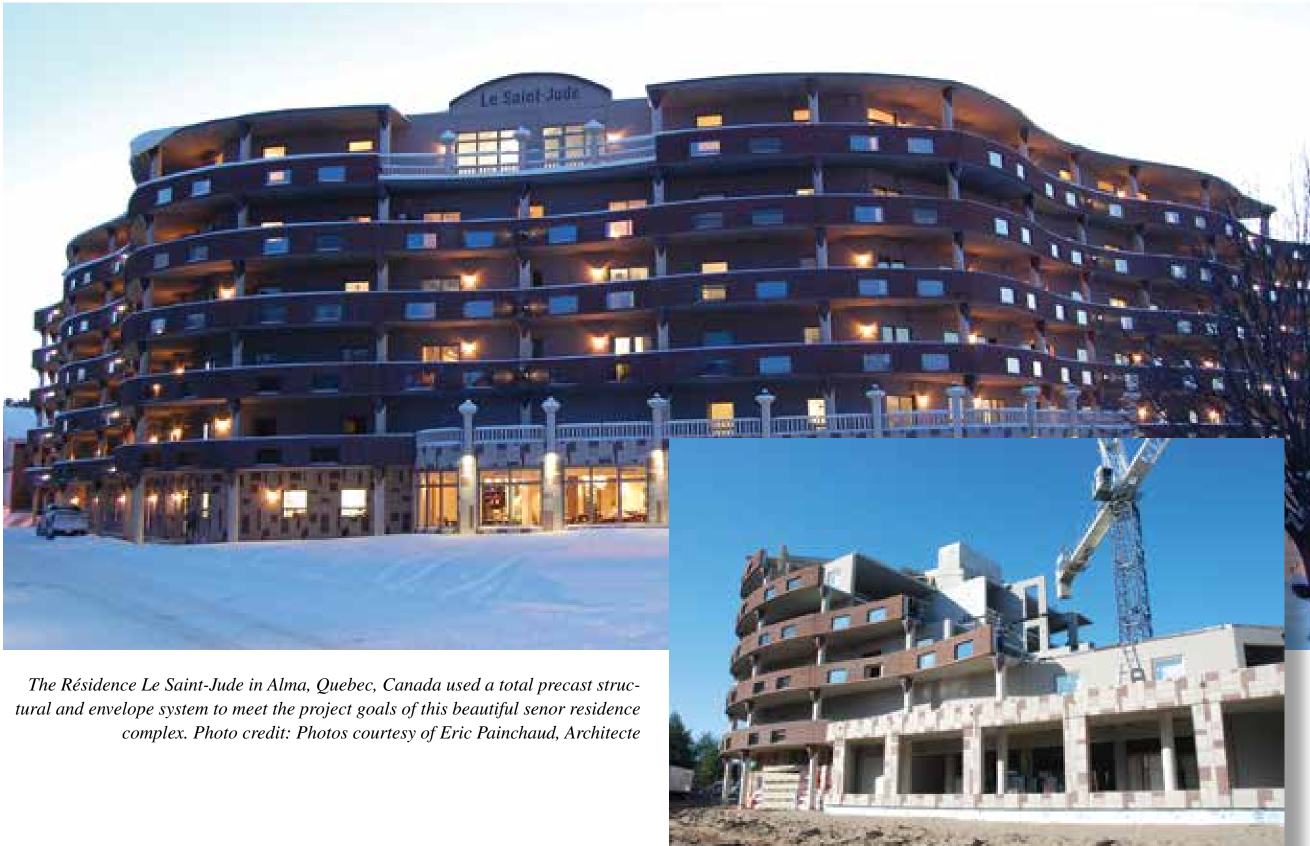
Aligned with BIM, IPD

Since the earliest days, TPS design compelled designers to reverse the traditional approach of Schematic Design (SD), Design Development (DD), Construction Documents (CD), and Construction Administration (CA), moving much of the CD effort related to core/shell to the SD phase. This change allows vital information to be collected sooner so decisions can be made earlier in the process, optimizing the design while saving time and money.

This is in-line with today's trend toward increased use of Building Information Modeling (BIM). More information is provided earlier in a project and then assembled in a model to identify challenges or concerns before construction actually begins. Modeling and BIM tools enhance the value available to designers when creating TPS projects.

It has become fairly common to bring key stakeholders to the table early in the design process. Owners are learning that this generates tremendous value and opportunity by allowing key contractors and subcontractors to optimize projects by taking advantage of each other's experience and expertise.

Examples include teams that work together to achieve LEED certification for projects or Integrated Project



The Résidence Le Saint-Jude in Alma, Quebec, Canada used a total precast structural and envelope system to meet the project goals of this beautiful senor residence complex. Photo credit: Photos courtesy of Eric Painchaud, Architecte

Delivery (IPD) approaches. This concept has long aligned with the use of TPS and fits well with the philosophy. Champions of this approach assimilate requisite talents and experience early in the process, developing and utilizing tools that allow for the creation of accurate and precise imagery during the SD phase of a project. Precast concrete manufacturers serve as an excellent resource to assist design teams in these early phases of design.

This early input maximizes the optimization of the three core aspects of a project: cost, time, and quality. It also helps identify any key requirements, concerns, or challenges early in the project, so they may be addressed before it becomes expensive to do so. Involving operations expertise in these discussions also provides great benefit.

Creating Value During Planning

High-level project planning can now precipitate the onset of conceptual design in parallel with high-level planning decisions being finalized. Resourceful inputs from this early design effort and operational input strengthen higher-level decision making. The goal is to capture added value at this stage and advance the project schedule. However, significant time can be lost if the finalization of financial/planning decisions cannot run in parallel with the commencement of the design process.

Key project design parameters and unique or special circumstances should be flushed out and carefully addressed as the team begins early SD efforts. For example, project location can present important system challenges, such as wind, earthquake, and special soil conditions. Project planning may generate onerous vertical-system requirements, such as heavy storage, vehicle loading, or heavy mechanical, electrical, or plumbing systems. Special security requirements may also include blast considerations. Knowing that some of these critical requirements are in play can add value in the early stages of SD work.

Foundation concepts based on soil observations, site conditions, and civil review should be available, and may present ways to increase the savings. For example, piers provide opportunities to integrate the precast system as grade-beam elements. Imagine the basic difference working with vertical panel elements as opposed to horizontal panel elements. Vertical elements requiring structural support at ground level would generate spread footings or grade beams. If the architecture can be accommodated with a horizontal panel concept, it is possible these panels could span across piers, omitting cast-in-place concrete grade beams.

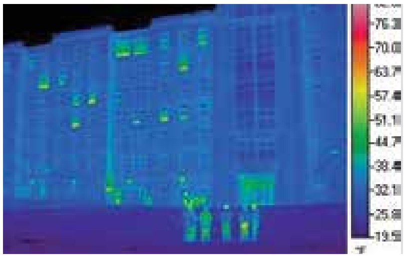
Precast foundation wall systems can accommodate a variety of excavation and soil scenarios, although the manner in which these systems are conceived will vary depending on the circumstances of each project. Early understanding of unique soil/site and foundation challenges reduces wasted design effort and helps leverage value creation.

As plan layouts begin to take shape, function usually defines interior space requirements and the location of cores, anticipated story heights are established, and floor-framing concepts are determined. For TPS, an opportunity to increase value relates to careful study of the basic dimensioning and layout, especially an efficient use of floor framing. A TPS often allows greater open spans and a reduction in intermediate columns or supports relative to steel or cast-in-place. This allows for greater versatility in how a building's floor space can be used, or adapted for future use.

Specific attention to maximizing the

Catholic University of America, Opus Hall left the interior side of the precast envelope system exposed providing a durable, mold-resistant, interior finish. This approach also helps the structure take advantage of the thermal mass properties of precast concrete. Photo credit: Photo © John Cole 2009 / Image provided by Little

Continuous, edge-to-edge insulation is often used in precast concrete wall systems meeting ASHRAE requirements and helping to improve overall energy performance. Photo credit: Photo courtesy of Gate Precast Company



Thermal imaging validates that there are no thermal bridges in this precast concrete envelope system. Photo credit: Image provided by Little

design capacities of the structural elements is also of importance. Imagine a two-bay rectangular structure that requires one additional floor-framing piece in each bay at each end to close out the requisite interior space dimensionally. In a four-story structure, this could result in a swing of between $50,000 to $100,000 in overall costs.

Opportunities to create walls will materialize in designing elements such as cores, usage separation, and shell development. With a basic layout in hand and an understanding of special loading circumstances and fire-separation requirements, the load-carrying capacity of walls can be studied in parallel with building-envelope requirements.

Integration of TPS

TPS provide opportunities for aesthetics to be designed for both external and internal sides of the envelope system. Often, the interior side of precast concrete sandwich wall panels is designed to be exposed and serve as the interior finish. This provides a durable interior surface while reducing waste materials, improving sound attenuation, and eliminating the potential for mold. It also improves the project's ability to take advantage of the thermal mass benefits associated with precast concrete.

Optimization of heating, venting, and air conditioning (HVAC) equipment based on the thermal mass of the precast concrete is important. Mass walls essentially provide a greater effective R-value, which allows for a reduction in heating and cooling loads relative to a standard non-mass wall structure. It also allows for smaller HVAC equipment, reducing first costs.

Many TPS use continuous, edge-to-edge insulation, which is required by most energy codes. These walls can also serve as a vapor barrier. Since precast concrete provides an air bar-

IlOften TPS incorporate part of the MEP systems such as electrical conduit, ductwork, or radiant heat into the panels and elements helping to save time and reduce work onsite. Photos credit: Image provided by Dukane Precast

rier as well, this effectively integrates the air, moisture, and heat management of the envelope system into the precast concrete. In addition, combining the architectural façade with the structural system reduces the need for additional connections. This also reduces thermal bridges in an envelope system.

Mechanical, electrical, and plumbing (MEP) systems are a large part of any project and therefore a critical element of SD. Early and extensive coordination needs to include the key core shell requirements, any challenges including vertical and horizontal system requirements, and the best layout for efficient MEP system delivery, clearances, and human-conveyance systems.

Value-added coordination at this stage may include designing repetitive MEP details into the TPS development. For example, piping, drains, and supports can all be cast into the precast concrete, which saves time and resources onsite. In some projects, the HVAC delivery systems have been included within the TPS envelope (utilizing framed spaces in lieu of ducting). Also, if roof loads are increased in specific areas related to MEP equipment support, this should be provided in the TPS roof design. Additional topping or reinforcement can be used to address these needs.

Coordination between TPS and MEP can result in major savings and improve the overall financial success of a project.

TPS Structural Options

The next step is to determine the best approach to vertical and lateral load resistance. A TPS can be designed as simple or special shear-wall structures. They can also be designed as basic frame systems or take the shape of special moment-resistant frames.

Incorporating the perimeter shell system into the lateral structural system may provide additional value. Imagine an architectural skin comprising window box–type architecture. Many times, these are conceived as cladding systems or simply vertical load-bearing systems. In these situations, interior cores, frames, shearwalls, or a combination of these components typically are provided.

Given these internal solutions are isolated to minimize impact on interior space planning, loads tend to concentrate, requiring additional concrete and steel for element design, as well as foundations to resist overturning. Diaphragm design can also become more onerous, as it must span and connect the cores and shearwall elements.

These challenges are readily resolved if the architectural precast envelope system also serves as part of the structural system. By including the perimeter architectural precast as part of the lateral system in the SD phase, concentrated lateral loading is minimized, and internal cores, frames, shearwalls, and diaphragms can be made more efficient.

TPS can utilize an exterior loaded wall system. These are essentially "punched- window" type walls that can be used as exterior shear walls. Specific attention to more common shear-wall type structures allows design teams to utilize intermediate versus ordinary shear-wall designs. For example, most precast shearwall structures, conceived in SD/DD/CD phase of design, are ordinary, or R=3 for load generation (where 'R' is the response modification factor used in seismic design).

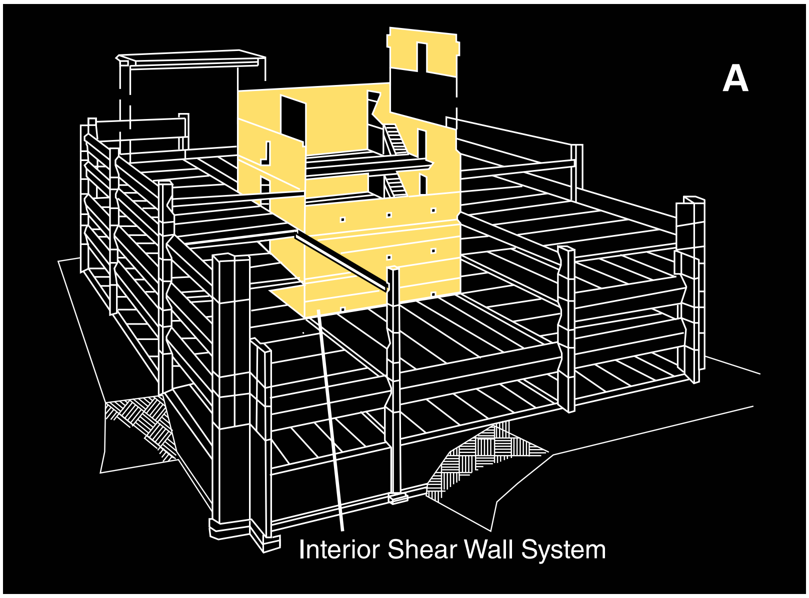
With some prior understanding of precast system requirements to generate intermediate shearwall designation (not a stretch, nor of measurable cost impact in my experience), the design effort can proceed with R=4 for load generation. This reduces overall lateral loads for seismic design by 25%, as R occupies the denominator in load calculations. This facilitates a more efficient assessment of all lateral system loading, including the foundations.

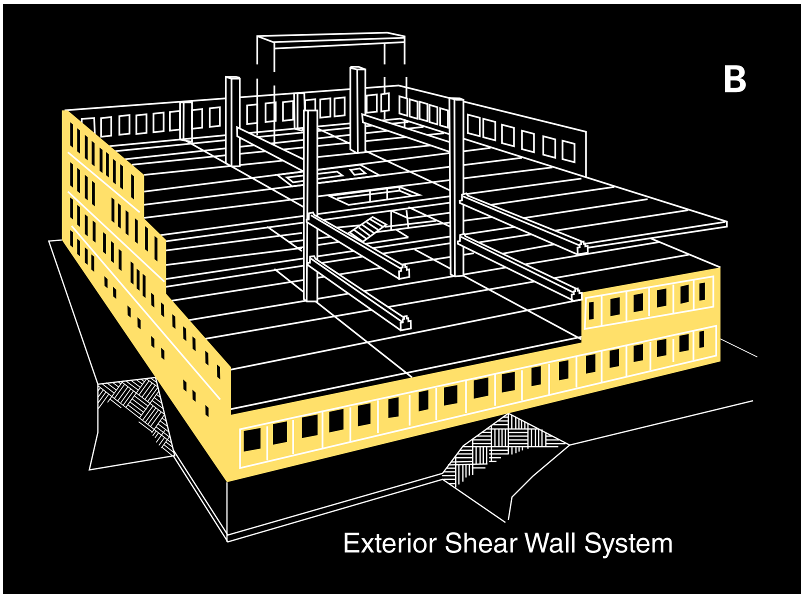
Precast can also be used in traditional framing systems using a beam and column approach. Often, the envelope system will consist of spandrel panels, but other configurations could also be used. In this approach, shear forces are still resisted by internal shear walls or the core(s) of the structure.

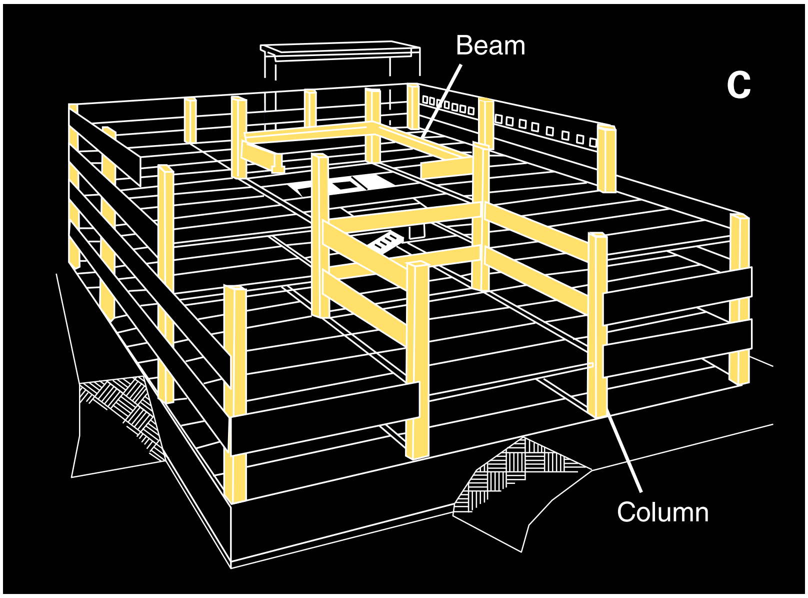
Special hybrid moment frames have been constructed in TPS. They provide lateral stability to extreme earthquake events, incorporating some of the exterior-shell architecture and returning the structure to the original shape and dimensions following a significant event. These systems are accepted in building codes and perform very well.

TPS Aesthetic Benefits

As these decisions are being made, architectural and functional designs should also be progressing in parallel, generating specific inputs to the core/shell system development. Precast concrete provides incredible aesthetic versatility in color, form, and texture. This offers the designer a wide array of options, from exposed concrete to thin-brick and other traditional finish materials. These can also be combined into one panel, reducing detailing, joints, and the number of trades







These diagrams show examples of the versatility of precast structural systems: (A)–interior shear wall system, (B) - exterior shear wall system (C) – rigid frame system. Photo credit: Images by Ed Derwent, PCI

onsite. The Precast/Prestressed Concrete Institute (PCI) offers extensive resources on this subject.

Virtual 3D mockups (VMUs) can be of great value for this design process. Providing the requisite design expertise on the TPS team, combined with virtual imagery through VMUs, enhances the team's ability to collaborate and finalize key aesthetic and functional challenges in early SD stages over normal design processing. More robust physical mockups, which can be beneficial to projects, can follow and mimic these virtual cousins.

As the design/construction team moves to finalize SD and move into DD/CD planning, the TPS team accelerates. Armed with the above information, in a high-quality model format, final choices for a precast concrete supplier can be solidified, and shop-drawing efforts can be scheduled to run concurrent with DD/CD efforts.

Scheduling leverage with TPS allows for CDs to be finalized and issued while precast fabrication is in final stages of planning. The entire team benefits from this as a result. More precise and accurate input on the core/shell system is at the design team's fingertips, while the precast shop-drawing development accelerates support to the design team. These more thorough and accurate early inputs allow the design team to finalize issues related to the TPS and core/shell, reducing the amount of work required to produce the construction documents.

The effort roughly outlined above provides the design team with the opportunities to include significant areas of value in the continuing DD/CD efforts. Much of what's been noted can be readily integrated into the SD phase of planning and design. The results of this leveraged effort are generous input on the most efficient structural systems, coordinated MEP, and integrated core/shell architecture.

In my 30 years of practice in this rather specialized field, I have witnessed fabulous success stories where the team utilized the TPS method of design and construction. Total Precast Systems offer an incredible array of opportunities to optimize projects saving time and money, while increasing the delivered value to project owners. ■

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

The MGM Grand Hotel and Casino in Las Vegas used a precast concrete structural and envelope system to create the world's largest hotel at that time.
Photo credit: Photos courtesy of FDG

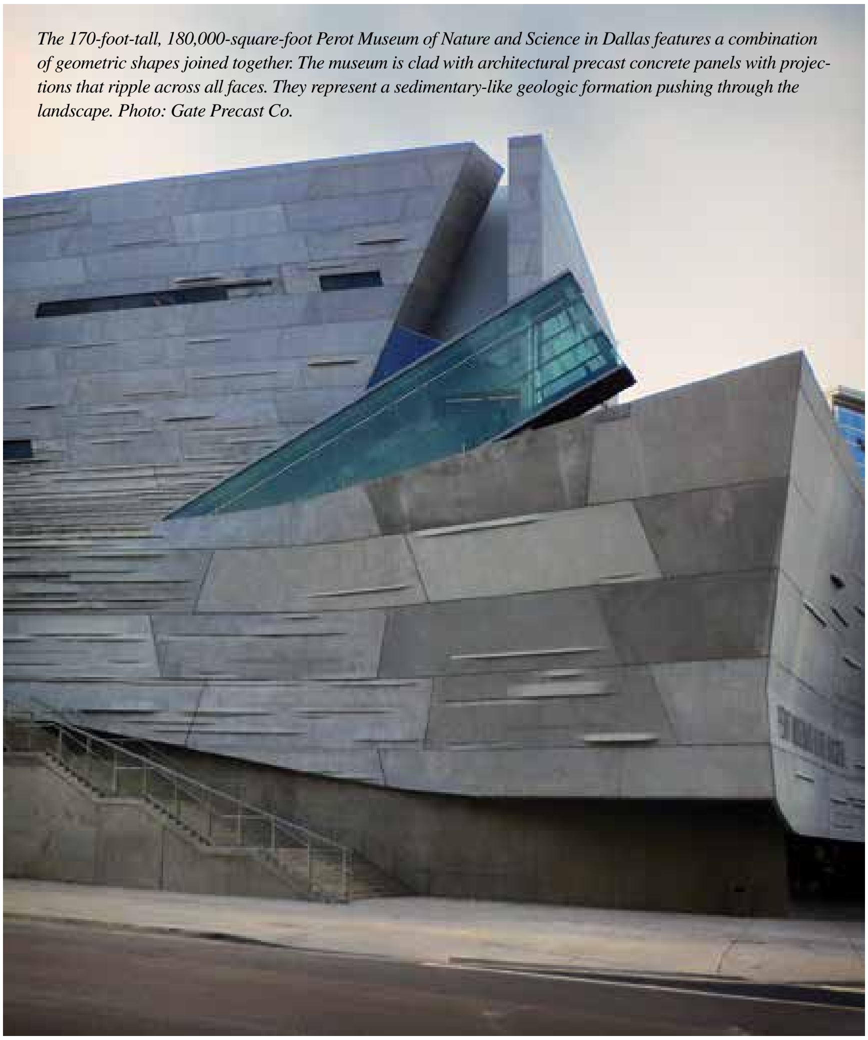
Making Waves

Perot Museum in Dallas uses an innovative and complex pattern of precast concrete panels to set the tone for this educational facility

— Craig A. Shutt

Museums are designed to stimulate curiosity, raise awareness, and inspire visitors — shaping our vision of the past and future. The designers of the Perot Museum of Nature and Science in Dallas wanted to project those attributes onto the building itself, using an innovative concept of projections, striations, and geometric shapes produced with architectural precast concrete panels.

"The museum creates a distinct identity, enhances the institution's prominence in the city, and enriches the city's evolving cultural fabric," explains Thom Mayne, president and design director at Morphosis. "It's designed to engage a broad audience, invigorate young minds, and inspire wonder and curiosity in its visitors."



The 170-foot-tall, 180,000-square-foot Perot Museum of Nature and Science in Dallas features a combination of geometric shapes joined together. The museum is clad with architectural precast concrete panels with projections that ripple across all faces. They represent a sedimentary-like geologic formation pushing through the landscape. Photo: Gate Precast Co.

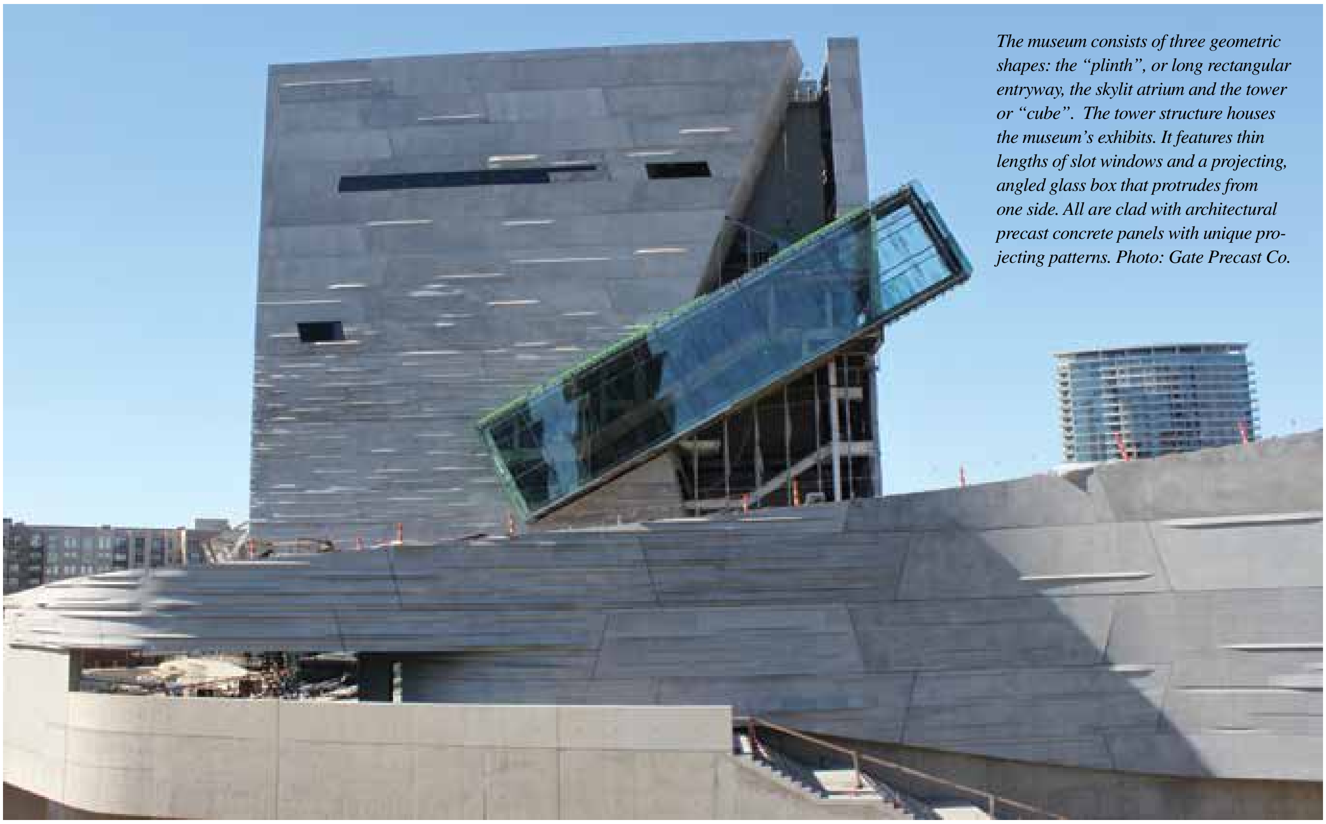
Photos courtesy of Gate Precast Co.

The 170-ft-tall, 180,000-square-ft museum consists of three geometric shapes: the "plinth," or long, one-story rectangular entryway that greets visitors upon arrival; the skylit atrium, which leads visitors up into the exhibition halls via escalators, elevators, and stairs; and the tower or "cube," which features thin lengths of slot windows and a projecting, angled glass box that protrudes from one side. All are clad with architectural precast concrete panels with unique projecting patterns.

Visitors enter through the plinth and take escalators to the top of the building, arriving at a glazed balcony that provides a bird's-eye view of downtown. They proceed down through galleries to reach the ground. "This dynamic spatial procession creates a visceral experience that engages visitors and establishes an immediate connection to the immersive architecture and natural environments of the museum," Mayne says.

A Series of Waves

The immersive architecture begins with the exterior statement. The rippling projections across all faces, extending up the tower, work with curved shapes, both concave and convex, that flow across the plinth's façade. Designers wanted the tower to represent a sedimentary-like geologic



The museum consists of three geometric shapes: the "plinth", or long rectangular entryway, the skylit atrium and the tower or "cube". The tower structure houses the museum's exhibits. It features thin lengths of slot windows and a projecting, angled glass box that protrudes from one side. All are clad with architectural precast concrete panels with unique projecting patterns. Photo: Gate Precast Co.

formation, pushing its way through the landscape. "The design intent was to create a series of waves that gives a dynamic effect on the building that changes throughout the day." The texturing is denser at the bottom of the tower and slowly fades as the cladding moves up to its designed height of 140 ft.

'Ultimately, precast concrete panels provided the simplest erection option and could achieve the complex appearance.'

A variety of options were considered to achieve the unique, random-looking façade texture, says Jeff Koke, senior associate with Datum Engineers. The firm worked with John A. Martin & Associates on the structural design. "We considered various precast and cast-in-place concrete options as well as blown-on gunite and some other options to find the best way to achieve the textural look we wanted," he says. "Ultimately, precast concrete panels provided the simplest

PROJECT SPOTLIGHT

Perot Museum of Nature and Science

Location: *Dallas*

Project Type: *Museum*

Size: *180,000 square feet*

Cost: *$185 million*

Designer: *Morphosis, Culver City, Calif.*

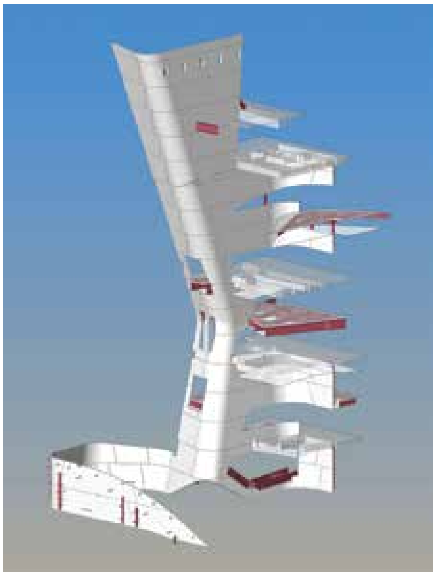
Owner: *Museum of Nature and Science, Dallas*

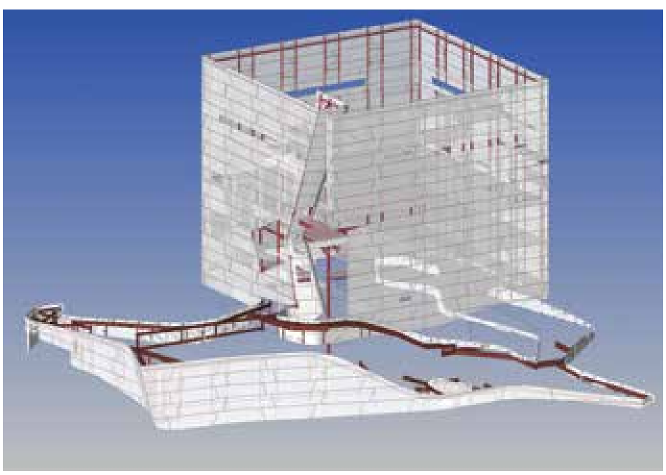
Structural Engineers: *Datum Engineers, Dallas, and John A. Martin & Associates, Los Angeles*

Contractor: *Balfour Beatty Construction, Dallas*

PCI-Certified Precaster: *Gate Precast Co., Hillsboro, Texas*

Precast Components: *700+ gray as-cast architectural precast concrete panels.*





The architect, steel fabricator and precaster collaborated through building information modeling (BIM). The panels were designed with a 6 1/2 in. nominal thickness with 2 in. recesses and 8 in. projections. Photo: Gate Precast Co.

erection option and could achieve the complex appearance."

The panels minimized material and sped construction because they were designed using a standardized panel shape that maximized modularity, interchangeability, and appearance options. "The panels were very regular in shape to keep them economical," says Koke. "From the back, many of them, especially on the atrium, are similar. That made it easier to create a system to attach them to the building."

Even so, the textural designs took a lot of planning. "This difficult and challenging project pushed precast concrete production to a new level, presenting multiple obstacles in production and quality of diverse, individual components," says Mayne. "Since this was a non-traditional project, thousands of man-hours were spent scheming and dreaming over engineering, production, stripping, and shipping challenges. Every angle had to be proven to be accepted as a best practice."

The architect, steel fabricator, and precaster collaborated through building information modeling (BIM) and web meetings to ensure the architectural intent was satisfied, and that joint locations and panel sizes were accurate.

BIM Aids Design

The precaster, Gate Precast Co., had never undertaken a project quite so complex, notes Todd Petty, vice president of operations. "The project really put a new spin on the term design-build. Morphosis conceived and drew up what they wanted and how the flow of each panel was to be constructed. They were extremely creative in their design about where the outer and inner profiles would start and stop, how deep they would be, how tall the profile would be and the distance the profile would cover as it ran horizontally. BIM was most helpful in locating the panels on the structure, essentially determining where that structure needed to be for the panels to connect to it. Without BIM, this would have been an arduous task."

The panels were designed with a $6\frac{1}{2}$ in. nominal thickness, with 2 in. recesses and 8 in. projections. To avoid the appearance of repetition in the panels containing projections (even though there is a considerable amount), a modular concept was developed. Modules were assembled in multiple configurations to eliminate any similar panels being placed close to each other. "Casting polyurethane modules provided a faster means of mold fabrication," Petty notes. "We spent an exorbitant amount on urethane."

'Casting polyurethane modules provided a faster means of mold fabrication.'

Each panel-fabrication ticket noted where projections and indentations were placed in the mold. The tickets were drawn depicting the back of the panels as well. The tickets show panel dimensions, color, detailing, area, connection hardware, stripping and lifting inserts, reinforcing, erection diagrams, and areas for each specific finish. "Most of the tickets are three to four pages long due to the massive amount of information that needed to be conveyed from the engineering and drafting team to the production floor," says Petty.

The crews quickly gained experience with the mechanics of the intricate pours, he adds. "Once they understood how the shapes went together and how the intended flow traversed horizontally from point to point, it got easier."

The most challenging part was not pouring around the formliners, but handling the molds' perimeters, he notes. "The adjacent panels had to match each one around it. Each projection had to meet up exactly wherever it stopped, either on the ends or top or bottom, with all of the panels around it." Each projection was outlined with a $^{1}/_{8}$ in. by $^{1}/_{8}$ in. rounded, protruding outline that served as a perimeter line around the edge. These had to track correctly in each panel as well as panel-to-panel.

More than 250 forms were built to cast the 660 panels. The molds took in-house carpentry craftsmen up to two weeks to construct, and some were used only once. "There was some repetition in casting the tower portions, but very few forms built for the plinth or atrium were used more than four times," Petty says.

Morphosis designers created the wave patterns and applied them to the modular panels. Gate then had to extract each individual projection or indentation piece from the panel drawing and create a form drawing. They varied in size from 4 in. by 42 in. to 24 in. by 42 in. The mold carpenters used the drawings to create their forms, after which a crew poured polyurethane into the mold to create the negative design of the required shape.

The more heavily profiled panels at the bottom of the cube required 130 individual projections installed in the wooden forms in specific arrangements to achieve the proper look. In all, more than 350 individual module forms were constructed and 1650 pieces were built for the forms.

Creating Curved Panels

Another key challenge focused on the curved panels required to create the undulating flow of the façade across the plinth and atrium. "Radiused panels don't generally create a problem," Petty says. "The challenge arose with the small radiuses required on the atrium panels and even more so on the precast concrete skylights."

The tight curves required the precast to backpan, or form up the back of the panel as well so the concrete stays inside the form as it is cast. The backpan had to be carefully constructed to ensure the vibration pressures from the self-compacting concrete didn't cause the backpan to come loose. Fabricators also had to give these pieces a smooth-trowel A-1 architectural finish because the designers wanted to leave the panel backs exposed and paint them.

The plinth's curved panels posed challenges both because there were so many and because they featured so many different radiuses. Complicating matters was that the panels did not only follow a curve along their face left to right, but also included a flat area on one end or both. To ensure close tolerances, the precaster created master molds so several panels could be cast from the same mold at different widths, accommodating the curves where needed.

"This allowed us to cut down on the number of molds that would be used for just one cast, creating an economical solution," Petty says. "Any time you have the deck space to build a larger mold and simply move top, bottom, and side forms around, you save time and material. It also works better in the field. It ensures that the area will fit up properly and look appropriate."

The plinth panels were curved, with most of them canted, radiused, half canted or half radiused. Photos: Gate Precast Co.

Corners also created challenges. "We try to cast all corner panels, which typically are smaller, sequentially after the main panel, because it offers the best way to ensure the pieces match and can be braced properly," Petty explains. "On this project, most corners had a continued profile to them from the adjacent panel, so we cast the corners prior to the larger panel so it could be cast in the exact location of the mold. Engineering had to ensure that the panel was drawn exactly to ensure the projections joined perfectly, and then production had to ensure it was cast in the exact

Gate Precast Awarded Inaugural Sidney Freedman Craftsmanship Award for Work on the Perot Museum

Gate Precast was awarded the 2012 Sidney Freedman Craftsmanship Award for producing the custom textured cladding panels on the Perot Museum of Nature and Science. The new award recognizes PCI-certified plants for excellence in manufacturing and craftsmanship of architectural precast and glass fiber-reinforced concrete (GFRC) structures and individual components. PRETECSA was named a co-winner of the award for producing the cladding panels for the Latter Day Saints Quetzaltenango Temple in Quetzaltenango, Guatemala.

PCI's Architectural Precast Concrete Services and Manual Committee created the new awards program and serves as its judging panel. Judging is based on precasters' success in overcoming obstacles to production, solutions to formwork or finishing challenges, and the quality of individual architectural precast/prestressed concrete or GFRC units.

Sidney Freedman, the award's namesake, is the staff liaison to the Architectural Precast Concrete Services and Manual Committee and also PCI's director of architectural systems and director of operations and safety. Freedman received his bachelor's degree in civil engineering from Northeastern University in Boston and his M.B.A. from Loyola University in Chicago. Freedman joined PCI in 1973 after working for the Portland Cement Association. His many contributions to the precast concrete industry include serving in editorial capacities for the *Manual for Quality Control for Plants and Production of Architectural Precast Concrete* and the second and third editions of *Architectural Precast Concrete*.

Entries are now being accepted for the second annual Sidney Freedman Craftsmanship Award. For more information on this program, visit www.pci.org or contact Sid Freedman at sfreedman@pci.org.

location in the main mold."

Achieving the proper coloring was not a problem, he notes. "For most projects, color has to be consistent from day to day and from panel to panel. This was less of a factor on this project because the design architect preferred a mottled, 'as cast' texture." Moisture meters placed in the aggregate bins and in the bottom of the mixer coupled with metered water going into the mixer ensured the mix colors stayed within the agreed-upon limits.

"Tree Column" Bracing

Attaching these panels to the museum's steel frame required an innovative connection grid that engineers designated "tree columns." They consisted of long steel-tube "trunks" with frames branching off. "It was simple in concept and was aided by the panels being the same standardized sizes," Koke explains. The framing columns helped tie the floors together and minimized deflection from floor to floor.

The panels were erected horizontally to allow for horizontal slot windows used in selected locations. "It wasn't possible in many locations to have a traditional vertical panel hung from the floor and extend from floor to floor," he says.

Indeed, the floors were as much as 35 ft high and cantilevered 9 ft from the column lines. "The tree columns helped with the differential movement in joints of the panels. They needed substantial bracing to handle the loads floor to floor. But since all the deflection was the same due to the standardization of sizes, the precaster could create $^1/_2$-in. joints and be assured that they would be consistent."

The atrium had a more irregular shape, climbing vertically from ground level at a 45-degree angle into the building's body. A transition panel at level three features a radius, after which the top half moves in the opposite direction. The field of each panel

The precaster had to cast a variety of curved panels with many different radiuses, many of them tight. These curves required the back of the panels to be formed up so the concrete stayed inside the form at the panel was cast. Photo: Gate Precast Co.

in this area was divided into modules approximately 3 ft. 7 in. wide, and ranging in height from 4 in. to 24 in.

These required more adjustments to the tree columns, Koke notes. "Each panel had a custom radius, so we had to work closely with Gate to ensure we had the specific requirements for each to brace it. In most cases, regardless of the radius, the panel backs were straight so connecting them was easier." The atrium contains 100 complex architectural panels averaging 10 ft by 10 ft in size.

The plinth had the most curved panels, with most of them either canted, radiused, half canted, or half radiused. Some curved and canted at the same time. That created the appearance of a twisted panel, but the top and bottom held to the horizontal, providing connection points. The plinth contains 220 panels ranging in size from 2 ft by 6 ft to 8 ft by 28 ft. The panels hanging from the top of the plinth created an overturning moment that had to be

The panels were connected to the structure's steel frame using a connection grid, designated "tree columns," featuring long steel-tube "trunks" with frames branching off. Panels were erected horizontally to allow for horizontal slot windows in selected locations. Many locations didn't allow for traditional vertical panels to be hung and extend floor to floor. Photos: Datum Engineers

The panels were erected in a careful sequence to avoid overloading one side of the structure. Work began at the base and went around the perimeter, connecting each panel to the next and to the frame. Photo: Gate Precast Co.

Erection of the panels required meticulous care, often requiring chain falls and cone-alongs to set them. Photos: Gate Precast Co.

resisted through the roof diaphragm and concrete shear walls.

The tower features the distinctive horizontal striations on all four elevations. It contains 350 panels, totaling more than 70,000 square ft, with typical panels averaging 8 ft tall and 28 ft wide with alternating 20-degree sloped ends.

Erection Required Meticulous Care

The erection process moved "painfully slowly," says Mayne, due to the meticulous care required to load the building properly and match the striations from panel to panel.

"We couldn't overload one side of the structure, so we started at the bottom and went around the perimeter, connecting the panels to each other and the frame," explains Koke. "We wanted to load the building all at once rather than do one side, as there was too much eccentricity to the project." Erecting the panels in this progression also minimized potential damage to the panels from sliding a panel into place between two already set.

The precaster had to provide a "face of panel" dimension to each corner of each panel so surveyors could locate exactly where the panel face should be in its correct erected position.

The most challenging aspect was erecting the under-structure panels where the building cantilevered out at a 12-degree angle. The tower crane lowered the panels into the building, where erection crews took the panel away from the crane with up to seven chain falls and trolleys that hung from previously installed stair-stringers or the superstructure. From there, the panels were raised to the proper elevation and then pulled into place by chain falls and come-alongs hooked to the panels' four corners.

An average of five to eight panels were erected per day on the tower, while two panels were erected per day on the plinth and only one was erected per day in the atrium. Three erection crews, comprising 20 ironworkers, were used. On a typical project with less complexity, each crew could have erected eight to 12 panels per day, Petty notes.

The result of this meticulous work has been great acclaim for the building, a variety of awards (including a PCI Design Award), and a striking aesthetic statement. "The Museum will cultivate a memorable experience that will persist in the minds of its visitors," says Mayne. "It will ultimately broaden individuals' and society's understanding of nature and science."

The precast concrete façade enhanced that achievement, adds Petty. "The Museum is unusual and eye-catching. The use of precast concrete has given the design community greater leverage to develop intricate designs, knowing they can be easily produced. It takes a design team that knows what they want, an owner who can pay for it, and a precaster that is willing to get outside of the box and try something new."

It also makes it clear how aesthetically versatile and innovative precast concrete can be, says Dean Gwin, president and COO of Gate Precast. "The Perot Museum has elevated precast concrete design to a new level. It has led to many new and exciting precast projects for all eight of our plants." ■

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

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C-CAPP: Lightweight Integrated Composite Panels Push the Limits of Pre-Assembly and High-Performance

C-CAPP Panel with Architectural Finish ©Clark Pacific 2013

The Design and Value Engineering Challenge

The design-build team for a high-rise residential project in downtown Los Angeles were hitting hurdles. The façade system for their 23-story, highly-visible hotel, predominately metal panel and glass curtain wall, was not penciling out. The owner and design-build team tasked Clark Pacific to come up with a solution that would meet the budget and high-performance needs (including continuous insulation "ci" requirements) of the project without compromising the aesthetics of their design.

The Solution

Clark Pacific's preconstruction team, working with long-time strategic glass partner, AGA (Architectural Glass and Aluminum, Livermore, CA), came up with multiple options for the design team. The solution chosen was a façade comprised of multi-colored and finished Clark Composite Architectural Precast Panels (C-CAPP) that are pre-insulated and pre-glazed at the precast plant as part of the assembly and sent to the jobsite ready for interior finishing after installation.

Each composite panel consists of:

- 2¼" – 3" of integral three-color and multi-finish mesh-reinforced concrete skin (5500psi average compressive strength);
- 2" of NCFI spray foam insulation (two-component, self-adhering polyurethane closed cell foam system with 2pcf core density provides an R-value of 6.8/inch, an air and vapor barrier, high STC rating and high resistance to bacterial or fungal growth);
- 1.5" offset, 4" deep light gauge and tube steel engineered frame system with galvanized pins to connect the skin to the frame and provide window support;
- AGA custom designed thermally broken window assembly for minimal heat/cold transmittance with anchors designed specifically for precast panels (Glass selected was high performance tinted, Low E glass, accented with custom color spandrel inserts);
- Return air HVAC vents, LED lighting connections;
- Joint sealants (Dow Corning® 790 and 795 for panel-to-panel and panel-to-window mullions, respectively).

Interior Panel View with Spray Foam Insulation ©Clark Pacific 2013

Putting the System to the Test

Performance mockup tests were conducted at Construction Consulting Lab West (Ontario, CA). After standard pre-test tune ups and adjustments, industry recommended ASTM and AAMA tests were performed including air infiltration, structural wind loading to 100, 150 and 200% of design loads (70-131mph winds), cyclic static and dynamic water penetration at 12.0 psf (68.5mph wind), elastic and inelastic in-plane seismic movement up to 1.5" at the floorline for 3 cycles and vertical live load deflections. No structural damage to the mockup occurred and designs were verified. No uncontrolled water leakage occured into the mockup under design loading and elastic movement.

Performance Mockup ©Clark Pacific 2013

Meeting the Continuous Insulation Requirement

A final challenge presented to Clark Pacific was the question whether a pre-insulated, panelized system meets the intents of 'ci' requirements in ASHRAE 90.1 and California's Energy Code since the joints themselves would not receive the spray foam application and only a single line of backer rod and caulking were used. And would the pins connecting the skin to the frame create a thermal bridge?

Dynamic Water Penetration Test of Mockup ©Clark Pacific 2013

ASHRAE 90.1 defines "ci" as "Insulation that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building envelope."

Building enclosure consultants Simpson, Gumpertz and Heger (San Francisco) had already been retained to analyze the issue for Clark Pacific on a Net Zero Energy project in Northern California where the pre-insulated version of the system was initially used. Their findings:

"Our extensive 3D modeling of the C-CAPP system shows that the effect of the intermittent rod anchors is negligible on thermal performance and that therefore, the spray foam insulation can be considered as a layer of 'continuous insulation' as defined in both ASHRAE 90.1 and the California Energy Code. (…) Furthermore, we determined that the effect of not insulating across the C-CAPP panel joints is less than 2% for the field of wall and less than 5% across edge-of-slab conditions that have fire/smoke seals. (…) Given the above findings of our thermal analysis that there is only a minor thermal penalty for interrupting the continuous insulation at panel joints, we maintain our recommendation to not install spray foam across panel joints so that the movement between panels is not restricted."

Summary

Clark Pacific's Composite Architectural Precast Panels delivered the aesthetic and budgetary goals. Pre-glazing and pre-insulation can deliver a state-of-the-art precast solution for design-build teams looking for cost-effective façade assemblies.

Mike Ryan, PE, LEED AP BD&C,
Clark Pacific

Clark Pacific is a design-build precast manufacturer serving US West Coast states from four plants in California. Producing leading edge architectural and structural precast concrete solutions for over 50 years, the company currently has over 500 employees, including over 70 engineers on staff. Call Clark Pacific to help with your next design-build project.

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Upcoming Webinars:

- **High Performance Precast Defined**
  March 26 and 28, 2013

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  February 26 - 28, 2013, Toronto, Canada

  Certified Company Auditor
  May 10, 2013, Nashville, Tennessee

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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.

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Design Factors Affecting Aesthetics of Architectural Precast Concrete

PCI designer's notebook

Design Factors Affecting Aesthetics of Architectural Precast Concrete

Architects find that precast concrete panels provide an unlimited vocabulary that allows design concepts to be executed in a broad range of architectural styles, shapes, and sizes. The material offers limitless potential for developing and manipulating mass, color, form, texture, and detail to obtain simple, clean shapes yielding an interesting play of light and shadow.

Proper selection of color, form, and texture for a building's precast concrete exterior is critical to creating a successful aesthetic appearance. The decisions depend not only on cost, delivery schedule, and client preferences but on the local and regional context as well. The desired colors and textures can be achieved by varying aggregate selection, matrix color, size of aggregates, finishing processes, and depth of exposure of the aggregate. This textural flexibility allows designers to use combinations of different finishes using the same or different concrete mixtures, within a single precast concrete unit. Multiple finishing techniques or concrete mixtures with differently colored matrices exposed at the face of the same panel offer an economical, yet effective, way to heighten aesthetic interest through the use of tones and texture in façade treatments. The use of multiple finishes means the designer must make an early decision to ensure that the overall concept allows for the change in finish color and texture. A suitable rustication (that is, some demarcation) needs to be detailed to separate the different colors and/or finishes.

The building's appearance results from the architect's use of light, shadow, texture, and color. Color and, consequently, color tone represent relative values. They are affected by light and shadow, intensity, time of day, and nearby colors. Thus, color selection should be made in lighting that replicates the light and shadows of the site's natural daylight.

The ***Architectural Precast Concrete: Color and Texture Selection Guide***, 2nd Edition (CTG) published by PCI, helps architects define and achieve their aspirations. The guide's photographs serve as a visual reference for initial selection of color, texture, and finish and should be followed by producing samples at a precaster's plant to aid in the final selection of color and texture.

The initial plasticity of concrete makes it responsive to the designer's creative

PCI designer'snotebook

needs. It allows the designer to achieve a high level of detail in the profile, scale, and character of a building that cannot be economically matched by other materials. Precast concrete mold-building techniques allow designers to enhance a building's visual interest through elements such as ribs, bullnoses, reveals, chamfers, or textures. Designers can economically incorporate details such as cornices, quoins, arches, and decorative relief panels. In addition to these benefits, the ability to manipulate color, form, and texture make precast concrete an excellent material to consider in situations where the relationship of a building to its existing context is an important design consideration. Precast concrete can be designed to harmonize with and complement other materials. Natural stone, brick, tile, or terra cotta can be cast into panels allowing designers even more choices for panel finishes. Precast concrete provides the freedom and flexibility of shaping concrete into structure and architecture.

Uniformity and Development of Samples

Because acceptable color uniformity and shading intensity are evaluated visually, they are generally a matter of an individual's subjective judgment and interpretation. Acceptable variations in color, texture, and uniformity should be determined at the time the sample, mockup, or initial production units are approved. A suitable criteria for acceptability requires that the finished concrete surface should have a pleasing appearance with minimal color and texture variations from the approved samples. The finished face surface should show no obvious imperfections other than minimal color and texture variations from the approved samples or evidence of repairs when viewed in typical lighting with the unaided eye at a 20 ft (6.1 m) viewing distance. Appearance of the surface should not be evaluated when light is illuminating the surface from an extreme angle, as this tends to accentuate minor surface irregularities. Appearance of the surface should also be evaluated when the concrete is frost-free and completely dry.

Uniformity

Concrete contains natural materials, and it is these materials' inherent beauty that is most often expressed in architectural concrete. The limitations of these natural materials with respect to uniformity must be considered, and the requirements for uniformity of the precast concrete product must be set within these limitations.

Some color difference between nominally identical precast concrete units is inevitable, but color variation, between and within panels, should be kept within an agreed range. Therefore, it is important, at the sample stage, to reconcile the expectations of the owner and architect with the practical limits of color uniformity. Some designers prefer to see color variation akin to timber and natural stone, while others desire the consistency and uniformity of paint. Where uniformity is essential, the precaster can provide significant input in balancing colors, textures, and shapes to achieve this uniformity.

Color control is, thus, about ensuring that panels or other precast concrete elements for a project have an acceptable tonal range.

Uniformity of color and texture requires the precaster to manage a complex set of variables, including raw materials, mixture proportions, mixing, casting and consolidation, curing, finishing, and weathering. When fabrication continues over extended periods, color can vary because of the changes in the physical characteristics of cements, coarse aggregates, and sand, even though they may be from the same sources. Colors can also change because of natural variations in ambient weather conditions.

The color of a concrete is dependent on, among other factors, the cement and other materials used. Variation in the color can occur from day to day in the product from a single cement plant, and color differences are to be expected among cements obtained from different plants. Cement color reflects chemical composition and processing conditions. Usually, cement colors vary from white to shades of gray and brown. Greater color uniformity results can be expected when using white cement than when using gray cement.

The type and brand of cement must also remain consistent. Changing from Type I to Type III portland cement within one job will cause color variations because Type III portland cement is a finer grind of cement than Type I. Even though the color changes of the cement would be minimal, it is recommended that types or cement brands not be changed.

Because the largest portion of a concrete mixture is aggregate, the color or gradation of aggregate can influence the color of concrete. A substantial change in aggregate color can make a noticeable difference in surface color, especially if an exposed aggregate finish is specified. Therefore, the precaster should stockpile, either at the plant or quarry, the fine and coarse aggregates for each type of exposed finishes.

Coarse aggregates should be reasonably uniform in color. A mixture can have more than one aggregate type to get the desired color. Light and dark coarse aggregates require care in blending so that color uniformity is achieved within a single unit. Choosing aggregates with a small color difference between the light and dark aggregate will enhance uniformity. The architect should specify that the matrix's color or tone match that of the coarse aggregate so that variations in the depth of exposure and concentration of aggregate will not be as noticeable. Panels containing aggregates and matrices of contrasting colors will appear less uniform. Also, as the size of the coarse aggregate increases, less matrix is seen.

If a sample is stored indoors, its color will vary from a panel stored outdoors. A panel stored outdoors and exposed to precipitation is cured differently than the controlled environment of the sample. It is difficult to exclude the influence of the climatic changes on color over a year if the precast concrete units are placed in storage for long periods of time, as may be dictated by contractual conditions or by operations at the construction site beyond the control of the precaster.

The last production process that affects panel aesthetics and needs to be controlled is the finishing. A smooth-off-the-form finish is extremely difficult to produce consistently. Any type of finish that has some degree of aggregate exposure will appear more uniform than a smooth finish because the natural variations in the aggregates will camouflage subtle differences in the texture and color of the concrete. The degree of uniformity normally improves with an increased depth of exposure. Some variation is to be expected in color and texture, even after finishing. Assessment of color uniformity of the panels prior to finishing offers little information. Dividing large surface areas into smaller ones with reveals or rustications also helps to lessen visible variations in color and texture.

Many finishes cannot be achieved with equal visual quality on all faces of the unit because of several factors, such as mixture designs, variable depths (pressures) of concrete, and differences in consolidation techniques, particularly in the case of intricate shapes with complex flow of concrete.

During consolidation, the effect of gravity forces the larger aggregates to the bottom and the smaller aggregates, plus the sand and cement, upwards. Consequently, the downface in the mold will nearly always be the most uniform and dense surface of the unit. The final orientation of aggregates may also result in differences in exposure between the down face and the returns in exposed-aggregate surfaces. Emphasis should be placed on choosing suitable concrete mixtures with aggregates that are reasonably spherical or cubical in shape to minimize differences. For large returns, or situations where it is necessary to minimize variations in appearance between adjacent surfaces, concrete mixtures should be selected where the aggregate gradation can be uniformly controlled and preferably fully graded. Exposures on returns should be medium to deep, and color differences between the ingredients of the mixture should be minimal.

The color of any concrete product can be expected to change to some degree over time. Atmospheric pollution and any accumulated grime or soot will darken the surface. These effects can be controlled by producing well-detailed precast concrete units with high-quality concrete. Just like all material surfaces left in the open, precast concrete occasionally must be cleaned to remove pollutants and restore color. Efflorescence may occur randomly on the product surface during its first several years of exposure. This can cause it to look faded or lighter in color if not cleaned off. After years of exposure, the cement paste may erode from the surface depending on environmental conditions, such as acid rain. This will expose more fine aggregate and shift the color of the concrete to the color of the aggregate.

The sample's appearance should be assessed during both wet and dry weather. White concrete usually produces less of a difference in tone between wet and dry panels. In climates with intermittent dry and wet conditions, drying-out periods may produce temporary mottled appearances in all-gray cement façades, particularly on fine-textured surfaces. On the other hand, dirt (or weathering) normally will be less objectionable in gray panels.

Although material and production factors may cause differences in color or texture, lack of uniformity will be minimized if the following recommendations are followed. These include creating pre-bid samples to establish the general color and texture for the project, producing approval samples after the contract award to evaluate the same mixture under sample production conditions, producing 4 × 4 ft (1.2 × 1.2 m) sample panels to show the range of anticipated color and texture variations, and viewing initial production panels to see the final outcome of the process based on bulk ordering of currently quarried materials and full scale production operations.

Achieving the desired textures and colors with feasible production techniques is a process that requires the precaster to produce samples that satisfy the architect's design concepts. This may be accomplished by producing a few samples, or it may require a series of samples integrating the development of corresponding production and finishing techniques.

The use of a separate concrete face mixture and a subsequent backup concrete or the use of a uniform concrete mixture throughout a unit depends on the practice of the particular plant and the configuration of the unit. The choice on the use of backup mixes should be left to the precaster.The face mixtures contain specific decorative aggregates, often in combination with white portland cement and pigment and are specially designed to achieve the desired surface appearance. Backup mixtures are composed of inexpensive aggregates and gray cement, thus reducing material costs in large units with decorative face mixtures. A face mixture will be used for the full thickness when the material savings do not warrant the added costs of working with two mixtures.

The drafts required for finish consideration are a function of the shape of the panel, the specified stripping strength of the concrete, production techniques, and the desire for long-term durability. The architect is urged to consult local precasters for specific recommendations, particularly at openings where windows, doors, or louvers will be mounted. At areas where negative draft is required, it may be necessary to incorporate slip blocks (removable plugs) to aid in stripping the precast concrete panel from the mold. Vertical sides or reverse (negative) drafts will create entrapped air voids, which, if exposed, may be objectionable. Remediating these surface blemishes will incur extra cost. Mold and production costs also increase with negative draft because a slip block must be incorporated with the side rail and removed with each panel during stripping or the side rail must be removed in order to strip the panel. When the side rail is removed, dimensional tolerance becomes a daily variable. Before requiring a negative draft on the top of a parapet panel, consideration needs to be given to the roofing or flashing details required for the parapet and the finish. In general, the greater the positive draft the architect can allow, the more economical and uniform the finish. A compromise may be required between the finish and the shape of a precast concrete unit.

Reveals and Demarcation Features

A reveal or demarcation feature is a groove or a step in a panel face generally used to create a desired architectural effect, or separating finishes or concrete mixtures. Another name for it is rustication or false joint. Reveals can take vertical, horizontal, diagonal, or curved forms, as well as any combination of these, and there may be several bands of them on a building. They can be narrow and delicate or deep, wide, and bold; they can offer a rectangular profile or take on any sectional shape desired, such as concave or triangular.

Reveals can be much more than a joint or line of demarcation between textures or finishes. Designing reveals in varying shapes, sizes, and depths for a precast concrete wall can transform what initially might be considered a mundane, solid surface into a rich texture of shade and shadow, bringing visual interest to the building's façade. Used effectively to create shadow lines, reveals offer the simplest way to reduce or change the building's apparent visual scale or to keep the visual appearance from focusing on any differences that may occur in texture or coloration between panels. Reveals typically measure ½ to $^{3}/_{4}$ in. (13 to 19 mm) deep and $^{3}/_{4}$ to 4 in. (19 to 100 mm) wide, with 45° to 75° beveled surfaces allowing for ease of stripping, usually $^{1}/_{16}$ in. (1.6 mm) taper per $^{1}/_{4}$ in. (6.3 mm). Designers can increase the draft to articulate and manipulate the way the reveal or panel joint is perceived.

Reveals typically are designed where there are changes in the precast concrete's surface. For example, a shift in the panel's finish from smooth to textured can be emphasized using a reveal at the point where the surface texture changes. Reveals also work well where fundamental materials change within a precast concrete panel, such as from an exposed-aggregate finish to a non-exposed-aggregate finish. Reveals allow a crisp, clean transition between these different textures, finishes, colors, or profiles within a panel.

To continue this article and take the test, visit www.pci.org/elearning.

Ascent 2013 – Design Factors Affecting Aesthetics of Architectural Precast Concrete

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.

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Instructions

Review the learning objectives below.

Read the AIA Learning Units article. Note: The complete article is avaliable 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:

1. Explain the finish options of precast concrete.
2. Describe the methods used to achieve color, form and texture for precast concrete finishes.
3. Explain how clay products and natural stones can be veneered to precast concrete to speed construction.
4. Describe what composite casting is, it's advantages and the next time to use it.

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

PCI-Certified Plants

(as of December 2012)

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.

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- Using quality products, construction crews can get the job done right the first time, keeping labor costs down.
- Quality products help construction proceed smoothly, expediting project completion.

Guide Specification

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

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

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

Product Groups and Categories

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

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

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

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

GROUPS

GROUP A – *Architectural Products*

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

Category A1 – Architectural Cladding and Load-Bearing Units
Precast or precast, prestressed concrete building elements such as exterior cladding, load-bearing and non-load-bearing wall panels, spandrels, beams, mullions, columns, column covers, and miscellaneous shapes. This category includes Category AT.

GROUP B – *Bridges*

Category B1 – Precast Concrete Bridge Products
Mild-steel-reinforced precast concrete elements that include some types of bridge beams or slabs, sheet piling, pile caps, retaining-wall elements, parapet walls, sound barriers, and box culverts.

Category B2 – Prestressed Miscellaneous Bridge Products
Any precast, prestressed element excluding super-structure beams. Includes piling, sheet piling, retaining-wall elements, stay-in-place bridge deck panels, and products in Category B1.

Category B3 – Prestressed Straight-Strand Bridge Members
Includes all superstructure elements such as box beams, I-beams, bulb-tees, stemmed members, solid slabs, full-depth bridge deck slabs, and products in Categories B1 and B2.

Category B4 – Prestressed Deflected-Strand Bridge Members
Includes all products covered in Categories B1, B2, and B3.

GROUP BA – *Bridge Products with an Architectural Finish*

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

GROUP C – *Commercial (Structural)*

Category C1 – Precast Concrete Products
Mild-steel-reinforced precast concrete elements including sheet piling, pile caps, piling, retaining-wall elements, floor and roof slabs, joists, stairs, seating members, columns, beams, walls, spandrels, etc.

Category C2 – Prestressed Hollow-Core and Repetitive Products
Standard shapes made in a repetitive process prestressed with straight strands. Included are hollow-core slabs, railroad ties, flat slabs, poles, wall panels, and products in Category C1.

Category C3 – Prestressed Straight-Strand Structural Members
Includes stemmed members, beams, columns, joists, seating members, and products in Categories C1 and C2.

Category C4 – Prestressed Deflected-Strand Structural Members
Includes stemmed members, beams, joists, and products in Categories C1, C2, and C3.

GROUP CA – *Commercial Products with an Architectural Finish*

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

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

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

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

ALABAMA

Gate Precast Company, Monroeville (251) 575-2803 .... **A1, C4A**
Hanson Pipe and Precast Southeast, Pelham (205) 663-4681 .... **B4, C4**
Standard Concrete Products, Theodore (251) 443-1113 .... **B4, C2**

ARIZONA

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

ARKANSAS

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

CALIFORNIA

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

COLORADO

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

CONNECTICUT

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

DELAWARE

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

FLORIDA

Cement Industries, Inc., Fort Myers (239) 332-1440 .... **B3, C3**
Colonial Construction, Concrete, Precast, LLC, Placida (941) 698-4180 .... **C2**
Coreslab Structures (MIAMI) Inc., Medley (305) 823-8950 .... **A1, C4A**
Coreslab Structures (ORLANDO) Inc., Orlando (407) 855-3191 .... **C2**
Coreslab Structures (TAMPA) Inc., Tampa (813) 626-1141 .... **A1, B3, C3A**
Dura-Stress, Inc., Leesburg (800) 342-9239 .... **A1, B4A, C4A**
Finfrock Industries, Inc., Orlando (407) 293-4000 .... **A1, C3**
Florida Precast Industries, Inc., Sebring (863) 655-1515 .... **C2**
Gate Precast Company, Jacksonville (904) 757-0860 .... **A1, B4, C3A**
Gate Precast Company, Kissimmee (407) 847-5285 .... **A1, C2**
Metromont Corporation, Bartow (863) 440-5400 .... **A1, C3A**
Oldcastle Precast, Jacksonville (904) 768-7081 .... **C1**
Pre-Cast Specialties Inc. (*), Pompano Beach (800) 749-4041 .... **C4**
South Eastern Prestressed Concrete, Inc.,
West Palm Beach (561) 793-1177 .... **B3, C3**
Stabil Concrete Products, LLC, St. Petersburg (727) 321-6000 .... **A1**
Standard Concrete Products, Inc., Tampa (813) 831-9520 .... **B4, C3**

GEORGIA

Atlanta Structural Concrete Co., Buchanan (770) 646-1888 .... **C4A**
Colonial Construction, Concrete, Precast, LLC,
Elberton (941) 698-4180 .... **C2**
ConArt Precast, LLC, Cobb (229) 853-5000 .... **A1, AT, C3**
Coreslab Structures (ATLANTA) Inc., Jonesboro (770) 471-1150 .... **C3A**
Gulf Coast Pre-Stress, Inc., Jonesboro (228) 234-7866 .... **B4**
Metromont Corporation, Hiram (770) 943-8688 .... **A1, C4A**
Standard Concrete Products, Inc., Atlanta (404) 792-1600 .... **B4**
Standard Concrete Products, Inc., Savannah (912) 233-8263 .... **B4, C4**
Tindall Corporation, Conley (800) 849-6383 .... **C2A**
Tindall Corporation, Conley (800) 849-6383 .... **C4A**

HAWAII

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

IDAHO

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

ILLINOIS

ATMI Precast, Aurora (630) 896-4679 .... **A1, C3A**
AVAN Precast Concrete Products, Lynwood (708) 757-6200 .... **A1, C3**
County Materials Corporation, Champaign (217) 352-4181 .... **B3, B3-IL**
County Materials Corporation, Salem (618) 548-1190 .... **A1, B4, B4-IL, C4**
Dukane Precast, Inc., Aurora (630) 355-8118 .... **A1, B3, B3-IL, C3**
Illini Concrete Company of Illinois, LLC, Tremont (309) 925-5290 .... **B3, B3-IL**
Illini Precast, LLC, Marseilles (708) 562-7700 .... **B4, B4-IL, C3**
Lombard Architectural Precast Products Co., Alsip (708) 389-1060 .... **A1**
Mid-States Concrete Industries, South Beloit (608) 364-1072 .... **A1, B3, B3-IL, C3A**
Prestress Engineering Corporation, Blackstone (815) 586-4239 **B4, B4-IL, C4**
Spancrete of Illinois, Inc., Crystal Lake (815) 459-5580 .... **C2**
St. Louis Prestress, Inc., Glen Carbon (618) 656-8934 .... **B3, B3-IL, C3**
Utility Concrete Products, LLC, Morris (815) 416-1000 .... **B1A, C1A**

INDIANA

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

IOWA

Advanced Precast Co., Farley (563) 744-3909 .... **C1A**
Andrews Prestressed Concrete, Inc., Clear Lake (641) 357-5217 .... **B4, C4**
Cretex Concrete Products Midwest, Inc.,
Iowa Falls (515) 243-5118 .... **A1, B4, B4-IL, C4A**
MPC Enterprises, Inc., Mount Pleasant (319) 986-2226 .... **A1, C3A**
PDM Precast, Inc., Des Moines (515) 243-5118 .... **B3, C4**

KANSAS

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

KENTUCKY

Bristol Group, Inc., Lexington (859) 233-9050 .... **B3A, C3A**
de AM - RON Building Systems LLC, Owensboro (270) 684-6226 .... **B3, C3A**
Gate Precast Company, Winchester (859) 744-9481 .... **A1, C1**
Prestress Services Industries LLC, Lexington (859) 299-0461 .... **A1, B4, C4A**
Prestress Services Industries LLC, Lexington (260) 724-7117 .... **B4, B4-IL, C4A**
Prestress Services Industries LLC, Melbourne (859) 441-0068 .... **B4, C3**

LOUISIANA

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

MAINE

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

MARYLAND

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

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MASSACHUSETTS

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

MICHIGAN

International Precast Solution, LLC, River Rouge (313) 843-0073 . **A1, B3, C3**
Kerkstra Precast Inc., Grandville (800) 434-5830 .... **A1, B3, C3A**
Nucon Schokbeton / Stress-Con Industries, Inc.,
Kalamazoo (269) 381-1550 .... **A1, B4, C3A**
Peninsula Prestress Company, Wyoming (517) 206-4775 .... **B4, C1**
Stress-Con Industries, Inc., Detroit (313) 873-4711 .... **B3, C3**
Stress-Con Industries, Inc., Saginaw (989) 239-2447 .... **B4, C3**

MINNESOTA

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

MISSISSIPPI

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

MISSOURI

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

MONTANA

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

NEBRASKA

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

NEW HAMPSHIRE

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

NEW JERSEY

Boccella Precast LLC, Berlin (856) 767-3861.......... **C2**
Jersey Precast, Hamilton Township (609) 689-3700 .... **B4, C4**
Northeast Precast*, Millville (856) 765-9088 .... **B2, C2**
Precast Systems, Inc., Allentown (609) 208-1987 .... **B4, C4**

NEW MEXICO

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

NEW YORK

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

NORTH CAROLINA

Gate Precast Company, Oxford (919) 603-1633 .... **A1, C2**
International Precast Inc., Siler City (919) 742-3132 .... **A1, C3A**
Metromont Corporation, Charlotte (704) 372-1080.......... **A1, C3A**
Prestress of the Carolinas, Charlotte (704) 587-4273 .... **B4, C4**
S & G Prestress Company, Wilmington (910) 763-7702.......... **B4, C3**
Utility Precast, Inc., Concord (704) 721-0106 .... **B3A**

NORTH DAKOTA

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

OHIO

DBS Prestress of Ohio, Huber Heights (937) 878-8232 .... **C3**
Fabcon LLC, Grove City (614) 875-8601 .... **A1, C3A**
High Concrete Group LLC, Springboro (937) 748-2412.......... **A1, C3A**
KSA, Sciotoville (740) 776-3238.......... **C2**
Mack Industries, Inc., Valley City (330) 483-3111 .... **C3**
Prestress Services Industries LLC, Grove City (614) 871-2900 .... **B4, C1**
Prestress Services Industries of Ohio, LLC, Mt. Vernon (800) 366-8740 **B4, C3**
Prestress Services Industries of Ohio, LLC, Mt. Vernon (740) 393-1121 **B3, C1**
Sidley Precast, Thompson (440) 298-3232.......... **A1, C4A**

OKLAHOMA

Coreslab Structures (OKLA) Inc. (Plant No.1),
Oklahoma City (405) 632-4944.......... **A1, C4A**
Coreslab Structures (OKLA) Inc. (Plant No.2),
Oklahoma City (405) 672-2325.......... **B4, C1**
Coreslab Structures (TULSA) Inc., Tulsa (918) 438-0230 .... **B4, C4**
Tulsa Dynaspan, Inc., Broken Arrow (918) 258-1549 .... **A1, C3**

OREGON

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

PENNSYLVANIA

Advantage Precast Solutions, LLC, Saxonburg (724) 352-5600 .... **C1**
Concrete Safety Systems, LLC, Bethel (717) 933-4107 .... **B1A, C1A**
Conewago Precast Building Systems, Hanover (717) 632-7722 .... **A1, C2A**
Dutchland, Inc., Gap (717) 442-8282.......... **C3**
Fabcon East, LLC, Mahanoy City (570) 773-2480 .... **A1, B1A, C3A**
High Concrete Group LLC, Denver (717) 336-9300 .... **A1, B3, C3A**
J & R Slaw, Inc., Lehighton (610) 852-2020.......... **A1, B4, C3**
Newcrete Products, Roaring Spring (814) 224-2121 .... **B4, C4**
Nitterhouse Concrete Products, Inc., Chambersburg (717) 267-4505 **A1, C4A**
Northeast Prestressed Products, LLC, Cressona (570) 385-2352.......... **B4, C3**
Pittsburgh Flexicore Company, Inc., Donora (724) 258-4450.......... **C2**
Say-Core, Inc., Portage (814) 736-8018 .... **C2**
Sidley Precast, Youngwood (724) 755-0205 .... **C3**
Universal Concrete Products Corporation, Stowe (610) 323-0700 .... **A1, C3A**
US Concrete Precast Group Mid-Atlantic, Middleburg (570) 837-1774 .. **A1, C3A**

SOUTH CAROLINA

Florence Concrete Products, Inc., Sumter (803) 775-4372.......... **B4, C3A**
Metromont Corporation, Greenville (864) 295-0295 .... **A1, C4A**
Tekna Corporation, Charleston (843) 853-9118.......... **B4, C2**
Tindall Corporation, Fairforest (864) 576-3230.......... **A1, C4A**

SOUTH DAKOTA

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

TENNESSEE

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

TEXAS

Coreslab Structures (TEXAS) Inc., Cedar Park (512) 250-0755 .... **A1, C4A**
CXT, Inc., Hillsboro (254) 580-9100 .... **B1, C1A**
Eagle Precast Corporation, Decatur (940) 626-8020 .... **A1, C3**
East Texas Precast Co., LTD., Hempstead (936) 857-5077 .... **C4A**
Enterprise Concrete Products, LLC, Dallas (214) 631-7006 .... **B3, C3**
Gate Precast Company, Hillsboro (254) 582-7200 .... **A1**
Gate Precast Company, Pearland (281) 485-3273 .... **C2**
GFRC Cladding Systems, LLC, Garland (972) 494-9000 .... **G**
Heldenfels Enterprises, Inc., Corpus Christi (361) 883-9334 .... **B4, C4**
Heldenfels Enterprises, Inc., San Marcos (512) 396-2376 .... **B4, C4**
Manco Structures, Ltd., Schertz (210) 690-1705 .... **C4A**
North American Precast Company, San Antonio (210) 509-9100 .... **A1, C3A**
Rocla Concrete Tie, Inc., Amarillo (806) 383-7071 .... **C2**
Tindall Corporation, San Antonio (210) 248-2345 .... **A1, C2A**

UTAH

Hanson Structural Precast Eagle, Salt Lake City (801) 966-1060 ... **A1, B4, C4A, G**
Harper Contracting, Salt Lake City (801) 326-1016 .... **B2, C1**
Owell Precast LLC, Bluffdale (801) 571-5041 .... **A1, B3A, C3A**
The Shockey Precast Group, LLC, Harriman (540) 667-7700 .... **C3**

VERMONT

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

VIRGINIA

Atlantic Metrocast, Inc., Portsmouth (757) 397-2317 .... **B4, C4**
Bayshore Concrete Products Corporation,
Cape Charles (757) 331-2300 .... **B4, C4**
Bayshore Concrete Products/Chesapeake, Inc.,
Chesapeake (757) 549-1630 .... **B4, C3**
Coastal Precast Systems, LLC, Chesapeake (757) 545-5215 .... **A1, B4, C3**
Metromont Corporation, Richmond (804) 222-8111 .... **A1, C3A**
Smith-Midland Corporation, Midland (540) 439-3266 .... **A1, B2, C3**
The Shockey Precast Group, Fredericksburg (540) 898-1221 .... **A1, C3A**
The Shockey Precast Group, Winchester (540) 667-7700 .... **A1, C4A**
Tindall Corporation, Petersburg (804) 861-8447 .... **A1, C4A**

WASHINGTON

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

WEST VIRGINIA

Carr Concrete Corporation, Waverly (304) 464-4441 .... **B4, C3**
Eastern Vault Company, Inc., Princeton (304) 425-8955 .... **B3, C3**
voestalpine Nortrak, Inc., Cheyenne (509) 220-6837 .... **C2**

WISCONSIN

Advance Cast Stone Co., Inc., Random Lake (920) 994-4381 .... **A1**
County Materials Corporation, Eau Claire (800) 729-7701 .... **B4**
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, Inc., Valders (920) 775-4121 .... **B4, C3**
Stonecast Products, Inc., Germantown (262) 253-6600 .... **A1, C1**
Wausau Tile Inc., Rothschild (715) 359-3121 .... **AT**

CANADA

BRITISH COLUMBIA

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

NEW BRUNSWICK

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

ONTARIO

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

QUEBEC

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

NOVA SCOTIA

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

MEXICO

PRETECSA, S.A. DE C.V., Atizapan De Zaragoza (000) 000-0000 .... **A1, G**
Willis De Mexico S.A. de C.V., Tecate .... **A1, C1, G**

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PCI-Qualified & PCI-Certified Erectors

(as of December 2012

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

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

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

Guide Specification

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

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

Erector Classifications

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

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

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

GROUPS

Category S1 - Simple Structural Systems

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

Category S2 - Complex Structural Systems

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

Category A - Architectural Systems

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

Certified erectors are listed in blue.

ALABAMA

Masonry Arts, Inc. (*), Bessemer (205) 428-0780 .... A

ARIZONA

Coreslab Structures (ARIZ), Inc., Phoenix (602) 237-3875 .... S2, A
TPAC, Phoenix (602) 262-1360 .... S2, A

ARKANSAS

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

CALIFORNIA

Coreslab Structures (L.A.), Inc., Perris (951) 943-9119 .... S2, A
Walters & Wolf Precast, Fremont (510) 226-9800 .... A

COLORADO

Encon Field Services, LLC, Denver (303) 287-4312 .... S2
Gibbons Erectors, Inc., Englewood (303) 841-0457 .... S2, A
Rocky Mountain Prestress, Denver (303) 480-1111 .... S2, A
S. F. Erectors Inc., Elizabeth (303) 646-6411 .... S2, A

CONNECTICUT

Blakeslee Prestress, Inc., Branford (203) 481-5306 .... S2
Jacob Erecting & Construction LLC, Durham (860) 788-2676 .... S2,
A

FLORIDA

Concrete Erectors, Inc., Altamonte Springs (407) 862-7100 .... S2, A
Finfrock Industries, Inc., Orlando (407) 293-4000 .... S2, A
Florida Builders Group, Inc., Miami (305) 278-0098 .... S2
Florida Precast Industries, Sebring (863) 655-1515 .... S1
Gate Precast Erection Co., Kissimmee (407) 847-5285 .... A
James Toffoli Construction Company, Inc., Fort Myers (239) 479-5100 . S2, A
Pre-Con Construction of Tampa Inc., Tampa (813) 626-2545 .... S2, A
Prestressed Contractors Inc., Palm Beach Gardens (561) 741-4369 .... S1
Solar Erectors U. S. Inc., Medley (305) 825-2514 .... S2, A
Specialty Concrete Services, Inc., Altoona (352) 669-8888 .... S2, A
Structural Prestressed Industries, Inc., Medley (305) 556-6699 .... S2
Summit Erectors, Inc., Jacksonville (904) 783-6002 .... S2, A

GEORGIA

Big Red Erectors Inc., Covington (770) 385-2928 .... S2, A
ConArt Precast, LLC, Cobb (229) 853-5000 .... S2, A
Precision Stone Setting Co., Inc., Hiram (770) 439-1068 .... S2, A
Rutledge & Son's, Woodstock (770) 592-0380 .... S2

IDAHO

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

ILLINOIS

Area Erectors, Inc., Rockford (815) 562-4000 .... S2, A
Creative Erectors, LLC, Rockford (815) 229-8303 .... S2, A
Mid-States Concrete Industries, South Beloit (800) 236-1072 .... S2
Spancrete of Illinois, Inc., Crystal Lake (815) 459-5580 .... S2
Trinity Roofing Service Inc, Blue Island (708) 385-7830 .... S1

INDIANA

Stres Core Inc., South Bend (574) 233-1117 .... S1

IOWA

Cedar Valley Steel, Inc., Cedar Rapids (319) 373-0291 .... S2, A
Topping Out Inc. / dba Northwest Steel Erection,
Des Moines (800) 247-5409 .... S2

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Carl Harris Co., Inc., Wichita (316) 267-8700 .... **S2, A**
Crossland Construction Company, Inc., Columbus (620) 429-1414........ **S2, A**
Ferco, Inc., Salina **S1**
Topping Out Inc. / dba Davis Erection Kansas City, Kansas City (800) 613-9547 .... **S2**

MARYLAND

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

MAINE

American Aerial Services, Inc., Falmouth (207) 797-8987 .... **S1**
Cianbro Corporation, Pittsfield (207) 679-2435 .... **S2**
Reed & Reed, Inc., Woolwich (207) 443-9747 .... **S2, A**

MASSACHUSETTS

Prime Steel Erecting, Inc., North Billerica (978) 671-0111 .... **S2, A**

MICHIGAN

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

MINNESOTA

Amerect, Inc., Newport (651) 459-9909 .... **A**
Fabcon, Inc., Savage (952) 890-4444 .... **S2**
Hanson Structural Precast Midwest, Inc., Maple Grove (763) 425-5555 **S2, A**
Molin Concrete Products Company, Lino Lakes (651) 786-7722 .... **S2, A**
Wells Concrete Products Co., Wells (507) 553-3138 .... **S2, A**

MISSISSIPPI

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

MISSOURI

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

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Moen Steel Erection, Inc., Omaha (402) 884-0925 .... **S2**
Structural Enterprises Incorporated, Lincoln (402) 423-3469 .... **S2**
Topping Out Inc. / dba Davis Erection Lincoln, Lincoln (800) 881-2931 .... **S2**
Topping Out Inc. / dba Davis Erection Omaha, Omaha (800) 279-1201 **S2, A**

NEW HAMPSHIRE

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

NEW JERSEY

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

NEW MEXICO

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

NEW YORK

J.C. Steel Corp., Bohemia (631) 563-3545 .... **A**
Koehler Masonry, Farmingdale (631) 694-4720 .... **S1**
Oldcastle Building Systems Div. / Project Services, | Manchester (518) 767-2116 .... **S2, A**
Oldcastle Building Systems Div. / Project Services, Selkirk (518) 767-2116 .... **S2, A**
The L.C. Whitford Co., Inc., Wellsville (585) 593-2741 .... **S2**

NORTH CAROLINA

Buckner Steel Erection Inc., Graham (336) 376-8888 .... **S2**
Carolina Precast Erectors, Inc., Taylorsville (828) 635-1721 .... **S2, A**

NORTH DAKOTA

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

OHIO

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

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

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Century Steel Erectors, Kittanning (724) 545-3444 .... **S2, A**
Conewago Enterprises, Inc., Hanover (717) 632-7722 .... **S2**
High Concrete Group, Denver (717) 336-9300 .... **S2, A**
Kinsley Construction Inc., York (717) 757-8761 .... **S1**
Maccabee Industrial, Inc., Belle Vernon (724) 930-7557 .... **S2, A**
Nitterhouse Concrete Products, Inc., Chambersburg (717) 267-4505 .... **S2**
Patterson Construction Company, Inc., Monongahela (724) 258-4450 .... **S1**

SOUTH CAROLINA

Davis Erecting & Finishing, Inc., Greenville (864) 220-0490 .... **S2, A**
Florence Concrete Products Inc., Florence (843) 662-2549 .... **S2**
Tindall Corporation, Fairforest (864) 576-3230 .... **S2**

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

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Hoosier Prestress, Inc., Brentwood (615) 661-5198 .... **S2**
River City Erectors, LLC, Rossville (901) 861-6174 .... **A**

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Derr and Isbell Construction, LLC, Euless (817) 571-4044 .... **S2, A**
Empire Steel Erectors LP, Humble (281) 548-7377 .... **A**
Gate Precast Company, Pearland (281) 485-3273 .... **S1**
Gulf Coast Precast Erectors, LLC, Hempstead (832) 451-4395 .... **S2**
Precast Erectors, Inc., Hurst (817) 684-9080 .... **S2, A**

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Hanson Structural Precast Eagle, Salt Lake City (801) 966-1060 .... **S2, A**
OutWest C & E Inc., Bluffdale (801) 446-5673 .... **S2, A**

VERMONT

CCS Constructors LLC, Morrisville (802) 888-7701 .... **S2**

VIRGINIA

Sprinkle Masonry Inc., Chesapeake (757) 545-8435 .... **A**
The Shockey Precast Group, Winchester (540) 665-3253 .... **S2, A**

WASHINGTON

Central Pre-Mix Prestress Co., Spokane Valley (509) 536-3334 .... **S2, A**

WISCONSIN

Miron Construction Co. Inc., Neenah (920) 969-7000 .... **S2, A**
Spancrete, Valders (920) 775-4121 .... **S2, A**
Spancrete, Waukesha (414) 290-9000 .... **S2, A**
The Boldt Company, Appleton (920) 225-6127 .... **S2, A**

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