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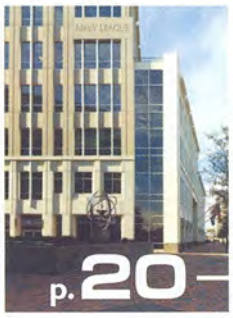

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Photo: ©2005 Boris Feldblyum

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Colorado Prestressers Assn. — Walter J. Prebis
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Florida Prestressed Concrete Association (FPCA) — Joseph Lord
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Georgia/Carolinas PCI (GCPCI) — Peter Finsen
phone: (678) 638-6220 fax: (678) 638-6221
email: peter.finsen@gcpci.org www.gcpci.org

Mid-Atlantic Precast Association (MAPA) — Monica Schultes
phone: (800) 453-4447 fax: (302) 235-1139
email: info@mapaprecast.org www.mapaprecast.org

Midwest Precast Association (MPA) — Mike Johnsrud
phone: (952) 806-9997 fax: (952) 806-9998
email: Mike@MidwestPrecast.com www.midwestprecast.com

New England Region PCI (PCINE) — Rita L. Seraderian, P.E.
phone: (888) 700-5670 fax: (617) 489-5810
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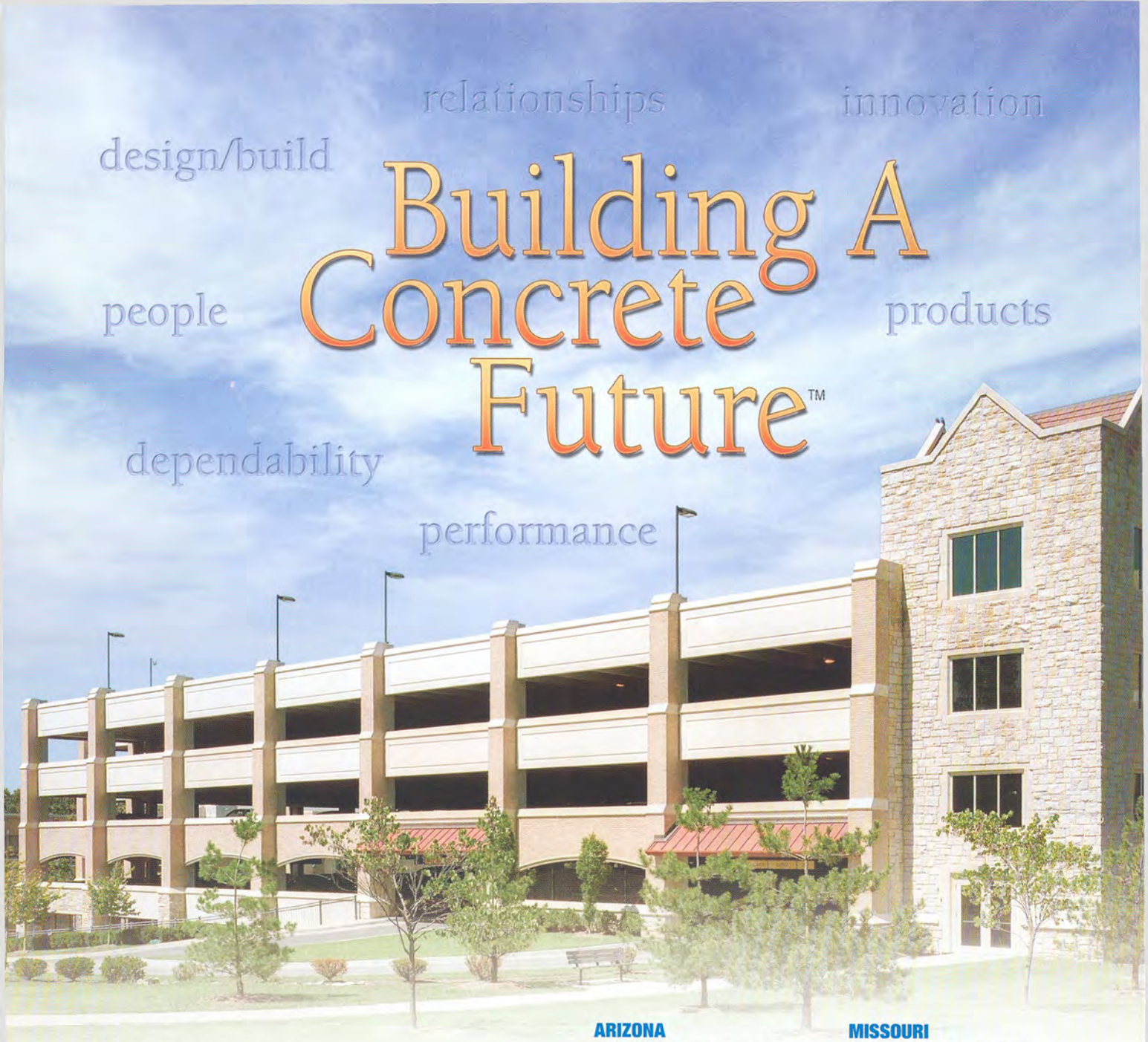
PCI Central Region — Phil Wiedemann
(Indiana, Kentucky, Michigan, Ohio & West Virginia)
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email: phil@pci-central.org www.pci-central.org

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email: info@pci.org www.pci.org

Precast/Prestressed Concrete Manufacturer Assn. of California Inc. (PCMAC) — Doug Mooradian
phone: (818) 247-6177 fax: (818) 240-3041
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PCI of Illinois & Wisconsin (PCI-I&W) — Marty McIntyre
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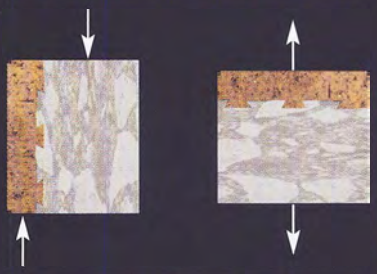
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Endicott's unique "keyback" design mechanically locks Thin Brick into the concrete for maximum durability and permanence.



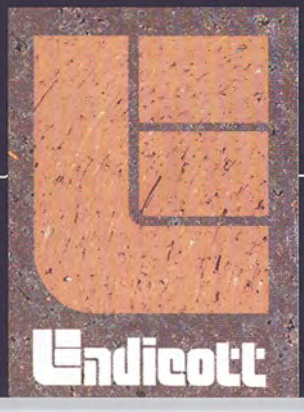
The "keyback" design also provides advantages of increased shear values and pull-out strengths.

Thin Brick is rapidly developing into one of the favored finishes for precast concrete panels. Endicott's specially designed "keyback" configuration makes for a natural marriage between the desired look of brick and the practicality of precast panels.

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To *Elle* and Back



Jim Schneider
Executive Editor

About 10 months ago, I was working on the editorial calendar for this magazine. Back then, I decided that the Spring 2007 issue of *Ascent* would be our sustainability issue. Novel idea, right? Well, it *was* a novel idea. Now I could fill several pages with a listing of "green issues" that have hit the newsstands in the past few months.

I was going to make some witty joke like, "I hear even *Elle* magazine is coming out with a green issue." Except, guess what? *Elle* HAS come out with a green issue. Green is the new black. But you probably already knew that.

Even while acknowledging that my thunder has been stolen by every print publication in the Western Hemisphere, I can't help but celebrate the fact that this topic has become such a part of the popular consciousness in the past year.

For those of us who have long been interested in environmental stewardship, it would be easy to look down our noses at these Johnny-come-latelys who are suddenly paying attention. "Where were you 10 years ago," we might ask. "Why does Leonardo DiCaprio's face on a magazine cover suddenly make people pay attention to what scientists have been saying for years?" True, all the hoopla can be a bit much, and the whole thing may feel like a fad. But the enthusiasm is a good thing.

Several years ago, I worked for an educational technology magazine and heard many of the same kinds of things about the "fad" that was the Internet. Suddenly every magazine was doing its "Cyber Issue." There was a lot of noise in that arena, too, but when it all died down, the technology and the awareness were still there. Today, the Web is a part of everyday life.

I think that the so-called "green" movement is on the same path. The wave of marketing will die down, but the awareness will still be there. We're finally at a point where the tide is turning toward positive change.

And we who are the stewards of the built environment have a great challenge and a great opportunity within this change. The challenge is that, at this moment, we are part of the problem. Buildings account for a large percentage of the emissions that cause global warming. The opportunity is that by adjusting our approach to design, we can be a very large part of the solution.

That solution begins right now. It begins with being aware of what the long-term energy impact of your structure will be. It begins with the materials you specify and how they work together. It begins when you sit down with the entire team—designers, engineers, owners, contractors and suppliers—and think about structures that provide a positive impact to their inhabitants, their surrounding communities and the world at large.

And in your spare time, keep your eye out for the next issue of *Mad* magazine. I hear they're doing a green issue.

PCI

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ASCENT®

The Cover: Two Wachovia Center Main Building, Charlotte, N.C. (see page 32)

- **Executive Editor:** Jim Schneider
- **Managing Editor:** Craig A. Shutt
- **Editorial Staff:** Roy Diez, Wayne A. Endicott, Donald P. Merwin, Anne Patterson, Daniel C. Brown
- **Editorial Administration:** James O. Ahtes Inc.
- **Art Director:** Mark Leader
- **Electronic Production:** Chris Bakker, Jim Henson, Leader Graphic Design Inc.
- **Eastern Ad Sales:** Chuck Minor, Phone: (847) 854-1666, Fax: (847) 854-1672, adsales@pci.org
- **Western Ad Sales:** Dick Railton, Phone: (951) 587-2982, Fax: (951) 587-3982, adsales@pci.org
- **Reprint Sales:** Mark Leader (847) 564-5409 e-mail: sales@leadergraphics.com
- **Precast/Prestressed Concrete Institute:** James G. Toscas, President
- **Industry Technical Review Team:** Sidney Freedman, Edward S. Knowles, Jason J. Krohn, Brian Miller, Andy Osborn, Nancy Peterson, Jim Sirko
- **POSTMASTER:** Send address changes to Ascent®, 209 W. Jackson Blvd., Suite 500, Chicago, IL 60606-6938. Periodical postage paid at Chicago, IL and additional mailing offices.
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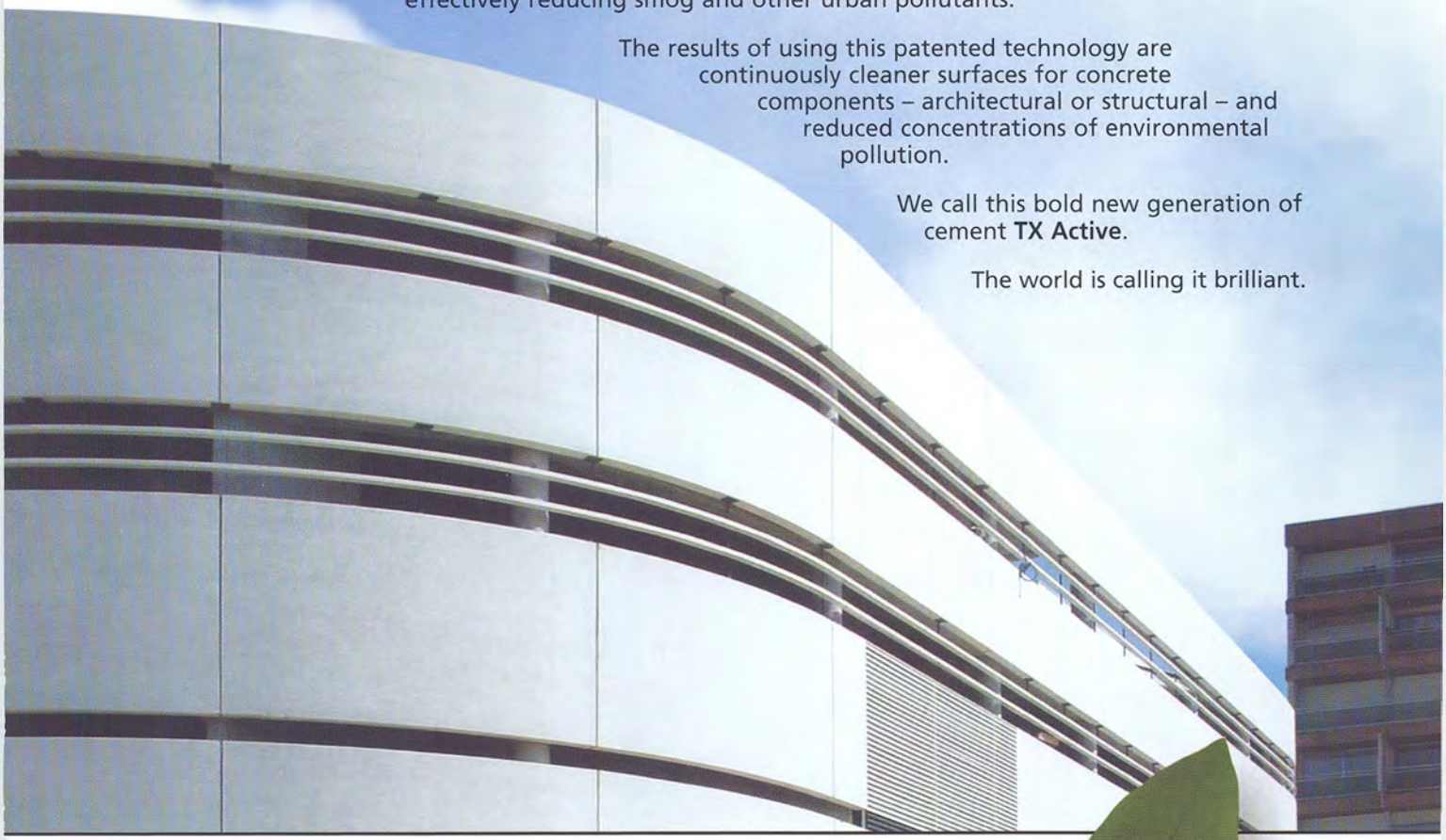
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AltusGroup Names Executive Director

LANCASTER, PA.

Bruce Koepcke has been named the first executive director of **AltusGroup Inc.**, a partnership of precast concrete manufacturers across the country that produce CarbonCast concrete products with C-Grid carbon grid for secondary reinforcing and shear transfer. In this new capacity, Koepcke will assist the board with strategic planning, management and administrative services.

A marketing consultant since 1990, Koepcke was part of the core team that launched AltusGroup in 2004. He has assisted with key initiatives to communicate the group's goals both within and outside the organization.

"As AltusGroup continues to grow, we need dedicated, centralized management coordination to effectively operate and deliver the benefits inherent in the partnership," says Tom McEvoy, chairman of AltusGroup's board and the president of **High Concrete Structures Inc.** in Denver, Pa.

StructureWorks, LEAP Join Forces

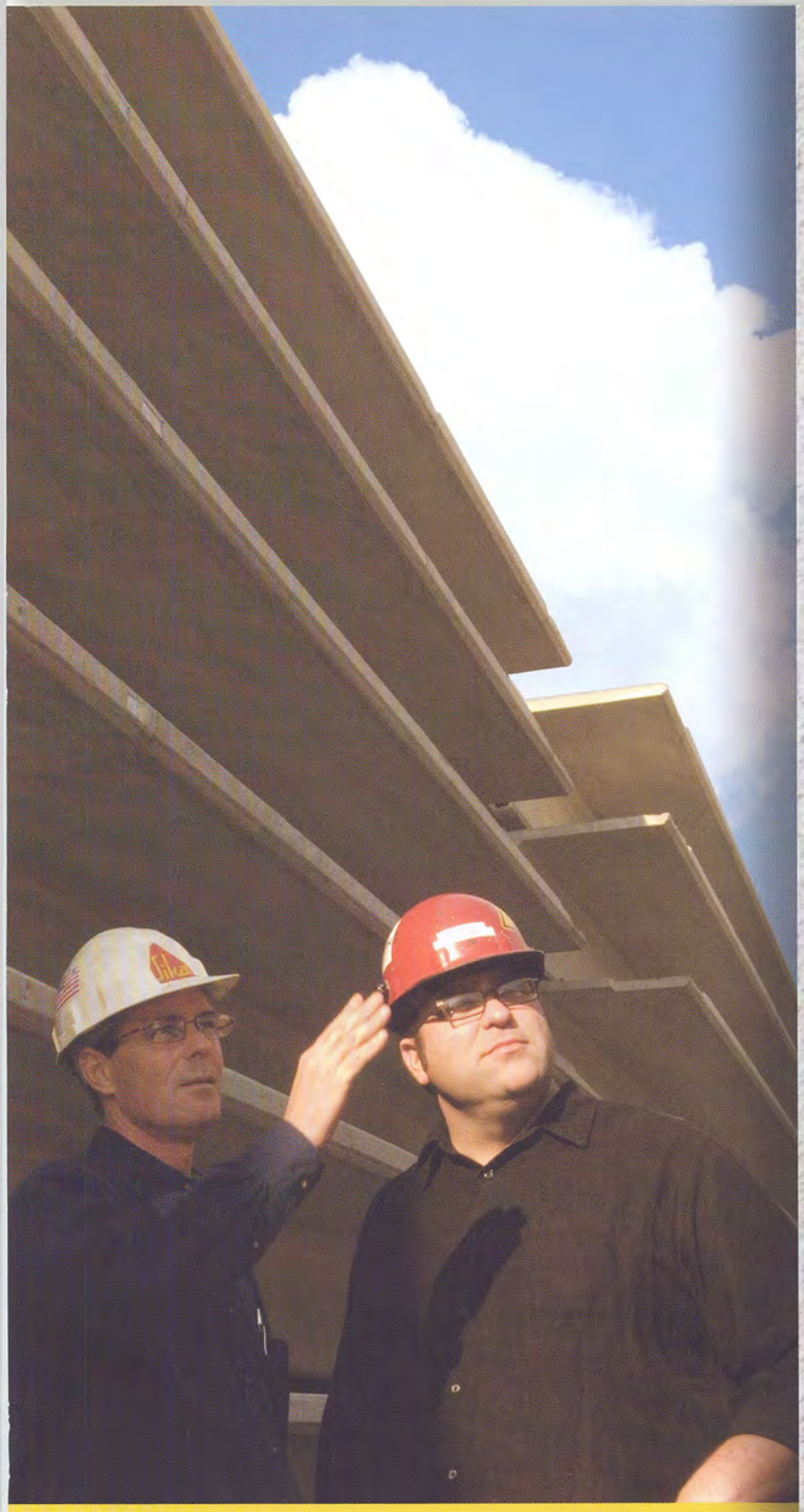
DENVER

StructureWorks LLC has announced a partnership agreement for design-software integration with **LEAP Software Inc.** in Tampa, Fla. StructureWorks offers three-dimensional modeling software for the precast concrete industry, while LEAP offers software solutions for the structural-engineering community.

The agreement will allow for the integration of two of LEAP's programs with StructureWork's precast design software. The two LEAP programs are Presto, which analyzes and designs prestressed or mildly reinforced concrete beams, and Axsys, which analyzes and designs reinforced precast, prestressed multistory columns and wall panels.

The interoperability of the programs will be included in StructureWorks Precast 2008, which will be released by November 2007, the company says. The program facilitates the development of building projects by synchronizing and automating all drawing types, bills of material and engineering content. It is designed for use in a variety of applications, including structural, architectural, utility, site-cast, precast or prestressed concrete.





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Clarifications

The profile article of HOK Sport in the Winter 2007 *Ascent* omitted credits for several precasting companies in the Project Spotlight case histories. *Ascent* regrets the omissions.

International Concrete Products in Germantown, Wis., provided the architectural precast concrete wall panels, including those featuring embedded thin brick, for the new Busch Stadium in St. Louis.

Gate Precast Co. in Ashland City, Tenn., provided nearly 50,000 square feet of architectural precast panels for the exterior of the Mizzou Arena in Columbia, Mo.

ACI Releases Five Publications

FARMINGTON HILLS, MICH.

The **American Concrete Institute** (ACI) is offering five new publications for architects:

- *Causes, Evaluation and Repair of Cracks in Concrete Structures (224.1R-07),* which summarizes the causes of cracks and presents procedures to evaluate cracking and techniques for repair.
- *Guide to Residential Concrete Construction (332.1R-06),* which offers information on constructing one- and two-family dwellings to a maximum height of two stories above grade.
- *Code Requirements for Environmental Engineering Concrete Structures & Commentary (350-06),* which covers structural design, materials selection and construction of environmental-engineering concrete structures used for conveying, storing or treating liquids or solid wastes.
- *Load Tests of Concrete Structures: Methods, Magnitude, Protocols & Acceptance Criteria (437.1R-07),* which provides recommendations when performing load testing to evaluate safety and serviceability of concrete structural members and systems.
- *Guide for the Selection of Materials for the Repair of Concrete (546.3R-06),* which provides an overview of repair materials appropriate for specific applications and service conditions.

To learn more about these guides or to order copies, call (248) 848-3800 or visit the online bookstore at *www.concrete.org*.

Oldcastle Supplies Colorado Prisons

TELFORD, PA.

Oldcastle's Precast Modular Group has been selected to supply secure precast concrete prison cells for two privately run Colorado prisons for Corrections Corporation of America. The two facilities are the first two projects in the state for which Oldcastle has supplied components.

The projects expand existing facilities, both of which will add 720 beds. The work will take place at the 700-bed Bent County Correctional Facility in Las Animas, Colo., and the 768-bed Kit Carson Correctional Facility in Burlington, Colo. Both medium-security prisons will have the work completed by the second quarter of 2008. Each cell will be fully outfitted prior to delivery and will house two inmates.

The DLR Group of Nebraska is the architect of record on the project, with **J.E. Dunn Construction Group** in Denver serving as the general contractor.

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A Micro Approach To Macro Markets

— Craig A. Shutt

VOA has used its focus in key markets to greatly diversify its project base, and it often uses precast concrete to meet owners' changing needs



– Percy "Rebel" Roberts, president and CFO

"Our projects always provide the intersection of program, mission, site and the spirit of what the client wants to achieve."

Since it opened its doors in 1969, VOA Associates Inc. has been a highly diversified architectural firm. That diversification today focuses on core markets and serving those clients' needs in every type of building project required. By focusing on a macro market such as higher education or health care and honing its expertise on the micro needs within those markets, VOA has kept its practice rooted in the goals of its founders while meeting the changing and expanding needs of today's clients.

"We are involved in so many building types that it's not always easy to discern a specific architectural style to our work," says Percy "Rebel" Roberts, president and CFO. "But our philosophy is based on meeting the client's needs within the context of the building and the importance of the site. Our projects always provide the intersection of program, mission, site and the spirit of what the client wants to achieve."

That intersection has led the company into a diverse portfolio of projects in the fields of higher education, hospitality, health care, cultural, governmental, office, commercial building, multifamily residential, and science and technology. The projects are driven by a principal-led group of designers and services pulled from the firm's five domestic offices and international offices in Sao Paulo, Brazil, and Dubai, United Arab Emirates.

"We've found that our core markets can lead to a variety of work that we add to our expertise," explains Roberts. "That expertise can bring a new perspective to the work that other architects can't provide, because they don't have that additional background." The company has a long history in higher-education projects, for instance, having gained Rose-Hulman Institute of Technology as one of its first clients. Since 1969, VOA has designed more than 20 facilities for the school, including master plans.

Higher Education Blossoms

Higher-education work involves more than simply designing classrooms, Roberts notes. It includes recreational facilities, science and



PROJECT SPOTLIGHT

Hiett Residence Hall, Lawrence University

Location: *Appleton, Wis.*

Project Type: *Dormitory*

Area: *79,500 square feet*

Designer: *VOA Associates Inc.*

Owner: *Lawrence University*

Contractor: *Oscar J. Bolt Construction, Appleton, Wis.*

Precaster: *Stonecast Products Inc., Germantown, Wis.*

Description: *To expand the number of types of housing options available to students, administrators commissioned VOA to design a four-story residence hall on a bluff along the Fox River with spectacular southwest views to locks, spillways and a renovated paper mill. The building features two wings with a central entrance and public spaces.*

Architectural precast concrete components were used as accent pieces at the entry, windows and doors on the brick-clad façade. Large coping walls were used with a variety of different radii to create visual interest. The precast cut a variety of templates to create the big components rather than piece together smaller ones to create the appearance of a radius. Approximately 500 pieces of precast were used in the project, with an acid-wash finish providing an earthtone finish.

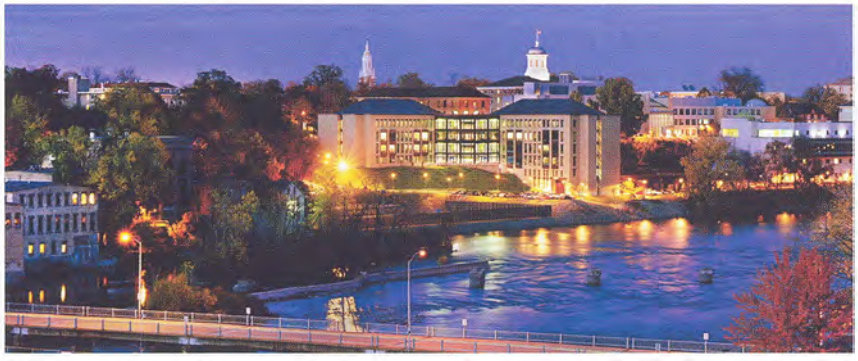
Each residential wing contains about 25 beds per floor with a mix of private rooms and suites. Bay windows promote the scenic views along the river or back to the campus. Among the environmentally friendly aspects of the project are room-occupancy sensors for lighting in public spaces, steam heat used in an in-floor radiant-heat system, ceilings with a high recycled content and a high-efficiency HVAC system.

technology laboratories, administrative offices and even retail. A recent project at the University of Illinois, which combined administrative offices with the campus bookstore, shows the multitude of functions that universities can require. "Higher-education work really includes four or five distinct building types," he notes.

That doesn't even include housing projects, which universities are building more often today as existing dormitories fall behind accepted standards and new concepts develop for housing of students. "When we design housing for a university, we can bring to it our expertise in commercial housing projects. That gives us a leg up on those architects who only do university housing work," he explains. "The cool thing is that university housing now extends to alumni retiring to the areas around their alma maters. So there are even more types of projects within that one category."

The same expansion has occurred with the company's cultural work, he notes. It recently designed a number of museum projects, including the Freedom Museum on the Magnificent Mile in Chicago and the Americans At War Museum in Washington, D.C., as well as a visitor-education center in Pella, Iowa, for the Army Corps of Engineers. But also included in that category is work on theaters, auditoriums, performing-arts facilities, community theater and specialized facilities such as the Shakespeare Theater at Navy Pier in Chicago.

"Our strength is that we are diverse but have a deep expertise



Hiett Hall at Lawrence University takes full advantage of its location along the Fox River in Wisconsin by fitting bay windows into the façade, which was accented with architectural precast concrete trim pieces along the windows, entry and other accent points. Photos: ©James Steinkamp, Photography.

'Higher-education work really includes four or five distinct building types.'



The new Outpatient Center at the Loyola University Health Center features architectural precast panels in two finishes on its exterior. The facility helped reorganize the organization's clinical services to add patient convenience.



PROJECT SPOTLIGHT

Loyola University Health Systems Outpatient Center

Location: *Maywood, Ill.*

Project Type: *Ambulatory care facility*

Area: *224,000 square feet*

Designer: *VOA Associates Inc.*

Owner: *Loyola University, Chicago*

Precaster: *International Concrete Products, Germantown, Wis. (For technical information on these projects, contact the precaster; see the Plant Certification listing on page 43.)*

Description: *Part of a campus of medical facilities, this $70-million project allowed Loyola to organize its various clinics to enhance patient convenience. It provides expanded ambulatory care for 14 clinical departments, as well as additional space for surgery and oncology needs and more facilities for diagnostic radiology and women's health services. Also included are a laboratory, optical shop and cafeteria.*

The building's exterior was designed to mirror the contemporary character of the life-enhancing interior space for the academic medical center. The building is clad in two colors of architectural precast concrete panels that blend with the other buildings on the campus. A sparkling gray mix consisted of granite sand and aggregate with a water-washed finish, the contrasting sparkling white mix featured granite sand with an etched finish.

The panels feature a number of distinctive features, including 2'6" to 3'8" returns cast into the panels and a 15-degree pitched return cast into the east end of the radiused ambulatory area. Some 20-foot-high panels also featured 2'6" pitched returns. Another distinctive approach was to combine several L-shaped panels to form a U-shape. Additional panels in the ambulatory area and in the loading dock created an erection challenge because of the restrictive space.

About 212 architectural precast pieces, encompassing 40,532 square feet, were used in the project.

in each type of building project. So we're never going to be doing a project type for the first time," he says. "And we can relate our work to the context of all of our expertise within that market."

Clients Demand More

Such expertise is needed today, he notes, because clients are making more demands. "Clients are much more sophisticated today about the design and construction process," he says. Typically, VOA designers will deal with a CEO or CFO, or a program manager who has been hired to control the project. "It doesn't change our responsibility in the design process, but we do have to focus on ensuring that we have made it convenient for them to work with us and that we can make the design as efficient as possible."

That sophistication is leading clients to expect more than ever before. "Clients expect you to be perfect," he says. "They want the



project on budget and on time, and that's a level of expectation that you have to bring to the table. Clients are selecting architectural firms based on their ability to expedite a project while also bringing them a beautiful, functional building."

Efficiency is often measured by the speed of design and construction today, he notes. This includes maneuvering through the regulatory process. "Projects are increasingly time-sensitive, so we have to ensure there are no delays for building permits or public-health requirements. Time is of the essence on every project, and it is an absolute expectation."

The demand for speed is driven by the large amount of investment capital being spent on these markets, he says. "Everything is geared to creating a shorter time frame for construction while still developing a quality project. That's our goal, because that's our client's goal. The sooner they get in and start returning revenue, the faster the project will be a success. And we are tied to that."

Precast concrete is a particular help in meeting the efficiency needs expected in today's market, he adds. "I don't think there's a single building type we're involved with where we haven't used precast concrete," he says. "We like it because of the image of permanence it can project. It has an institutional, solid quality. We also like its modularity. You get the characteristics of a strong substance like stone, yet it's plastic."

The material's ability to help speed up construction schedules is a key benefit, he notes. "We talk with precasters during the design phase because they have very helpful suggestions on jointing and connections in particular. We know that to be a success, we have to design with the precasters in mind. We're tied up as a team, and if we work together, we can aid the speed of erection and all the other issues involving the façade."

The construction process today, he stresses, "is not a linear process anymore. We're still designing while the building is being erected in the field. We're designing on the fly, which is why we like working with precast concrete so much. We often send our architects to the precaster's office to look at shop drawings and work out details. That can still be going on while the building is being erected from a structural standpoint and the GMP [Gross Maximum Price] is completed. While that is underway, we can work with the precaster to create ways to cast, transport and attach panels. We don't

'We talk with precasters during the design phase because they have very helpful suggestions.'



The Integrated Operational Support facility at Maxwell-Gunter Air Force base in Montgomery, Ala., features architectural precast concrete wall panels, which helped the project achieve LEED certification. Illustration: VOA Associates Incorporated.

PROJECT SPOTLIGHT

Integrated Operational Support (IOS Facility)

Location: *Montgomery, Ala.*

Project Type: *Secure office building*

Area: *53,580 square feet*

Designer: *VOA Associates Inc.*

Owner: *Maxwell-Gunter Air Force Base*

Construction Agent: *U.S. Army Corps of Engineers*

Contractor: *Bear Brothers Inc., Montgomery, Ala.*

Precaster: *Gate Precast Co., Oxford, N.C.*

Description: *This two-story secure office features concrete floor slabs and architectural precast concrete wall panels connected to a structural steel frame. The precast concrete components consisted of 133 pieces encompassing 29,430 square feet, with a light to medium sandblast finish.*

In addition to using precast concrete panels, the building incorporates a variety of other sustainable-design concepts and recyclable materials. The project was certified under the Leadership in Energy & Environmental Design (LEED) program with 28 points.

PROJECT SPOTLIGHT

Adventist Bolingbrook Hospital

Location: *Bolingbrook, Ill.*

Project Type: *Healthcare facility*

Area: *260,000 square feet*

Designer: *VOA Associates Inc.*

Owner: *Adventist Health System, Winter Park, Fla.*

Precaster: *Lombard Architectural Precast Products Co. (LAPPCO), Alsip, Ill.*

Description: *The hospital is an addition to the client's campus and was designed to enhance the patient's experience in receiving medical care from the facilities. The client wanted to achieve a strong image (as it faces a major interstate roadway) while also moving quickly through design and construction phases on an expedited schedule. Productivity and staff efficiency also were designated as priority objectives.*

To help achieve both the image and speed requirements, designers specified architectural precast concrete panels for the building's exterior. It serves as a frame for large expanses of glass that keep the interiors bright and welcoming. The two main wings of the hospital converge at a glass, multistory atrium that provides a central entry and waiting area. It features a treated glass panel that travels from floor to ceiling, suggesting a waterfall.



Adventist Bolingbrook Hospital used architectural precast concrete panels as cladding to help meet twin goals of projecting a strong, interesting image while meeting an expedited schedule. Illustrations: VOA Associates Incorporated.



need everything worked out when we give a GMP, because the precasters are good enough to cover the scope until we can determine the details that will save some of the cost."

The precaster's input is critical on the final drawings, he says. "We don't dictate, we bring in design ideas and talk with the precaster about how the project can be put together, what sections will look like and how we can efficiently transport them to the site."

Precast aids the project's speed in other ways as well, he adds. "Its ability to repeat any piece, regardless of shape, allows the components to be quickly manufactured, and we receive a high level of quality control. We have had few problems with pieces. We get a high consistency of material and color, and it attaches easily to the structure. All of that relates to the time required to complete the project."

The company takes full advantage of the expertise of its 240 employees in its various offices, creating teams led by a local principal on each project. On the Pella learning center, for instance, the principal was based in Orlando, Fla., while Roberts served as planning principal from Chicago. The structural/mechanical engineer worked from Peoria, Ill., the exhibit designer was based in Cincinnati, and the landscape architect worked from Des Moines, Iowa.

"There's nothing like face-to-face contact, but we can do a lot today via FTP sites and virtual communication," he says. "It allows us to tap into all of our expertise to remain on time and on budget. We need to provide the best team of experts



with the best background for each project."

Markets Will Remain Strong

Roberts expects that expertise to be needed even more in the future, as clients' demands increase and the need for speed continues. He also expects the company's work to continue to grow. "There is a lot of money available for development today," he says. "We hear people saying the market could turn the corner, but we don't see a slowdown on the horizon in any of our markets. We expect them all to remain strong."

Several, in fact, are growing quickly. "Hospitality projects have gone through the roof," he says. "A large number are being created or are repositioning." The company is working on hospitality projects not only in America but also in the Caribbean, Beijing City, China and Ras al Khaimah, UAE. "It's a very diversified market, especially at the

PROJECT SPOTLIGHT

Lombard Convention Center & Hotel

Location: *Lombard, Ill.*

Project Type: *Hotel and convention and conference center plus parking structure.*

Area: *422,200 square feet*

Designer: *VOA Associates Inc.*

Owner: *Mid America Realty, Chicago*

Contractor: *Walsh Construction, Chicago*

Precaster: *ATMI Precast, Aurora, Ill. (structural precast and tower panels); Lombard Architectural Precast Products Co. (LAPPCO), Alsip, Ill. (base architectural precast panels).*

Description: *This 500-room hotel is complemented by 50,000 net square feet of convention and conference facilities plus support areas, restaurants and a multi-level parking structure for 675 cars. The project sits on 6.69 acres and includes site improvements and landscaping, as well as at-grade parking.*

Designers used a total precast concrete system for the top 18 stories in the project. They are supported by a cast-in-place structural system for the first two floors. The precast levels feature 8-inch solid structural panels that support 10-inch hollow-core slabs that span 28 feet. The panels typically were 28 feet long and 10 feet high and featured two punched windows in each unit. A few corner panels spanned 36 feet, with mitered corners to create a tight corner. The panels were painted in the plant in two colors, white and light gray, so they could be shipped vertically to the site and erected immediately.

The parapet at the top of the building features vertical panels to clad the two-story feature. Those panels, finished similarly to the others, are 14 feet wide and 25 feet tall. The lower two levels feature architectural precast concrete panels connected to the cast-in-place columns in a similar finish to the higher structural pieces. They were supplied by a different precaster in the area. Erection of the hotel tower was completed in October.

'We don't dictate, we bring in design ideas and talk with the precaster.'



The Lombard Convention Center & Hotel in Lombard, Ill., features a total precast structural system for its top 18 floors, using structural panels and hollow-core slabs. The first two levels feature architectural precast concrete cladding on cast-in-place columns. Illustration: VOA Associates Incorporated.

PROJECT SPOTLIGHT

Pershing Courts

Location: *Chicago*

Project Type: *Multifamily housing*

Designer: *VOA Associates Inc.*

Owner: *Chicago Housing Authority*

Precaster: *Stonecast Products Inc., Germantown, Wis.*

Description: *This $13.2-million apartment rental building on Chicago's south side contains 80 units, including 20 public-housing replacement units and 60 market-rate units.*

The five-story project features architectural precast concrete panels along its base, as well as for window headers and sills and for coping at the roof. Structural pieces used in the entry replicate the accent pieces used throughout. These decorations resembled triangles pointing up, and they were designed to complement the other accents in the façade. The triangular insets were created to provide dimension and create shadow lines as the sun passed over the building, adding visual interest.

About 1,000 precast concrete pieces were used in the project, with two colors of concrete used to create an appealing appearance. The panels received an acid-wash finish, which was reviewed by the architects via mockup panels prior to casting.



The Pershing Court multifamily residential units in Chicago used precast concrete components for accent pieces around windows and at the roofline, using two colors of finish to create a contrast. Photos: ©James Steinkamp, Photography.



high end, and it never stops," he says. "Even the lower to medium end is expanding, especially with international firms such as Marriott, with which we do a lot of work. The hospitality market is booming all over the world."

Other strong markets are mixed-use and health care, he adds. "We see a lot of demand for healthcare facilities, and like education, it is becoming more diversified all the time." Hospitals are specializing more, and that specialization brings unique needs that can be designed into the facility to ensure it's efficient for its purposes.

That growth gives VOA chances for its own growth, he notes. "Our goal is to serve our clients and then look at opportunities for our people and for the rest of the market," says Roberts. He points to the firm's Arlington, Va., office, which was opened in 2001 when a principal expressed an interest in staying in the area after a project was completed. "When there is a project plus opportunity, we look to see if we can create a long-term presence."

The Sao Paulo and Dubai offices indicate that the firm is not tied to domestic locations, and its work in China and other international sites gives it a foothold for expansion. "There are ripe opportunities in many overseas markets for us," he says. Likewise, projects underway in California and the Southwest make both areas strong possibilities for expanding the firm's work to new regions.

As the company establishes itself in those new regions and countries, and begins work with clients, there is no doubt that it will find ways to expand its expertise and create micro opportunities within the macro market that gave it entry to new possibilities. ■

For more information on this or other projects visit *www.pci.org/ascent.*

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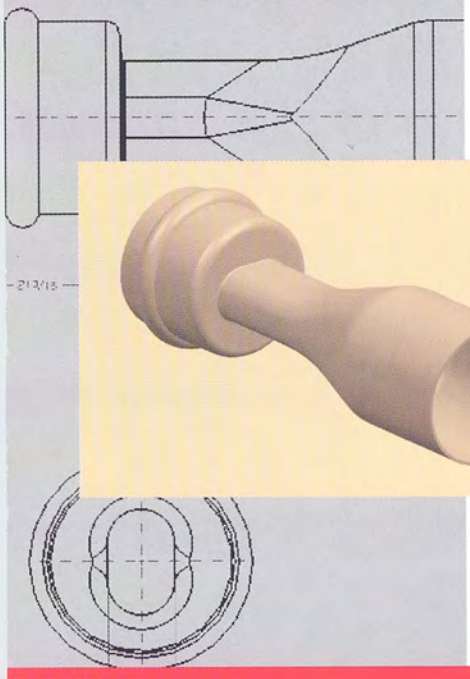
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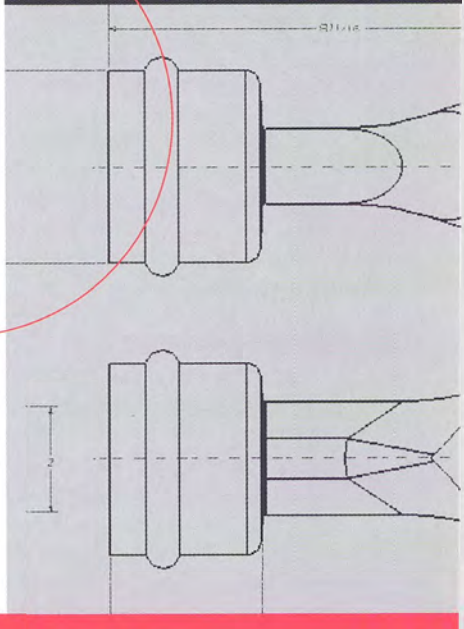


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Precast Concrete Achieves Sustainability Goals

CH2M Hill World Headquarters, Englewood, Colo., Architect: Barber Architecture, Denver.

Sustainability has become a watchword for owners and architects when designing new buildings, intermingled with terms such as "environmental friendliness" and "green building."

Today's green-building approaches extend beyond the ability to renew or recycle resources and examine the embodied energy required to make use of that material. This accounting practice encompasses all the energy necessary to manufacture, deliver and install the product. This includes the fuel to extract materials, finish them and transport them to the site.

While other building materials may have to alter their configurations or properties to be applicable to sustainable structures, precast concrete's inherent composition provides natural advantages for sustainability. It contributes by incorporating integrated design, efficient use of materials, and the reduction of construction waste, site disturbance and noise.

Precast concrete components can maximize benefits from integrated-design strategies, which focus on all of the building's materials and systems, as well as how they interact. An integrated-design strategy embracing sustainable concepts encompasses three ways to minimize material use:

1. Reduce the amount of material used and the toxicity of waste materials. Precast concrete can be designed to optimize or lessen the amount of concrete used. Industrial wastes such as slag cement and silica fume can be incorporated into the mix, reducing the amount of cement, which in turn reduces CO_2 emissions. As a manufactured product created under controlled conditions in the plant, precast concrete generates low amounts of waste, and the waste generated has low toxicity.

2. Reuse and repair products. Precast concrete panels can be reused when buildings are expanded. Concrete pieces from demolished structures also can be reused in other applications. Because the precast process is self-contained, formwork and finishing materials are reused. Wood or fiberglass forms can generally be used 40 to 50 times without major maintenance, while concrete and steel forms have practically unlimited service lives.

3. Recycle and use products with recycled content. Concrete can be recycled as fill or road base. Wood and steel forms are recycled when they become worn or obsolete. Virtually all reinforcing steel is made from recycled steel. Many cement plants burn waste-derived fuels such as spent solvents, used oils and tires.

Precast concrete can help buildings in a variety of ways to achieve the standards created by the Leadership in Energy & Environmental Design (LEED) building-rating system. The LEED system's points create a framework for assessing building performance and meeting sustainability goals.

Appropriate use of precast concrete components can help a building earn up to 27 LEED points, one more than is required for LEED certification (a chart that oulines these points is available at *www.pci.org/ascent*). The attributes and capabilities of precast concrete that help meet LEED certification vary by the intent of each category. The key applications center on these attributes:

Durability

Precast concrete panels provide a long service life due to their durable and low-maintenance concrete surfaces. A precast concrete shell can be left in place when the building interior is renovated. Yearly maintenance should include inspection and, if necessary, repair of joint material.

Modular and sandwich-panel construction with precast concrete exterior and interior walls provides long-term durability inside and out. Precast concrete construction creates the opportunity to refurbish the building if its use or function changes rather than tearing it down to start anew.

Precast concrete's inherent composition allows it to naturally achieve sustainability.

These characteristics decrease the contribution of solid waste to landfills, and reduce the depletion of natural resources and production of air and water pollution caused by new construction.

Mitigating Urban Heat Islands

Cities and urban areas are 3 °F to 8 °F warmer than surrounding areas due to buildings and pavements taking the place of vegetation. The ability of a material to reflect solar heat is called albedo, and the higher the material's albedo, the better it reflects.

Concrete has a relatively high albedo. Traditional portland-cement concrete generally has an albedo or solar reflectance of approximately 0.4 to 0.5.

Precast Concrete Production

The production of precast concrete has many environmental benefits, including:

- Less material is required because precise mixture proportions and tighter tolerances are achieved.
- Optimal insulation levels can be incorporated into sandwich wall panels.
- Waste materials are more likely to be recycled.
- Gray water can be recycled into future mixtures.
- Hardened concrete is recycled (about 5% to 20% of aggregate in precast concrete can be recycled concrete).
- Sand used for finishing surfaces is reused.
- Steel forms and other materials are reused.
- Less dust and waste are created at the construction site because only needed precast concrete elements are delivered.
- There is no debris from formwork and associated fasteners.
- Fewer trucks and less time are required for construction because concrete is made off-site.
- Precast concrete units are normally large components, so greater portions of the building are completed with each activity.
- Less noise occurs at the construction site because concrete is made off-site.
- Less concrete generally is used in precast buildings compared to other concrete buildings because of the optimization of materials. A properly designed precast concrete system will result in smaller structural members, longer spans and less material used on-site. This creates economic and environmental savings.

Constituent Materials

Concrete contributes to a sustainable environment because it does not use scarce resources. It consists of only a few ingredients, primarily cement, water, large and small aggregates, and admixtures, all of which are abundant locally. Although portland cement, a key ingredient, is energy intensive, the U.S. cement industry has reduced energy usage per ton of cement by 35% since 1972. Fly ash, slag cement and silica fume can be used to replace portland cement content.

Aggregates, which make up about 85% of concrete, generally consist of materials that require low levels of energy to produce, comprising local, naturally occurring sand and stone. Their benefits can be further improved by using blast-furnace slag or recycled concrete as aggregates.

Local Ingredients

The use of local materials reduces the transportation needs for heavy building materials, along with the associated energy and emissions. Most precast concrete plants are within 200 miles of a building site. The cement, aggregates and reinforcing steel used to fabricate precast concrete components, along with the raw materials used to manufacture cement, are usually obtained or extracted from sources within 200 miles of the precast concrete plant.

Energy Conservation

Energy conservation is a key tenet of sustainability. About 90% of the energy used during a building's life is attributed to heating, cooling and other utilities. The remaining 10% is attributed to manufacturing materials,construction, maintenance, replacement of components and demolition.

Precast concrete's inherent capabilities to provide energy efficiency rely on the high thermal mass of the material, which benefits exterior wall applications. Mass works well on the inside surfaces by absorbing the heat gains generated by people and equipment indoors. Light-colored precast concrete will reduce energy costs associated with indoor and outdoor lighting. The more reflective surfaces will reduce the amount of fixtures and lighting required.

Indoor Air Quality

Concrete contains low to negligible Volatile Organic Compounds (VOCs). These compounds degrade indoor air quality when they off-gas from new products such as interior finishings, carpet and furniture. Manufactured wood products such as laminate, particleboard, hardboard siding and treated wood can also lead to off-gassing. In addition, VOCs combine with other chemicals in the air to form ground-level ozone.

Polished concrete floors do not require carpeting. Exposed concrete walls do not require finishing materials. The VOCs in concrete construction can be minimized further by using low-VOC materials for form-release agents, curing compounds, damp-proofing materials, wall and floor coatings and primers, membranes, sealers and water repellants.

Concrete is not damaged by moisture and does not provide nutrients for mold growth.

The concrete industry has LEED-experienced professionals available to assist teams with concrete applications and help maximize points for concrete. An additional point is available if a principal participant of the project team is a LEED-Accredited Professional. ■

Sustainable Projects Utilize Precast Concrete's Benefits

— Craig A. Shutt

Designers looking to create energy-saving, sustainable designs are incorporating precast concrete with other innovative concepts



2930 Eisenhower Offices
Alexandria, Va.
Davis Carter Scott Ltd., McLean, Va.



Photo: ©2005 Boris Feldblyum

Navy League Building
Arlington, Va.
E.K. Fox & Associates Ltd., Fairfax, Va.

'Precast is an incredibly durable material that needs no maintenance.'



Pennington Street Garage
Tuscon, Ariz.
Dick & Fritsche Design Group, Phoenix

Building owners in every region are looking to enhance their projects' energy-saving methods, and they are encouraging designers to incorporate every aspect of sustainable design possible. In many cases, designers are finding that precast concrete components are helping them achieve the conservation goals owners are seeking, in conjunction with other innovative systems.

"We like precast concrete quite a bit," says Satish Bhide, project director for Davis Carter Scott Ltd. in McLean, Va., which recently designed the 2930 Eisenhower Avenue Office Building in Alexandria, Va. "It's an incredibly durable material that needs no maintenance. It will still look good in 20 years, which eliminates a lot of upkeep that saves money and labor. There also will be no moisture penetration, such as you would get by using brick, with its 10,000 joints."

Architectural precast concrete cladding was used on the structure, which also features an innovative geothermal HVAC system that will pay for itself in five years, Bhide says. The project recently received an award from the National Association of Industrial & Office Properties (NAIOP) for its architectural design.

Michael Schmitt, project designer for Dick & Fritsche Design Group in Phoenix, agrees that precast concrete can aid sustainable designs. "Precast concrete is a very sustainable product because you never have to change it or even maintain it. It will be there forever," he says. His firm recently designed a seven-level, 256,300-square-foot parking structure in Tucson, Ariz., featuring a total precast concrete structure.

To decrease its energy footprint, a creative 5,000-square-foot array of photovoltaic panels was added at roof level to both generate electricity and shade the roof from heat gain. Additional sustainable attributes also were incorporated throughout the project, which includes office space and retail on the first floor. "The owner is a forward-thinking organization, with a self-imposed responsibility to demonstrate the advantages of 'green architecture' and sustainability," Schmitt explains.

Even more sustainable features were incorporated into the Navy League Building in Arlington, Va., owing to that community's pilot program for offering density credits. Buildings that meet high sustainability goals can add density to their projects, explains James Wright, principal in charge and project designer at Page Southerland Page LLP in Arlington. Designing to achieve those credits created a high-stakes gamble, he notes, as the owner had to post a $250,000 bond and risked not receiving a certificate of occupancy if the sustainable aspects fell short and the density was too high without the credit.

But the project, which includes architectural precast concrete wall panels, spandrels and column covers, not only met the sustainable goals but achieved a high Silver LEED rating. Designers now are working with USGBC to review the building's

Fact Sheet

Project: *2930 Eisenhower Avenue Offices*

Type: *Class A office building*

Location: *Alexandria, Va.*

Designer: *Davis Carter Scott Ltd., McLean, Va.*

Engineer: *Fernandez & Associates, Falls Church, Va.*

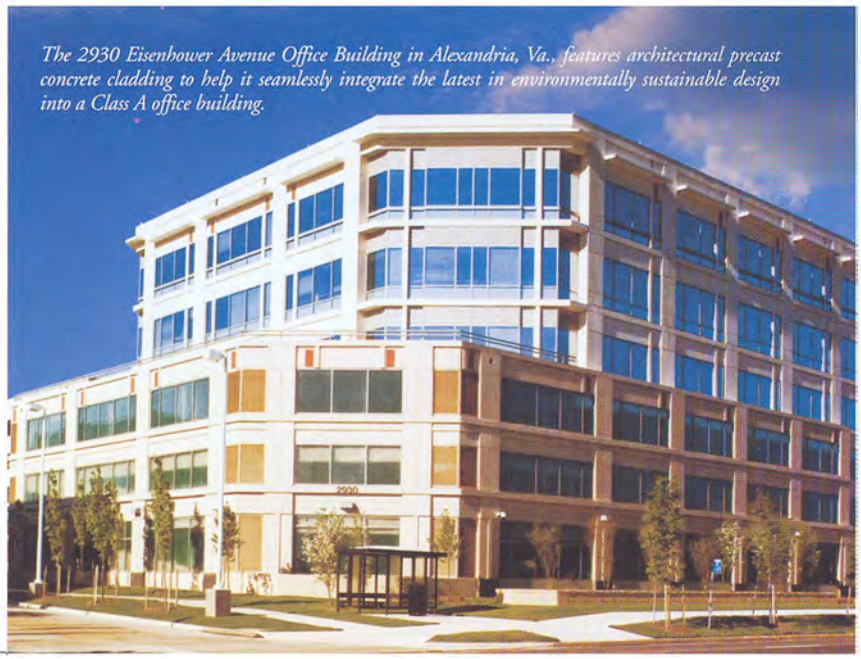
Contractor: *Harvey-Cleary Engineers & Builders, Gaithersburg, Md.*

Precaster: *Gate Precast Co., Oxford, N.C.*

Project Size: *184,277 square feet (including 109,351 square feet of parking)*

Precast Components: *529 architectural precast panels*

Project Cost: *$17.67 million*



The 2930 Eisenhower Avenue Office Building in Alexandria, Va., features architectural precast concrete cladding to help it seamlessly integrate the latest in environmentally sustainable design into a Class A office building.

attributes to gain the additional point needed for a Gold rating. "When it came to deciding on the building's cladding, we never seriously considered anything else," Wright says.

2930 Eisenhower Avenue Offices

The office building at 2930 Eisenhower Avenue seamlessly integrates the latest in environmentally sustainable design into a Class A office building that offers nearly 75,000 square feet of office space and 285 parking spaces. The project went through several public hearings to finalize the design, Bhide notes, and faced a variety of site restrictions for construction crews. The ultimate design features one below-grade level of parking, three more parking levels above that and three levels of office space on top.

The designers also incorporated a geothermal HVAC system, the first to be used in Alexandria. "Being the first of its kind, the project went through a rigorous architectural-review process, which also included a separate Development & Special Use permitting process in the city," he explains.

A key concern was the three levels of above-grade parking. Officials were concerned that such a highly functional parking structure above ground level might detract from the aesthetics of the surrounding neighborhood, which featured more traditional designs. The designers used architectural precast concrete panels to achieve the look that was desired, creating a fenestration pattern that replicated the appearance of the higher office levels.

Translucent glass was used in the window openings on the parking levels to provide the look of finished office space both during the day and at night. The panels were erected onto post-tensioned concrete beams placed 20 feet on-center with mild steel slab infill with column-free space between the core and the skin.

The geothermal system required 48 holes to be dug 150 feet deep to create geo-wells. The system of wells provides an efficient way to absorb heat in the winter and reduce heat gain in the summer, because the Earth remains approximately 65 °F year-round at depths below the frost line, Bhide explains. This system allows the building to maintain optimal fluid temperatures for a heat-pump application.

Although the project was not LEED certified, it would have garnered many points, Bhide says. Precast would have helped with a number of those, including energy efficiency and locally manufactured products. "Transportation costs for the material were minimal," he says. Gate Precast Co. in Oxford, N.C., provided the 529 precast concrete components.

The project had a "rigorous" 13-month, fast-track construction schedule, he adds, which required close contact with owner, development manager, contractor, and precaster to keep the work on budget and on schedule. "By getting early input from all disciplines, revisions to the construction documents were kept to a minimum, preserving the aggressive construction schedule."

The project indicates that it isn't necessary to sacrifice economic and environmental sustainability to accommodate development and growth, Bhide stresses, even in existing, long-time neighborhoods with sensitive design needs.

Pennington Street Garage

Even parking structures can achieve sustainable design goals. That was the case with the Pennington Street Garage in Tucson, where designers looked at every aspect of the 750-car parking structure, which includes 12,000 square feet of first-floor space split evenly between offices and a restaurant.

A key factor in using precast concrete was the constraints of the site, says Schmitt. Surrounded by busy streets on three sides and a historic building on the other, there was little room to maneuver. "A cast-in-place concrete solution would have required room to stage formwork and do other things that we didn't have room for," he says. "To be able to manufacture the pieces off-site, truck them in and set them in place was a big benefit."

Tpac, a division of Kiewit Western Co. in Phoenix, manufactured and erected the precast components. The total comprised double tees, tee and

L beams, columns, wall panels, shear walls and ramp beams. The structure was set on 60-foot-deep, cast-in-place concrete drilled caisson foundations, with steel rooftop canopies providing shade on top.

Several structural systems were considered, Schmitt notes, but "it became apparent early in the process that precast, prestressed concrete would best serve the needs of the schedule and program." Key factors were that the design-build process allowed the design-builder to select and award the precast contract early in the design phase. This early award allowed the precaster to work closely with the design-build team through the design process, producing shop drawings concurrent with the architect's design schedule. "This alone shaved several months off the project schedule, allowing precast fabrication during the permit-review process," he says.

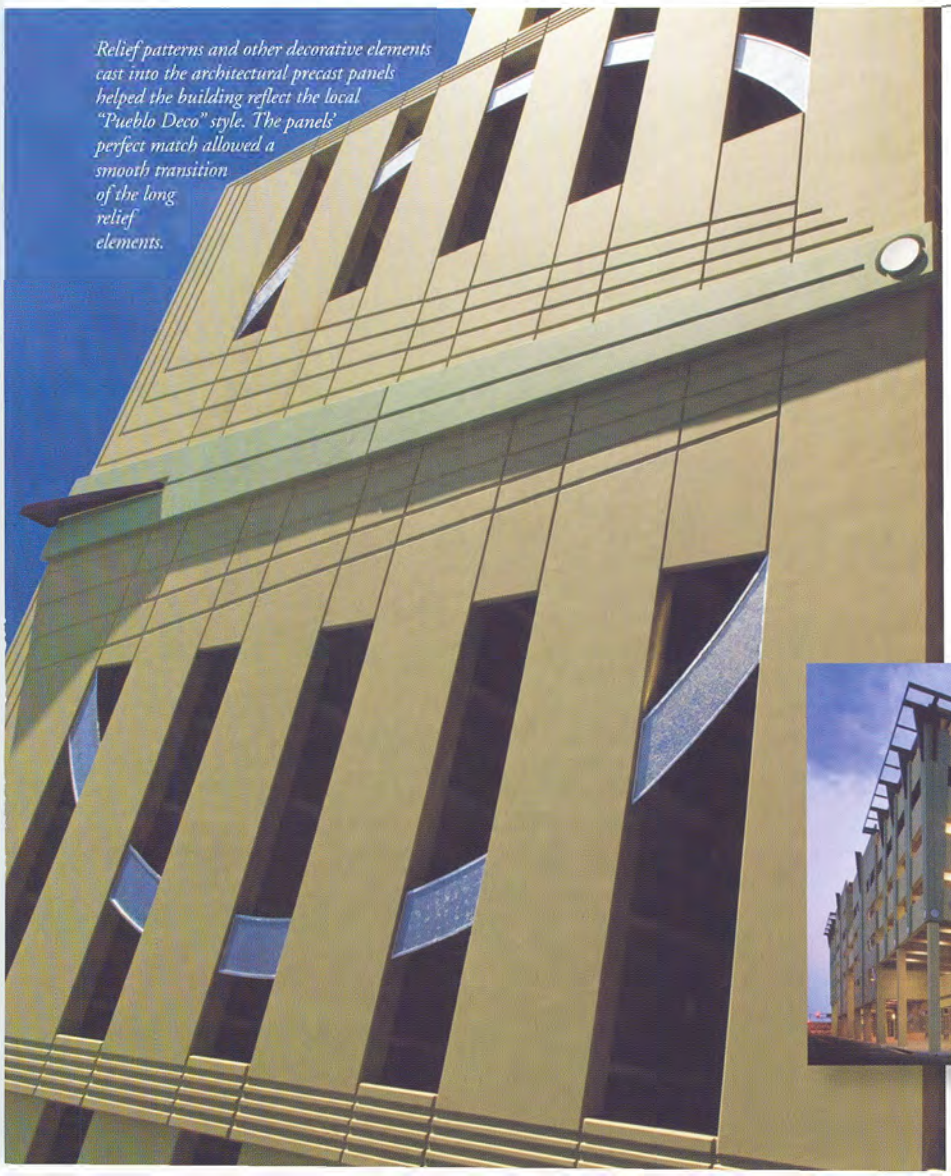
The neighborhood's distinctive style also played to precast concrete's benefits, he adds. The surrounding buildings feature a period look known locally as "Pueblo Deco," a stylized Southwestern interpretation of the 1930s Art Deco architecture.

The design features carefully coordinated reveals and articulation of columns and spandrel panels to create complex patterns on the building elevations that complement the Pueblo Deco styling. "The precision achieved through the precast-manufacturing process allowed reveals on various adjacent panels to align perfectly, forming the desired patterns," he says.

The precaster's plant, about 100 miles away, delivered components on a just-in-time basis to the congested site without difficulty, Schmitt notes. "Because the major structural components did not have to be stockpiled on-site, the contractor was able to work from within the very tight urban site, minimizing impact on the adjacent streets."

Precast aided with more than providing locally manufactured materials. The precast structure was designed to support the loads that will be imposed by overhead trolley power lines, which will be used with a proposed trolley system on the adjacent street. That will save future material use and maintenance needs. The elevator lobby at the center of the structure's north elevation was designed as a multimodal transit stop at the facility, allowing drivers to gain access to the trolley and bus system easily and avoid further driving.

The existing concrete building on the site was demolished to open up the site, and its concrete debris was crushed on-site and used as engineered fill material to fill in the former basement level. That saved



Relief patterns and other decorative elements cast into the architectural precast panels helped the building reflect the local "Pueblo Deco" style. The panels' perfect match allowed a smooth transition of the long relief elements.

Fact Sheet

Project: *Pennington Street Garage*

Type: *Mixed-use structure (parking with office and restaurant)*

Location: *Tucson, Ariz.*

Designer: *Dick & Fritsche Design Group, Phoenix*

Engineer: *Paul Koehler Structural Engineers, Scottsdale, Ariz.*

Contractor: *D.L. Withers Construction, Phoenix*

Owner: *City of Tucson*

Precaster: *T-PAC Inc., Phoenix*

Project Size: *256,300 square feet*

Precast Components: *771 pieces for total precast concrete structural system and façade*

Project Cost: *$10.35 million*



time, material and cost for both importing fill and exporting debris, Schmitt notes.

A key sustainable aspect focused on the inclusion of a 5,000-square-foot array of photovoltaic panels on the roof. With Arizona's abundance of clear, sunny days, these panels generate enough electricity to provide a majority of the power needed to light the facility. Mounted on an overhead steel framework, they also shade rooftop parking spaces.

Navy League Building

The seven-story Navy League Building provides 212,947 square feet of Class A office space, with extensive street-level retail space and four levels of underground parking. The owners use about 10% of the space, with other tenants using the remainder, making it a speculative office project.

Architectural precast concrete panels were chosen for cladding due to their inherent design flexibility and sense of dignity and permanence, he says. "It was necessary to give the building a great deal of architectural detail and character due to its extreme prominence within an active, energized community. We were admonished not to create 'flat' façades, because many of the buildings around us had taken that approach, and they wanted to avoid that. They really raised the bar on the façade design."

As a result, the design features a significant level of dimensional focus, including heavy vertical projections. Three mix designs were used with two finishes: white precast with embedded granite panels and a light acid-wash finish at the lower levels, with two buff-colored mixed with medium acid-wash finishes above.



The Navy League Building features architectural precast concrete panels for its cladding, designed to emphasize the building's verticality and provide decorative interest. It achieved a high Silver rating in the LEED classification system, using a variety of sustainable design techniques.
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Fact Sheet

Project: *Navy League Building*

Type: *Class A speculative office building*

Location: *Arlington, Va.*

Designer: *Page Southerland Page LLP, Arlington*

Engineer of Record: *E.K. Fox & Associates Ltd., Fairfax, Va.*

Structural Engineer: *ReStl Designers Inc., Gaithersburg, Md.*

Contractor: *James G. Davis Construction Corp., Rockville, Md.*

Owner: *Navy League Building LLC, Arlington*

Precaster: *Gate Precast Co., Oxford, N.C.*

Project Size: *212,947 square feet (including four levels of parking)*

Precast Components: *691 spandrel panels, wall panels and columns covers*

Project Cost: *$28.67 million*

Four spandrel panels have molded lettering showing the building name and address.

"Precast concrete offered the ability to create a rich architectural vocabulary of façade elements establishing the appropriate scale and image sought by the community, the local governing authorities and the owner," he says. The speed of construction also was a benefit, as the owners wanted to minimize construction time in this highly congested area. "We worked closely with the precaster to minimize the number of pieces that were needed, which sped up casting and erection, and saved money."

The precast also reinforced the project's sustainable strategy in a variety of ways, he says. In addition to offering locally manufactured materials, the precast panels worked in conjunction with windows outfitted with low-emissivity film to reduce energy costs. "Precast's thermal mass makes a fabulous insulator. The sun keeps it warm at night and maintains the heat to take load off the mechanical system." Analysis of the building showed that energy requirements will provide more than a 25% improvement over the standard represented in ASHRAE 90.1, "largely due to precast concrete's insulating properties." (For more on analyzing a building's energy signature, see the story on page 26.)

The project also features an innovative water-detention system that captures storm water and ground water for reuse in bathrooms and for landscaping. Potable water use for sewage conveyance was eliminated, and water-saving plumbing fixtures will reduce water usage by more than 77%.

All of those elements worked together to help the project achieve its high Silver—and possibly Gold—LEED rating and allow increased density in a congested area. "Precast concrete gave the project a sense of permanence, durability and dignity that was important in this area, as well as helping to meet LEED criteria," he says.

These projects show the creative ways that building owners are boosting the energy-saving and sustainable-design aspects of their projects. Precast concrete components are one element in those savings that can ensure the structure meets all of its functional, aesthetic and budgetary goals for today, as well as for generations to come. ■

HAMILTON FORM CREATES FUNCTION

2 CASE STUDY

ESCAMBIA BAY BRIDGE



"The forms work perfectly. Hamilton Form builds high quality, well-thought-out forms that have contributed to the success of many of our projects."

Don Theobald
Vice President of Engineering
Gulf Coast Pre-Stress



The Challenge:

Gulf Coast Pre-Stress — which itself was reeling from Katrina's impact — was awarded four major bridge projects damaged by hurricanes, including Escambia Bay Bridge near Pensacola, Florida.

The bridge elements include a heavily reinforced pile cap with a unique "on-site," cast tension connection to the precast/prestressed pile. This *moment connection* was designed to provide a continuous beam configuration and provide resistance to uplift from potential future storm surges.

The Solution:

Hamilton Form built the custom formwork including the piling, pile cap and BT78 forms. The pile cap form design includes two-piece, tapered voids at the connection locations to allow the top to be "popped" after initial preset of the concrete to accommodate final stripping.

The Results:

The forms are working perfectly. The project is progressing within budget and ahead of schedule. The eastbound bridge opened 11 days early to the delight of motorist. The westbound bridge is scheduled to open in November 2007.

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Building-Envelope Studies Assist LEED Design

— Craig A. Shutt



A range of attributes must come together for a building to be certified under the Leadership in Energy & Environmental (LEED) standards of the U.S. Green Building Council. Thermal analyses and insulated precast concrete wall panels can help ensure that the most efficient design and construction methods are used.

First Jacksonville Project

An example of the impact building-envelope studies and the use of precast concrete can have on the LEED-certification process can be seen in the new Social Sciences Building at the University of North Florida (UNF) in Jacksonville, Fla. The precast concrete insulated sandwich wall panels were instrumental in the building attaining the city's first LEED certification. School administrators were so pleased with the outcome that they intend to follow similar construction methods and specifications on future buildings to meet LEED standards.

"We put some more money into the design, and that's sort of consistent with our environment," says John A. Delaney, UNF president. The school is set in a nature preserve, and administrators wanted to not only create an environmentally friendly project but ensure it blended with its "green" surroundings.

In fact, the university did not have to increase its budget significantly to create a green building, notes Mark A. Gelfo, a LEED-certified principal with LEED consultant TLC Engineering for Architecture in Jacksonville. "The premium hard and soft costs for achieving LEED certification were approximately 1% of the construction cost," he estimates. "There were a lot of UNF standards that already were green or sustainable, which helped contribute to the point total."

Jacksonville, Fla., university uses thin-brick systems and thermal analysis along with precast concrete insulated wall panels to achieve certification



The $13.3-million, three-story project features 63,000 square feet of space, housing offices for faculty, staff and administration, as well as five conference rooms, lounges, and study areas. The centerpiece of the building is five regular and two theater-style classrooms and three teaching laboratories, all equipped with "smart" technology and wireless-communication systems.

The building features a variety of environmentally friendly aspects, including waterless urinals, an emphasis on natural light and energy-efficient heating and mechanical systems. It uses recycled water for irrigation and other needs while providing high energy efficiency.

Initially, designers planned to construct the building using a system of brick on steel studs structural system. But after an in-depth series of studies conducted by Dow Building Systems in conjunction with Gate Precast Co. in Jacksonville, designers were convinced to convert the exterior wall panels to a precast concrete sandwich wall-panel system featuring the Thermomass Building Insulation System.

"The UNF building is truly an achievement in sustainable construction using precast sandwich wall panels," says Brad Nesset, regional sales manager for Thermomass.

Withstanding Florida Extremes

The key concern was designing an envelope with a material that could withstand the extreme Florida temperatures and humidity. The campus previously had dealt with a mold and mildew issue with an existing building, so administrators were sensitive to those concerns. The precast system could reduce the risk and protect against vapor drive while also providing high thermal performance and interior comfort. The brick and steel-stud structure initially proposed featured highly conductive steel studs and brick ties, which reduced the R-value of the assembly under ASHRAE 90.1 standards while increasing the likelihood for moisture migration and infiltration.

"Even a slight thermal bridge through the insulation can reduce the overall thermal performance of a wall assembly tremendously," Nesset notes. "That can be critical with brick and steel-stud assemblies, which are thermally conductive, bridging the insulation and reducing the assembly's effective R-value."

In fact, an Isothermal Analysis determined the effective R-value of the wall assembly after all thermal bridges were taken into account, and found the original system was much less effective than expected. "The steady-state value of R-8.38 for the proposed brick and steel-stud structure was significantly less than the assumed material R-value of R-12.29—a reduction of approximately 30%," Nesset explains. The assumed R-value would have been used when sizing the mechanical equipment for the building and establishing code compliance.

The insulated precast panels provided no thermal short circuits, resulting in a constant, even, post-construction temperature. The panels also created a continuous vapor retarder, producing no potential locations for mold and mildew growth. "By designing a wall with nonconductive composite wall ties, edge-to-edge insulation, and no cavity, we removed thermal short circuits and convection looping," Nesset explains.



Fact Sheet

Project: *Social Sciences Building*

Type: *Classroom and offices*

Location: *Jacksonville, Fla.*

Designer: *Smith-McCrary, Jacksonville*

LEED Consultant: *TLC Engineering for Architecture, Orlando, Fla.*

Construction Manager: *Elkins Constructors Inc., Jacksonville*

Owner: *University of North Florida, Jacksonville*

Precaster: *Gate Precast Co., Monroeville, Ala.*

Project Size: *63,000 square feet*

Precast Components: *39,651 square feet of insulated precast concrete panels*

Project Cost: *$13.3 million*

The capabilities of the precast system were verified with thermal-imaging tools. This technology uses infrared rays to detect the amount of heat energy in a location. By collecting a thermal array, designers can determine if energy leaks are occurring and how much heat the walls are allowing to escape (or penetrate, if the interior is being imaged). This technology helps designers and owners ensure that they are using the best system possible for their project.

The insulated precast wall panels consisted of 2 inches of Styrofoam brand extruded polystyrene (XPS) insulation sandwiched between two wythes of concrete. The total thickness of the panels ranged from 10 to 12 inches, depending on the location and application, explains Jim Lewis, director of architectural systems for Gate Precast Co. in Jacksonville, Fla. Calculations showed that the high-mass system would provide a performance rating of R-24, significantly higher than the other system.

Lessons Learned

The design team achieved a significant accomplishment in certifying Jacksonville's first LEED project. But it learned several key lessons along the way:

1. Start Early. LEED certification did not become a goal until the program was developed, the site selected and the building form determined. Earlier planning could have allowed the building geometry and fenestration to further increase energy efficiency and achieve daylight and view credits.

2. Use an Integrated Team Approach. Include the entire design, construction and owner team from the beginning. Having all members on board, especially the contractor, contributed greatly to the success of the project.

3. Keep Improving Energy Efficiency. The building envelope, lighting systems and HVAC systems could have been designed with even greater energy efficiency if first costs could have been increased. The long-term costs would have offset that cost, and that can be a strong incentive for a building that is owned and operated by the client.

Brick Embedded In Panels

Most of the panels were finished with thin brick embedded in the panel face at Gate Precast's manufacturing facility in Monroeville, Ala. Other areas received a light sandblast finish to provide contrast with the brick. Some 39,651 square feet of panels were used in the project.

To create the brick façade, Gate Precast Co. used a newly developed formliner grid to hold the thin brick in place during casting. The sheets, which are peeled off after the panels are stripped from the forms, use 100% post-industrial recycled content, explains Lewis. "It's more costly, but it's a great product for this application and helps with several key LEED points."

Gelfo praised the in-depth analysis provided for the precast panels. "Gate Precast provided the best documentation for the LEED analysis of all the material suppliers," he says. "The entire precast wall system contributed greatly to the building's overall energy performance, along with HVAC and lighting." The result of this combination of systems was that the project is performing 34% above the minimum ASHRAE 90.1 requirement, he notes.

Early in the design process, a green-building design charette was held with the entire design and construction team to determine the "green goals" for the project and which LEED credits would be pursued. The goals included minimizing energy and water use, maximizing environmental quality and—most importantly—staying within budget.

'Credit Guardians' Named

Each member of the team was named a "Credit Guardian" for specific credits, including even ones that the team decided not to attempt to gain. The guardians reviewed, investigated and documented each credit, to ensure its requirements were being met (or could not be met) as the project progressed. The high-performance precast concrete insulated wall panels helped meet a number of the LEED criteria, including:

Energy & Atmosphere

Optimize Energy Performance:
The precast wall system maximized the thermal-mass effect of concrete, reducing the heating and cooling loads and providing an R-value (R-24) greater than what could be expected by the material alone or by what the code required.

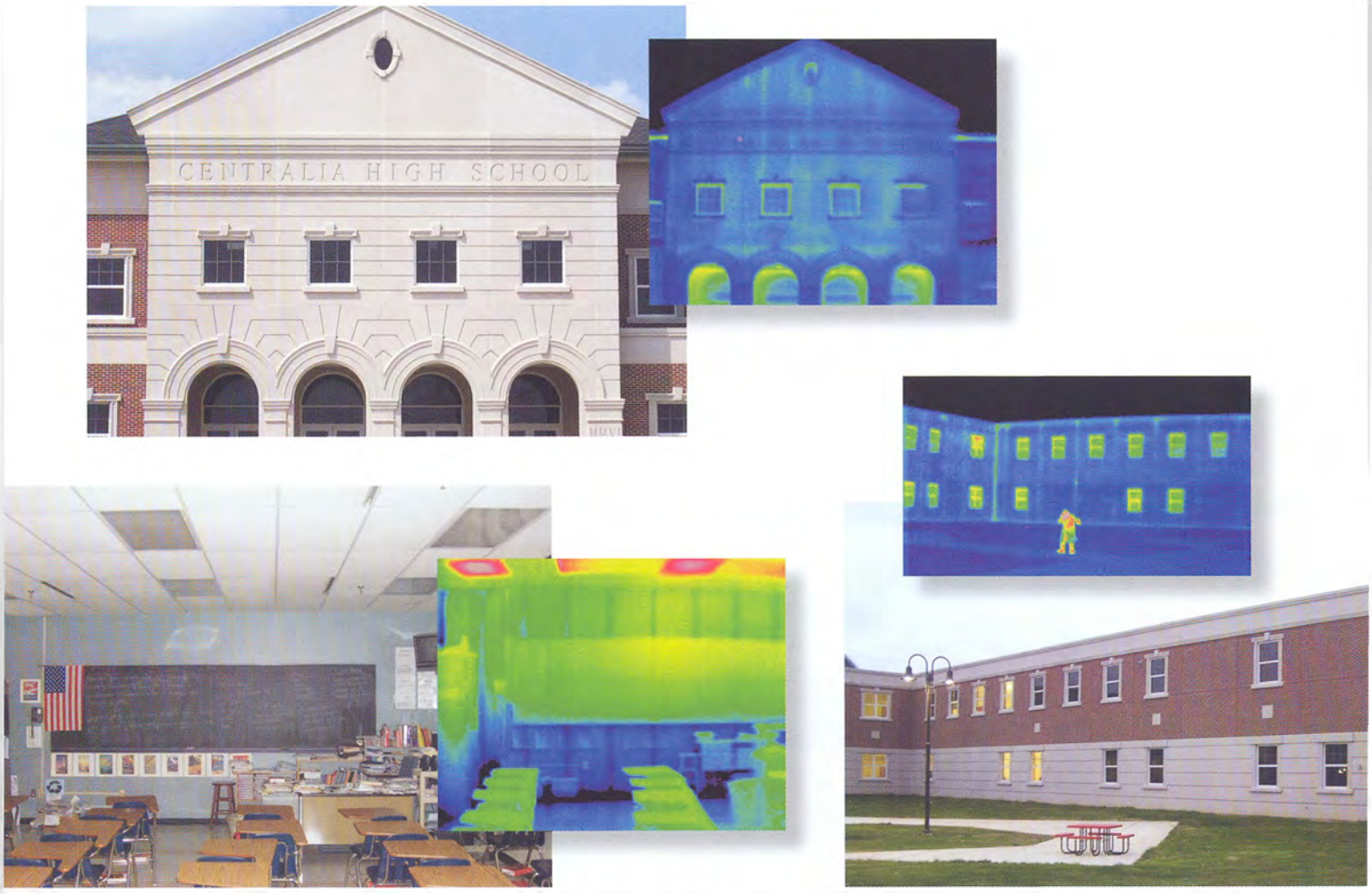
Materials & Resources

Building Reuse:
The wall panels will aid in extending the life cycle of the facility, reduce waste and environmental impacts and conserve resources. "The Social Sciences building was built to be a 100-year-plus facility, and the panels will help ensure it meets that goal," says Lewis.

Construction Waste Management:
The system's individual components all are 100% recyclable. Scrap materials were taken to a polystyrene recycling center and recycled into other products, diverting them from landfills. In addition, Gate diverted construction waste during production, crushing the 143 square feet of waste concrete in the plant and turning it into roadfill.

Recycled Content:
To reduce the impact from processing new virgin materials, the Styrofoam-brand XPS insulation contained up to 40% post-industrial recycled content. The reinforcing steel, wire mesh, steel connectors and white cement used in casting the panels also featured recycled content. Gray cement, which was used in the backup material for the panels, included silica fume and fly ash. (The additives could not be used with the white-cement mix, as they can alter the final color of the panels, Lewis says.)

Local/Regional Materials:
Manufacturing the precast panels at the local Gate plant reduced the environmental impacts of transportation. The thin brick also aided this reduction. As the bricks use less material, more can be packed on a delivery, and they weigh less. Approximately 65% of all materials used in the building were manufactured within 500 miles of the site, Gelfo says.



Thermal-imaging studies use infrared rays to detect the amount of heat energy in a location. These "after" images with precast concrete panels in place on a high-school project, show the low-heat blues and greens that are desired rather than the red/orange "hot spots" that indicate energy loss.

Indoor Environmental Air Quality

Construction IAQ Management Plan During Construction:
Installation methods for the precast wall panels were designed to help alleviate air-quality problems encountered during the construction process and to help sustain the comfort and well-being of construction workers. Since the panels were cast and cured off-site, they contributed no dust or airborne contaminants from drying or curing of compounds during the construction phase.

Thermal Comfort:
The USGBC encourages the construction industry to provide a thermally comfortable environment that supports productivity and well-being of building occupants. The panels effectively manage moisture and maintain a constant, even internal temperature.

Sustainable Sites

Site Development—Protect Or Restore Habitat:
The panels were erected with crawler cranes that were kept within 30 feet of the project, Lewis says, helping to minimize site disturbance and aid with this credit.

Heat Island Effect—Non-roof:
The panels helped raise the building's albedo, which is the amount of solar radiation the material reflects rather than absorbs. Gate used a high quantity of white cement in its design mix to enhance the albedo of the panels. The result was that 47.39% of the surface area qualified as having a high albedo rating, Lewis says.

"The high-performance precast wall panels provided exceptional performance, and we could confirm that to administrators and designers with independent analysis and our historical results," Nesset says.

It won't be the last such project at the university, Delaney says. "We're going to do the rest of our buildings in this same fashion from now on," he noted at a news conference. Planned "green" projects include a new student union, a parking-services facility, a housing project, the Brooks College of Health, and the College of Education & Human Services.

"I'm excited that the university is paving the way in Jacksonville with a new learning facility that is environmentally responsible," he says. "It's a healthy place for UNF students to learn and faculty and staff to work." ■



Clad to the Bone

— Wayne A. Endicott

The new façade of the 250 Park Avenue building is a welcome addition to a historic part of downtown Winter Park, Florida. Precast concrete panels not only gave the building a new face, but on the lower two floors, it actually increased the floor space.

Recladding with architectural precast panels can transform dated buildings into modern showplaces quickly and economically

When architects are commissioned to renovate the exterior façade of older buildings, they have myriad cladding options from which to choose. In the past, those options most often included glass curtain walls, aluminum panels, exterior insulation finish systems (EIFS) and brick masonry. But today, designers are realizing that architectural precast concrete wall panels offer many advantages for updating existing structures.

Designers on two recent renovation projects point to the advantages that make these panels a strong alternative. The benefits start with economy and include speed of construction and variety of aesthetic options. Unlike brick or masonry systems, no scaffolding is needed, and tradespeople are reduced at the site, keeping it less congested to cut costs and enhance safety. The work also can proceed even with the building still occupied and functioning. Perhaps best of all, it provides an exterior appearance that is high in quality and durability.

The two renovated projects are quite different. The first involved transforming a 1960s-era, 120,000-square-foot, six-story structure in historic downtown Winter Park, Fla., while the second featured a dynamic new look for a 12-story structure that faced a scenic plaza built after the building was originally constructed. The two illustrate the advantages that a carefully planned use of precast concrete can provide in renovating older buildings.

Creating A Neo-Classical Look

The 250 Park Avenue building in Winter Park is located in a quaint, historical downtown area. Designers at Baker Barrios Architects Inc. of Orlando, Florida, led by Principal and Project Architect Ray Acosta, were handed the task of providing the existing building with a neo-classical style that would complement the



Before renovation, the 250 Park Avenue building sported a nondescript steel and glass curtain wall.

Fact Sheet

Project: *250 Park Avenue*

Type: *Office building renovation*

Location: *Winter Park, Fla.*

Architect: *Baker Barrios Architects Inc., Orlando, Fla.*

Design Architects: *Associated Consulting International, Winter Park*

Engineer: *Bishop Engineering Co., Winter Park*

Engineer of Record: *Thompson Co. Inc., Winter Park*

General Contractor: *Jack Jennings & Sons, Orlando*

Owner: *Lincoln Property, Orlando*

Precaster: *Gate Precast Co., Kissimmee, Fla.*

Precast Specialty Engineer: *Leap Associates International, Tampa, Fla.*

Project Size: *120,000 square feet*

Precast Components: *356 pieces including column covers, spandrel panels and cornices, encompassing 38,352 square feet.*

Project Cost: *$13.6 million*

'By redesigning the façade with ornate precast panels, arched and punched windows, we were able to create a more classical look.'

surrounding historical architecture.

The designers initially intended to specify handset brick to reclad the structure. But it became apparent that this approach would require attaching a metal stud frame to the existing structure, with a cement board placed over the frame to create a flat surface for thin brick to be applied. Designers also explored the use of metal studs and EIFS. Although the cost was attractive, the final look would not meet the owner's goals.

As a result, the team turned to Gate Precast Co. in Kissimmee, Fla., which helped devise a more effective precast concrete solution. "We decided this approach offered several advantages," Acosta explains. "First, the building was 90% occupied, and we wanted to disrupt things as little as possible. Using precast concrete allowed the new exterior to essentially be built off-site and then be brought to the building and assembled. Also by redesigning the façade with ornate precast panels, arched and punched windows, we were able to create a more classical look."

The project was a first for the precaster, says Scott Robinson, southeast district vice president of sales and marketing for Gate. "We'd never been involved with a building that was not designed for precast concrete from the beginning," he says. "It's also the first time we've done this with an occupied building." To do so required a whole new approach.

The first step was to determine how best to attach the panels to the building. Crews drilled into the face of the existing structure and created a new exoskeleton by bolting and welding a steel-tube frame outside the existing walls and connecting it to the steel frame underneath. The precast walls then were attached to the new exoskeleton, using standard connections cast into the panels at Gate's plant. The building's existing substructure couldn't support new precast panels, so they were designed to be self-supporting. The new framework outside the walls serves merely to tie it to the existing structure.

Gate supplied 356 pieces of architectural precast concrete, totaling 38,352 square feet, including basic column covers, spandrels and cornice pieces. The overriding design feature of the building is the "old style" tavern-brick blend thin brick that was cast into the panels at the plant.

A unique challenge involved embedding an artistic detail into some of the façade pieces. The details featured reliefs of oranges that represent the owner's involvement in citrus farming. To accomplish this, Gates hired a local sculptor to create custom form liners. They were sculpted in plaster and then laid in forms to create a repetitious pattern in the spandrel arch panels that were supplied. Precast column covers complement the classical architectural theme.

The precast solution provided the owner with a high quality renovation while at the same time minimizing expense and increasing construction speed, even with the building at nearly full occupancy, Acosta notes.

Wachovia Renovation

Another project took advantage of GFRC panels in conjunction with wide expanses of glass curtain wall to create a totally new look for a building that had seen its neighborhood completely change since its original design.

Two Wachovia Center Main Building in downtown Charlotte, N.C., was built in the mid-1950s as a nine-story structure that was

'Structural codes, particularly for seismic and wind loads, had changed greatly since the building was built.'

expanded to 12 stories in the mid 1960s. The original exterior skin was replaced in the late 1970s, but by 2004, the building's systems and finishes had reached the end of their useful life, and more significant attention was needed. The company called on Little Diversified Architectural Consulting in Charlotte to determine the best approach.

Wachovia officials considered four options, explains Alice Olvera of Wachovia: a minor renovation to extend the building's useful life, a major renovation to bring the building up to Class A office standards, demolition and redevelopment of a completely new structure and demolition for later development. After studying the area and the potential for the building, a major renovation was decided upon.

The building is part of the Two Wachovia Center campus, a block-long complex that also includes the 30-story Two Wachovia Center Tower, the Wachovia Atrium and the Wachovia Plaza along the south side of the Main Building. Company officials wanted to take advantage of these newer spaces by better connecting the Main Building to the rest of the campus.

To accomplish this upgrade meant restructuring the building's façade, particularly the south wall facing the plaza. "It originally was a big, blank wall, behind which was housed all of the core systems—mechanical rooms, restrooms, stairs, elevators, etc.," explains John Walker, partner at Little. "There was no interconnection with the plaza, and so we looked at the opportunities that were available to integrate the building into the complex by shifting the core elements to the center of the building and opening up the south wall to the Plaza."

Original Structure Retained

The façade and roof were stripped off, leaving only the floor slabs and cast-in-place concrete columns. The reuse of that existing structure, which had been fairly light to support a cladding of marble and brick, limited the options for recladding the building, Walker notes. "Structural codes, particularly for seismic and wind loads, had changed greatly since the building was built," he says. To perform a major structural upgrade would have required significant bracing that would have been difficult to add onto the building. By creating a design that added no more than 5% to the loads in any structural element, the designers could maintain the existing system.

Architectural precast concrete panels were first considered, because they could provide an appearance that blended with the other adjacent structures. But precast concrete proved too heavy for the existing structural system. Instead, the designers chose GFRC to achieve the benefits of precast concrete with a lighter weight.

The goal was to create an appearance that offered a "kinship" to the 31-story Wachovia Center Tower. That structure is clad with Mount Airy Granite and faces the opposite side of the Wachovia Plaza from the Main Building. "We didn't want to replicate the other building's look and create a smaller version of it, but we wanted to create similarities so the renovated building had its own identity while incorporating characteristics of the newer building," Walker says.

The GFRC panels, produced by Architectural Cladding Systems in Hollis, N.H., provided a number of benefits, he says. The ability to match the Mount Airy granite appearance, using a white matrix with black-granite aggregate, was a key ingredient. It offered a lighter

The original exterior on the Wachovia campus' Main Building in Charlotte, N.C., featured a blank wall.



With a plaza and other scenic views constructed since its completion, the building received a grand makeover with glass curtain wall and GFRC panels.

Fact Sheet

Project: *Two Wachovia Center Main Building*

Type: *Office building*

Location: *Charlotte, N.C.*

Architect/Engineer: *Little Diversified Architectural Consulting, Charlotte*

General Contractor: *Batson-Cook Co., West Point, Ga.*

Owner: *Wachovia Corp., Charlotte*

Precaster: *Architectural Cladding Systems, Hollis, N.H.*

Project Size: *291,000 square feet*

Precast Components: *GFRC panels*

weight, which ensured the existing structural system could be used.

It also allowed the punched windows to recess about 6 inches into the panel, creating depth and shadow lines. "Using GFRC actually allowed us to produce more depth on the façade than we could have created economically with the use of a standard precast panel," Walker says. GFRC's economical cost also helped the project bids come in 15% under budget.

The precaster provided significant input on the design, helping to ensure the panels could connect to the existing structure. "Architectural Cladding Systems was good at showing us how the panels could be framed and supported, and detailing reveals, false joints and real joints. It was a good process."

The panels were designed as two-story pieces that could connect at both levels. "The erection went very smoothly," says Walker. Because tolerances were looser when the building was constructed, there were significant variations in floor levels and floor lines, even within one level, he notes. The GFRC panels were "floated" outside of the slabs to separate the window system from the interior. "That allowed us to produce the exterior skin as consistent modules without worrying about variations," he explains. The varying gap (up to 1½ inches) between the floor line and window-sill elevation was covered with drywall and metal sill extensions.

'GFRC actually allowed us to produce more depth on the façade.'

The GFRC was used on approximately 60% of the façade, primarily on the west and north sides, which combine the panels with punched windows. The east side features GFRC that joins to a structure connecting to the tower building, clad with black glass. The south façade, which faces the plaza, now features a glass curtain wall that provides plenty of daylight and sweeping views for everyone in the building.

"One of the biggest complaints about the building was its dark interior," says Olvera, who worked in the building prior to its renovation. "That has been totally eliminated now."

The design offers a lot of potential for other projects, particularly renovations, Walker notes. "We use a lot of precast concrete on our projects, and this offers a good alternative when light weight is required, which often is the case with renovations. It offers good economics and a lot of flexibility, just as precast concrete does." ■



How to do it in Precast...



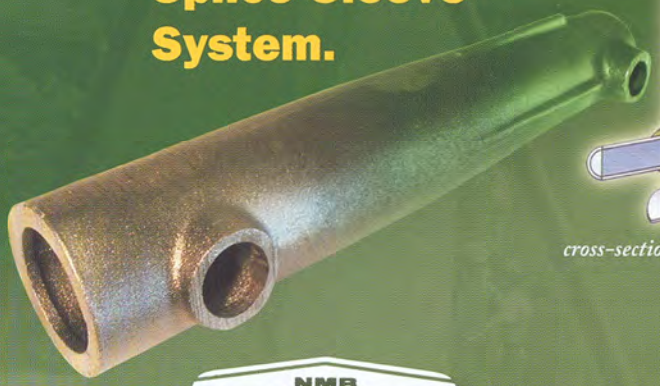
...a moment-resisting frame for a parking structure.

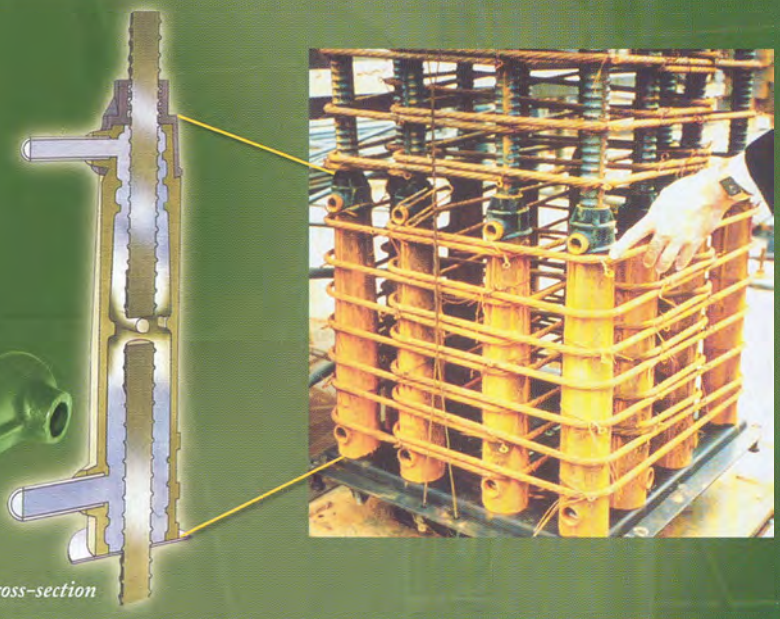
Q How is the moment connection made?

A All you need is an emulative detail, reconnect the concrete and rebar.

Q How do you connect the rebar?

A Use the...
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cross-section

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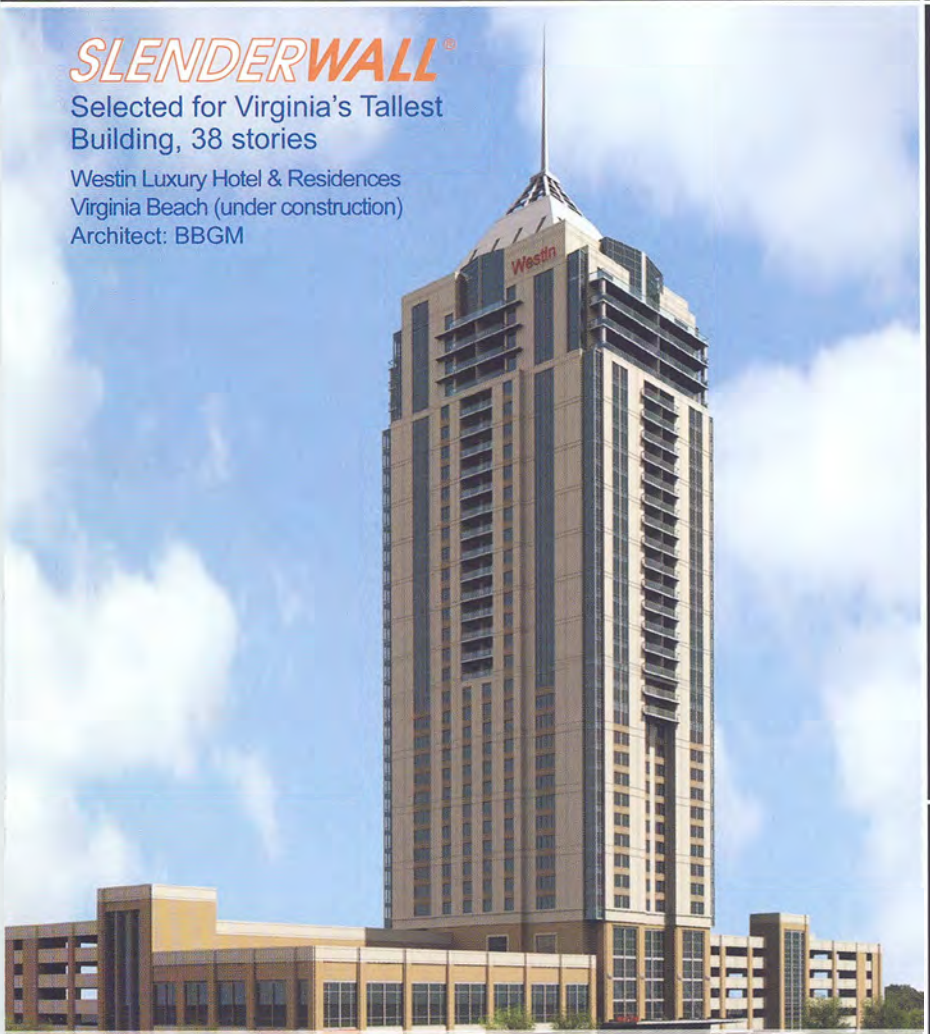
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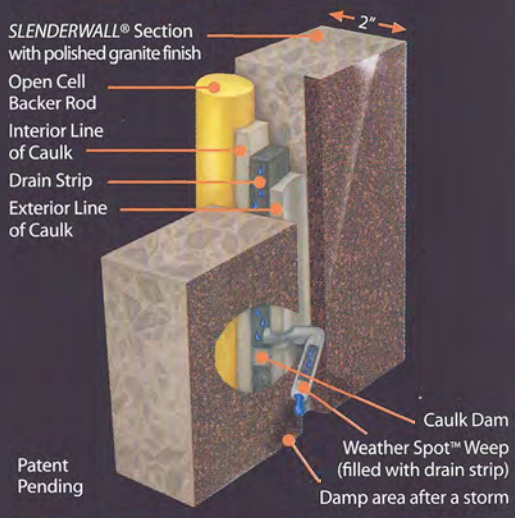
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Photo: Gate Precast.

Thin-Brick Standard Aids Design Specs

New standard from PCI ensures thin-brick applications achieve most efficient and attractive design while saving time, money and energy

Designs have long used embedded thin brick in architectural and structural precast concrete wall panels to achieve strong aesthetic goals and create more efficient designs. The specification of thin-brick panels has been aided by the introduction of a new PCI Standard for Thin Brick that helps architects ensure that brick manufacturers supply the most efficient materials for their projects.

"Using precast concrete panels embedded with thin brick requires the same considerations as designs using typical precast panels, except that allowances must be given to the dimensional layout of the clay-product material and its embedment in the concrete," explains Sidney Freedman, PCI's director of architectural services. (To review the standard, see the facing page.)

The benefits that embedded thin brick can offer are myriad and are becoming better known in the design community. The panels can help:

- Speed construction because the brick façade is panelized, creating a fast erection process.
- Eliminate the need to find qualified masons on the appropriate schedule.
- Minimize site disturbance by eliminating scaffolding and brick storage.

Energy-Resource Benefits of Embedded Thin Brick Precast Concrete Panels

Factor	Thin Brick	Full Brick
Raw material required	288 tons	1,440 tons
Shipping material to plant	13 loads	64 loads
	39 gallons of fuel	192 gallons
	$105	$537
Firing cost	710 mmbtu	3,500 mmbtu
	$8,520	$42,000
Shipping	12 loads, one way	100 loads, one way
	1,470 gallons of fuel	12,250 gallons of fuel
	$4,116	$34,300

Source: Gate Precast Co., 2007.

Thin-brick savings:
Raw material: 1,152 tons; Diesel fuel: 12,648 gallons; Natural gas: 2,790 mmbtu; Money: $68,894.

Calculations were based on these factors:

1. Pieces: 100,000 square feet of thin brick equates to 675,000 pieces of full bed-depth brick.
2. Sizes: Modular-size bricks are $3\frac{5}{8}$" x $2\frac{1}{4}$" x $7\frac{5}{8}$"; thin bricks are 5/8" x $2\frac{1}{4}$" x $7\frac{5}{8}$".
3. Shipping distance: Raw bricks—12 miles (24 total), with trucks returning empty; Finished precast panels—980 miles.
4. Fuel cost: 8.0 mpg @ $2.80 per gallon for both formats.
5. Truck capacities: 45,000 pounds.
5. Job-site construction waste: Brick—yes; Precast—no.
6. 10% loss on ignition (organic materials burned during kiln firing).
7. Natural gas cost delivered to plant: $12/mmbtu.

PCI Standard for Thin Brick

The objective of this standard is to outline material standards and specification criteria for brick manufacturers to meet when supplying materials to precast concrete manufacturers. The intent is to establish acceptable dimensional tolerances and consistent testing standards for brick embedded in precast concrete systems. The brick manufacturers must confirm through the provision of independent test results that their brick products comply with the PCI Standard. The PCI Standard should appear in all specifications as the new, approved industry standard. Brick manufacturers have agreed to promote the compliance of their brick with this new standard.

The following parameters have been established based on the successful use of embedded brick in precast concrete projects. The parameters set forth for use in these proposed standards are attainable brick properties that have been derived with input from brick manufacturers, precasters, engineers, and architects, as well as consideration of existing test results.

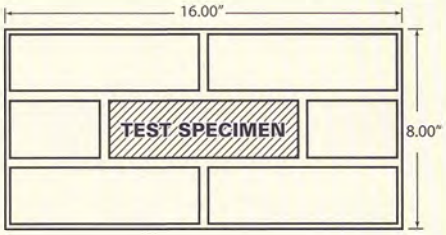
A. Thin Brick Units: PCI Standard, not less than 1/2 in. (13 mm) nor more than 1 in. (25 mm) thick with an overall tolerance of plus 0 in., minus 1/16 in. (+0 mm, -1.6 mm) for any unit dimension 8 in. (200 mm) or less and an overall tolerance of plus 0 in., minus 3/32 in. (+0 mm, -2.4 mm) for any unit dimension greater than 8 in. (200 mm) measured according to ASTM C 67.

1. Face Size: Modular, 2 1/4 in. (57 mm) high by 7 5/8 in. (190 mm) long.
2. Face Size: Norman, 2 1/4 in. (57 mm) high by 11 5/8 in. (290 mm) long.
3. Face Size: Closure Modular, 3 5/8 in. (90 mm) high by 7 5/8 in. (190 mm) long.
4. Face Size: Utility, 3 5/8 in. (90 mm) high by 11 5/8 in. (290 mm) long.
5. Face Size, Color, and Texture: **[Match Architect's approved samples] [Match existing adjacent brickwork]**.
   a. <**Insert information on existing brick if known.**>
6. Special Shapes: Include corners, edge corners, and end edge corners.
7. Cold Water Absorption at 24 hours: Maximum 6% when tested per ASTM C 67.
8. Efflorescence: Provide brick that has been tested according to ASTM C 67 and rated "not effloresced."
9. Out of Square: Plus or minus 1/16 in. (+/-1.6 mm) measured according to ASTM C 67.
10. Warpage: Consistent plane of plus 0 in., minus 1/16 in. (+0, -1.6 mm).
11. Variation of Shape from Specified Angle: Plus or minus 1 degree.
12. Tensile Bond Strength: Not less than 150 psi (1.0 MPa) when tested per modified ASTM E 488. Epoxy steel plate with welded rod on a single brick face for each test.
13. Freezing and Thawing Resistance: No detectable deterioration (spalling, cracking, or chafing) when tested in accordance with ASTM C 666 Method B.
14. Modulus of Rupture: Not less than 250 psi (1.7 MPa) when tested in accordance with ASTM C 67.
15. Chemical Resistance: Provide brick that has been tested according to ASTM C 650 and rated "not affected."
16. Surface Coloring: Brick with surface coloring shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in applied finish when viewed from 20 ft (6 m).
17. Back Surface Texture: **[Scored], [Combed], [Wire roughened], [Ribbed], [Keybacked], [Dovetailed]**.

Test sample size and configuration shall conform to the following parameters in order to validate compliance by brick manufacturer with PCI Standard for use in embedded brick precast concrete systems:

1. Minimum number of test specimens: Comply with appropriate specifications except for freeze-thaw and tensile bond strength tests on assembled systems.
2. Minimum number of test specimens for freeze-thaw and tensile bond strength test: Ten (10) assembled systems measuring 8 x 16 in. (200 mm x 405 mm) long with the brick embedded into the concrete substrate (assembled system). The ten assembled systems are divided into five Sample **A** assemblies and five Sample **B** assemblies. The precast concrete substrate shall have a minimum thickness of 2 1/2 in. (63 mm) plus the embedded brick thickness. The precast concrete shall have a minimum compressive strength of 5000 psi (34.5 MPa) and 4 to 6% entrained air. The embedded brick coursing pattern for testing purposes shall be modular size brick on a half running bond pattern with a formed raked joint geometry of no less than 3/8 in. (9 mm) wide and a depth no greater than 1/4 in. (6 mm) from the exterior face of the brick. One brick from the center of each Sample **A** assembly shall be tested for tensile bond strength, Item #12. Each Sample **B** assembly shall first be tested for freeze-thaw resistance, Item #13 and then one brick from the center of each Sample **B** assembly shall be tested for tensile bond strength, Item #12.

This is a clarification of the test sample preparation published on the PCI website for the Spring 2006 issue of ASCENT.



- Provide better response to freeze/thaw and tensile-bond attributes.
- Require little maintenance due to no periodic tuckpointing of mortar joints.
- Create considerably fewer joints for moisture penetration and no efflorescence.
- Can replicate historic brick and other specific designs of the past.
- Need no flashing to channel water or miscellaneous metal pieces.
- Offer a lower absorption rate due to their higher density, resulting in water being shed faster, helping to clean the façade.

Possibly one of the most dramatic benefits that is gaining attention is the ability of embedded thin-brick panels to aid in meeting LEED standards. Because they are so much thinner than traditional full brick (usually 3 inches thinner), thin bricks require far fewer energy resources to produce. They also are lighter in weight, and their smaller size allows more to be delivered in each shipment, using less energy for transportation, even over larger distances from the precast plant.

An example of these savings can be seen in the Cancer Genetics Research Center at the University of Florida in Gainesville, Fla. A comparison of the use of embedded thin-brick panels vs. full brick masonry walls for the 100,000 square feet of material required showed that there was a savings of 1.152 tons of material because thin brick was used. A variety of other energy savings also were achieved (see the chart). The material saved alone could be used to create 400,000 square feet more panels embedded with thin brick, or enough to clad four additional buildings of the same size.

To learn more about the benefits of embedded thin brick in precast concrete wall panels, see the article in the Winter 2007 issue of *ASCENT*, which is available online at *www.pci.org*. ■

The *new* PCI has raised the bar for Precast Concrete...*and so have we!*



PSA SLOTTED INSERTS

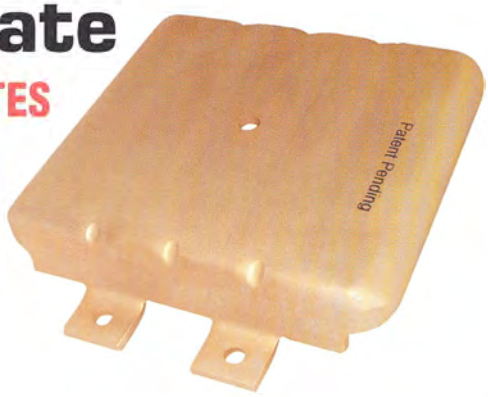
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SUSTAINABILITY

Designer's NOTEBOOK

Part 3 in a series



SUSTAINABILITY

Energy Use in Buildings

Energy conservation is a key tenet of sustainability. About 90% of the energy used during a building's life is attributed to heating, cooling, and other utilities. The remaining 10% is attributed to manufacturing materials, construction, maintenance, replacement of components, and demolition. Approximately 5% of the world's population resides in the United States., yet 25% of the world's energy is consumed in the U.S. The U.S. dependence on foreign energy sources is greater than ever, which has an effect on U.S political and defense policies. Meanwhile, many developing nations like China have increased energy demands due to increased manufacturing and urbanization.

Energy Codes

Energy codes provide cost effective, minimum building requirements that save energy. The energy saved is a cost savings through lower monthly utility bills, and smaller, and thus less expensive, HVAC equipment. More than two-thirds of the electricity and one-third of the total energy in the U.S. are used to heat, cool, and operate buildings. This means that implementing and enforcing energy codes will result in fewer power plants and natural resources being used to provide electricity and natural gas. It also means fewer emissions will be released into the atmosphere. Emissions have been linked to smog, acid rain, and climate change. In the U.S. most buildings are constructed to meet minimum energy code requirements; energy codes contribute to sustainability by saving energy and protecting the environment.

Energy codes are effective in reducing per capita energy usage (energy use per person). The per capita energy use in California has remained steady due to the state's active use and enforcement of energy codes for buildings, while in the rest of the U.S. that energy use has increased (Fig. 10).

The U.S. Energy Conservation and Production Act requires that each state certify it has a commercial building code that meets or exceeds ANSI/ASHRAE/IESNA Standard 90.1. In this sense, "commercial" means all buildings that are not low-rise residential (three stories or less above grade). This includes office, industrial, warehouse, school, religious, dormitories, and high-rise residential buildings. The ASHRAE standard and most codes recognize the benefits of thermal mass and require less insulation for mass walls.

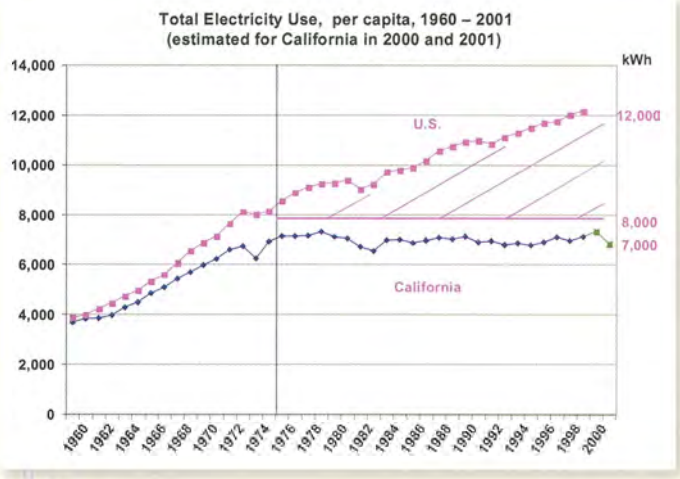


Fig. 10
Energy savings due to implementation of energy codes in 1976 in California (California Energy Commission).

Thermal mass in exterior walls has the following benefits and characteristics:

1. Delays and reduces peak loads.
2. Reduces total loads in many climates and locations.
3. Works best in commercial applications.
4. Works well in residential applications.
5. Works best when mass is exposed on the inside surface.
6. Works well regardless of the placement of mass.

Mass works well in commercial applications by delaying the peak summer load, which generally occurs around 3:00 p.m. to later when offices begin to close. As a case in point, the blackout in the northeastern U.S. in August 2003 occurred at 3:05 p.m. A shift in peak load would have helped alleviate the demand and, possibly, this peak power problem.

Also, many commercial and industrial customers incur significant time-of-use utility rate charges for the highest use of electricity for any one hour in a month in the summer. Thermal mass may help shift the peak hour of electric demand for air conditioning to a later hour, and help reduce these time-of-use charges. Nighttime ventilation can be used to cool thermal mass that has been warmed during the day. Local outdoor humidity levels influence the effectiveness of nighttime ventilation strategies.

As occupant and equipment heat is generated, it is absorbed not only by the indoor ventilated air but also by the massive elements of the building. Mass works well on the inside surfaces by absorbing the heat gains generated by people and equipment indoors. Interior mass from interior walls, floors, and ceilings will help moderate room temperatures and reduce peak energy use.

LEED Energy and Atmosphere Prerequisite 2 on Minimum Energy Performance. *All buildings must comply with certain sections on building energy efficiency and performance as required by the ANSI/ASHRAE/IESNA 90.1-2004, Energy Standard for Buildings Except Low-Rise Residential Buildings, or the local energy code, whichever is more stringent. The ASHRAE standard is usually more stringent and applies for most states. This prerequisite is a requirement and is not worth any points. The requirements of the ASHRAE standard are cost-effective and not particularly stringent for concrete. Insulating to meet or exceed the requirements of the standard is generally a wise business choice. Determining compliance for the envelope components is relatively straightforward using the tables in Chapter 5 of the ASHRAE standard. Minimum requirements are provided for mass and nonmass components such as walls and floors.*

Thermal mass is most effective in locations and seasons where the daily outdoor temperature rises above and falls below the balance point temperature of the building. The balance point temperature is the outdoor temperature below which heating will be required. It is less than room temperature, generally between 50 and 60 °F (10 and 15 °C), at the point where internal heat gains are about equal to the heat losses through the building envelope. In many climates, buildings with thermal mass have lower energy consumption than nonmassive buildings with walls of similar thermal resistance. In addition, heating and cooling needs can be met with smaller equipment sizes.

More information on thermal properties and energy code compliance of precast concrete walls is available at www.pci.org, in Designers Notebook, Energy Conservation (DN-15).

Table 4–Measured Air Leakage for Selected Building Materials

MATERIAL	AVERAGE LEAKAGE AT 0.3 IN. WATER, CFM/FT² SURFACE
6 mil (0.15 mm) polyethylene	No measurable leakage
1 in. (25 mm) expanded polystyrene	1.0
½ in. (12 mm) fiberboard sheathing	0.3
Breather type building membranes	0.002 – 0.7
Closed cell foam insulation	0.0002
Uncoated brick wall	0.3
Uncoated concrete block	0.4
Precast concrete wall	No measurable leakage

Table 5–LEED NC v2.2 Points Awarded for Energy Costs Saved Beyond Minimum Code

NEW BUILDINGS, ENERGY SAVED	EXISTING BUILDINGS, ENERGY SAVED	POINTS
10.5%	3.5%	1
14%	7%	2
17.5%	10.5%	3
21%	14%	4
24.5%	17.5%	5
28%	21%	6
31.5%	24.5%	7
35%	28%	8
38.5%	31.5%	9
42%	35%	10

Lighting

Light-colored precast concrete and other surfaces will reduce energy costs associated with indoor and outdoor lighting. The more reflective surfaces will reduce the amount of fixtures and lighting required. Light-colored precast concrete exposed to the interior will help reduce interior lighting requirements, and light-colored exterior walls will reduce outdoor lighting requirements.

Air Infiltration

Precast concrete panels have negligible air infiltration. Minimizing air infiltration between panels and at floors and ceilings will provide a building with low air infiltration. These effects will lower energy costs and help prevent moisture problems from infiltration of humid air. In hot and humid climates in the southeastern U.S., infiltration of moist air is a source of unsightly and unhealthy moisture problems in buildings. Some building codes now limit air leakage of building materials to 0.004 cfm/ft² (0.0012 m³/min/m²) under a pressure differential of 0.3 in. (7.6 mm) water (1.57 psf [0.75 kPa]); precast concrete meets this requirement. Table 4 lists the measured air leakage values for selected building materials.

Advanced Energy Guidelines

Sustainability or green building programs (such as LEED or Energy Star) encourage energy savings beyond minimum code requirements. The energy saved is a cost-savings to the building owner through lower monthly utility bills and smaller, less expensive heating, ventilating, and air-conditioning (HVAC) equipment. Some government programs offer tax incentives for energy-saving features. Other programs offer reduced mortgage rates. The Energy Star program offers simple computer programs to determine the utility savings and lease upgrades associated with energy saving upgrades.

Many energy-saving measures are cost-effective even though they exceed minimum codes. Insulation and other energy-saving measures in building codes generally have a payback of about five years, even though the building life may be anywhere from 30 to 100 years. The New Buildings Institute has developed the E-Benchmark guidelines to save energy beyond codes (see www.NewBuildings.org). *ASHRAE Advanced Energy Design Guide For Small Office Buildings* (see www.ASHRAE.org) has a similar purpose. Many utilities are interested in these advanced guidelines to delay the need for new power plants.

The panelized construction of precast concrete lends itself to good practice and optimization of insulation levels. To maximize the effectiveness of the insulation, thermal bridges should be minimized or avoided. Metal thermal bridges may occur as connectors that penetrate insulation to connect concrete layers. Concrete thermal bridges may occur at the bottom and top of concrete panels. Using fiberglass or carbon-fiber composite fasteners or thermal breaks may minimize thermal bridges.

LEED Energy Credit 1 on Optimizing Energy Performance. *This credit is allowed if energy cost savings can be shown compared to a base building that meets the requirements of ANSI/ASHRAE/IESNA 90.1-2004, Energy Standard for Buildings Except Low-Rise Residential Buildings. The method of determining energy cost savings must meet the requirements of Appendix G "Performance Rating Method" of the standard.*

Many engineering consulting firms have the capability to model a building to determine energy savings as required using a computer-based program such as DOE2. When concrete is considered, it is important to use a program like DOE2 that calculates annual energy use on an hourly basis. Such programs are needed to capture the beneficial thermal mass effects of concrete. Insulated concrete systems, used in conjunction with other energy savings measures will most likely be eligible for LEED points. The number of points awarded will depend on the building, climate, fuel costs, and minimum requirements of the standard. From 1 to 10 LEED points are awarded for energy cost savings of 10.5% to 42% for new buildings and 3.5% to 35% for existing buildings (Table 5). A small office building less than 20,000 ft² (1900 m²) complying with ASHRAE "Advanced Energy Design Guide For Small Office Buildings 2004" can achieve 4 points, and a building complying with "E-Benchmark" v1.1 (www.newbuildings.org) can achieve 1 point.

Indoor Environmental Quality

Concrete contains low to negligible VOCs. These compounds degrade indoor air quality when they off-gas from new products, such as interior finishings, carpet, and furniture. Manufactured wood products such as laminate, particle board, hardboard siding, and treated wood can also lead to off-gassing. In addition, VOCs combine with other chemicals in the air to form ground-level ozone. Table 6 presents the VOC concentration and emission rates for common materials. Complaints due to poor indoor air quality routinely include eye, nose, and throat irritation; dryness of the mucous membranes and skin;

Table 6–Concentrations and Emission Rates of VOCs for Common Materials

BUILDING MATERIAL	VOC CONCENTRATION, MG/M³	VOC EMISSION RATE, MG/M²H
Concrete with water-based form-release agent	0.018	0.003
Acryl latex paint	2.00	0.43
Epoxy, clear floor varnish	5.45	1.3
Felt carpet	1.95	0.080
Gypsum board	N/A	0.026
Linoleum	5.19	0.22
Particle board	N/A	2.0
Plastic silicone sealer	77.9	26.0
Plywood paneling	N/A	1.0
Putty strips	1.38	0.34
PVA glue cement	57.8	10.2
Sheet vinyl flooring	54.8	2.3
Silicone caulk	N/A	<2.0
Water-based EVA wall and floor glue	1,410.0	271.0

Note: 1 mg/m³ = 0.000009 oz/yd³; 1 mg/m²h = 0.00001 oz/yd²h.

LEED Indoor Environmental Quality Credit 3.1 on Construction IAQ Management Plan, During Construction. *This credit prevents indoor air quality problems resulting from the construction process. The intent is to reduce and contain dust and particulates during construction and to reduce moisture absorbed by materials that are damaged by moisture. During construction, the project must meet or exceed the recommended Design Approaches of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 1995, Chapter 3 on Control Measures (www.smacna.org). Using precast concrete can help meet the requirements because it is delivered to the site in pieces that do not require fabrication, processing, or cutting, thereby reducing dust and airborne contaminants on the construction site. Concrete is not damaged by moisture and does not provide nutrients for mold growth. This credit is worth one point.*

nose bleeds; skin rash; mental fatigue and headache; cough; hoarseness; wheezing; nausea; dizziness; and increased incidence of asthma.

Polished concrete floors do not require carpeting. Exposed concrete walls do not require finishing materials—this eliminates particulates from sanding drywall tape seams. VOCs in concrete construction can be further reduced by using low-VOC materials for form release agents, curing compounds, dampproofing materials, wall and floor coatings and primers, membranes, sealers, and water repellents.

Demolition

Precast concrete panels can be reused when buildings are expanded and precast concrete can be recycled as road base or fill at the end of its useful life. Concrete pieces from demolished structures can be reused to protect shorelines. Most concrete from demolition in urban areas is recycled and not placed in landfills.

LEED Materials Credit 2 on Construction Waste Management. *This credit is extended for diverting construction and demolition debris and land clearing waste from landfill disposal. It is awarded based on diverting at least 50% by weight or volume of the previously listed materials. Since precast concrete is a relatively heavy construction material and is frequently crushed and recycled into aggregate for road bases or construction fill, this credit should be obtainable when concrete buildings are demolished. This credit is worth 1 point if 50% of the construction and demolition debris and land clearing waste is recycled or salvaged and 2 points for 75%.*

Innovation

LEED Innovation and Design Process Credit 1. *This credit is available for projects that demonstrate exceptional performance above the requirements in LEED or not specifically addressed in LEED. For example, close collaboration with engineers on a given project to develop innovative systems that are more resource efficient or use less energy may earn a project an additional point. To earn credits (up to 4), the user must submit the intent of the proposed credit, the proposed requirement for compliance, submittals to demonstrate that compliance, and the design approach used to meet the requirement.*

Conclusion

Sustainable practices contribute to saving materials and energy, and reducing the negative effects of pollutants. The use of precast concrete contributes to these practices by incorporating integrated design, using materials efficiently, and reducing construction waste, site disturbance, and noise. Concrete is durable, resistant to corrosion and impact, and inedible.

Precast concrete structures are resistant to fires, wind, hurricanes, floods, earthquakes, wind-driven rain, blast forces, and moisture damage. Light- or natural-colored concrete reduces heat islands, thereby reducing outdoor temperatures, saving energy, and reducing smog. Recycled materials such as fly ash, slag cement, silica fume, and recycled aggregates can be incorporated into concrete, thereby reducing the amount of materials that are taken to landfills and reducing the use of virgin materials.

Concrete structures in urban areas are recycled into fill and road base material at the end of their useful life. Cement and concrete are generally made of abundant local materials. The thermal mass of concrete helps save heating and cooling energy in buildings. Concrete acts as an air barrier, reducing air infiltration and saving more energy. Concrete has low VOC emittance and does not degrade indoor air quality.

Sustainability attributes can be evaluated by performing a life-cycle assessment. Because these procedures are time consuming, green building rating systems such as LEED have become popular. Precast concrete can help a project earn up to 23 points towards LEED certification for new buildings (a total of 26 are required).

— Martha G. VanGeem, P.E.
Manager Building Science & Sustainability,
LEED Accredited Professional, CTL Group, Skokie, Illinois

PCI-Certified Plants

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

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

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

Guide Specification

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

"*Manufacturer Qualification:* The precast concrete manufacturing plant shall be certified by the Precast/Prestressed Concrete Institute Plant Certification Program. Manufacturer shall be certified at time of bidding. Certification shall be in the following product group(s) and category(ies): [Select appropriate groups and categories (AT or A1), (B1,2,3, or 4), (C1,2,3, or 4), (G)]."

**Please note: Some precast 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.*

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 Product*

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.

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 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 superstructure 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 supercedes Group B in the same category. For instance, a plant certified to produce products in category B2A also is 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 Hollowcore and Repetitive Products
Standard shapes made in a repetitive process prestressed with straight strands. Included are Hollowcore 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 supercedes Group C in the same category. For instance, a plant certified to produce products in category C2A also is 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.

(as of April 2007)

ALABAMA

Gate Precast Company, Monroeville (251) 575-2803 — **A1, C1A**
Hanson Pipe and Precast Southeast / Pelham Prestress, Birmingham (205) 663-4681 — **B4, C4**
Standard Concrete Products, Theodore (251) 443-1113 — **B3**

ARIZONA

Coreslab Structures (ARIZ) Inc., Phoenix (602) 237-3875 — **A1, C4A**
TPAC / A Div. of Kiewit Western Co., 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 — **C2**
Clark Pacific, Fontana (909) 823-1433 — **A1, C3, G**
Clark Pacific, West Sacramento (916) 371-0305 — **A1, C3**
Con-Fab California Corporation, Lathrop (209) 249-4700 — **B4, C4**
Conrad Constructors, Inc., Rialto (909) 350-8283 — **B4**
Coreslab Structures (L.A.) Inc., Perris (951) 943-9119 — **A1, B4, C4A**
Fintech Precast, Inc., Redding (530) 241-8397 — **C2**
Hanson Structural Precast, Irwindale (626) 962-8751 — **C4**
Hanson Structural Precast, San Diego (619) 423-9030 — **C4**
Mid-States Precast, L.P., Corcoran (559) 992-8180 — **A1, C1A**
Pomeroy Corporation, Perris (951) 657-6093 — **B4, C2**
Walters & Wolf Precast, Fremont (510) 226-5162 — **A1, G**
Willis Construction Co., Inc., San Juan Bautista (831) 623-2900 — **A1, C1, G**
Willis De Mexico S.A. de C.V., Tecate (011) 52-665-665-2222 — **A1, C1**

COLORADO

EnCon Bridge Company, LLC, Denver (303) 287-4312 — **B4**
Plum Creek Structures, Littleton (303) 471-1569 — **B4, C3**
Rocky Mountain Prestress, Inc. / Architectural Concrete Plant, Denver (303) 480-1111 — **A1, C3A**
Rocky Mountain Prestress, Inc. / Structural Plant, Denver (303) 480-1111 — **B4, C4**
Rocla Concrete Tie, Inc., Denver (303) 296-3505 — **C2**
Stresscon Corporation, Colorado Springs (719) 390-5041 — **A1, B4, C4A**
Stresscon Corporation / Denver-Metro Division, Dacono (303) 659-6661 — **C4**

CONNECTICUT

Blakeslee Prestress Inc., Branford (203) 481-5306 — **A1, B4, C4A**
Coreslab Structures (CONN) Inc., Thomaston (860) 283-8281 — **A1**
Oldcastle Precast, Inc. / dba Rotondo Precast, Avon (860) 673-3291 — **B1, C1A**

DELAWARE

Concrete Building Systems, 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**
Coreslab Structures (MIAMI) Inc., Medley (305) 823-8950 — **A1, C4**
Coreslab Structures (ORLANDO) Inc., Orlando (407) 855-3191 — **C2**
Coreslab Structures (TAMPA) Inc., Tampa (813) 626-1141 — **B3, C3A**
Dura-Stress, Inc., Leesburg (800) 342-9239 — **A1, B4A, C3A**
Finfrock Industries, Inc., Orlando (407) 293-4000 — **C4**
Florida Rock and Sand Prestress Precast Co., Inc., Florida City (305) 247-9611 — **B2, C3**
Gate Concrete Products Company, Jacksonville (904) 757-0860 — **B4, C4**
Gate Precast Company, Kissimmee (407) 847-5285 — **A1**
Gate Precast Company, Sarasota (941) 957-0270 — **A1**
South Eastern Prestressed Concrete, Inc. / JAMCO, West Palm Beach (561) 793-1177 — **B3, C3**
Southern Prestressed Concrete, Inc., Pensacola (850) 476-6120 — **C4**
Standard Concrete Products, Inc., Tampa (813) 831-9520 — **B4, C3**

GEORGIA

Atlanta Structural Concrete Co., Buchanan (770) 646-1888 — **C4A**
ConArt, Inc., Cobb (229) 853-5000 — **A1, AT, C3**
Coreslab Structures (ATLANTA) Inc., Jonesboro (770) 471-1150 — **C2A**
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 / Prestress Division, Conley (800) 849-6383 — **C4A**
Tindall Corporation / Corrections Division, Conley (800) 849-6383 — **C2**

HAWAII

Grace Pacific Rocky Mountain Prestress (East), Kapolei (808) 682-5761 — **B3, C3**
Grace Pacific Rocky Mountain Prestress (West), Kapolei (808) 682-6000 — **A1, B4, C4**

IDAHO

Eagle Precast Company, Caldwell (208) 454-8116 — **A1, B4, C1**
Teton Prestress Concrete, LLC., Idaho Falls (208) 523-6410 — **B4, C3**

ILLINOIS

ATMI Dynacore, Lockport (815) 838-9492 — **C2**
ATMI Precast, Aurora (630) 896-4679 — **C3A**
County Materials Corporation, Champaign (217) 352-4181 — **B3**
Dukane Precast, Inc., Aurora (708) 898-6311 — **A1, C3**
Egyptian Concrete Company, Salem (618) 548-1190 — **A1, B4, C4**
High Concrete Technology, LLC, Paxton (217) 379-9790 — **A1, C3A**
J.W. Peters, Inc. / Subsidiary of The Cretex Companies, Inc., Rochelle (815) 562-4136 — **A1, B4, C4A**
Lombard Architectural Precast Products Co., Alsip (708) 389-1060 — **A1**
Mid-States Concrete Industries Co., South Beloit (608) 364-1072 — **C2**
Prestress Engineering Corporation, Blackstone (815) 586-4239 — **B4, C4**
Spancrete of Illinois, Inc., Crystal Lake (815) 459-5580 — **C2**
St. Louis Prestress, Inc., Glen Carbon (618) 656-8934 — **B3, C3**

INDIANA

ATMI Indy, LLC / ATMI Precast, Greenfield (317) 891-6280 — **C2**
Coreslab Structures (INDIANAPOLIS) Inc., Indianapolis (317) 353-2118 — **A1, C4A**
Fabcon LLC, Westfield (317) 896-2556 — **C2A**
Hoosier Precast LLC / Prestress Engineering Corporation, Salem (812) 883-4665 — **B3, C1A**
Precast Specialties, Inc., Monroeville (260) 623-6131 — **A1**
Prestress Services Industries LLC / Decatur Division, Decatur (260) 724-7117 — **B4, C4**
StresCore, Inc., South Bend (574) 233-1117 — **C2**

IOWA

Andrews Prestressed Concrete, Inc., Clear Lake (641) 357-5217 — **B4, C4**
IPC, Inc. / Subsidiary of The Cretex Companies, Inc., Des Moines (800) 826-0464 — **C4**
IPC, Inc. / Subsidiary of The Cretex Companies, Inc., Iowa Falls (641) 648-2579 — **B4, C4A**
IPC, Inc. / Subsidiary of the Cretex Companies, Inc., West Burlington (319) 754-0477 — **A1, B4, C3A**

KANSAS

Coreslab Structures (KANSAS) Inc., Kansas City (913) 287-5725 — **B4, C4**
Prestressed Concrete, Inc., Newton (316) 283-2277 — **A1, B4, C4**
Stress-Cast, Inc., Assaria (785) 667-3905 — **C3A**
Waffle-Crete International, Inc., Hays (785) 625-3486 — **C2**

KENTUCKY

de AM - RON Building Systems LLC, Owensboro (270) 684-6226 — **A1, C4**
Gate Precast Company, Winchester (859) 744-9481 — **A1**
Prestress Services Industries LLC / Henderson Division, Henderson (270) 826-6244 — **B4, C3**
Prestress Services Industries LLC / Lexington Division, Lexington (859) 299-0461 — **A1, B4, C4**
Prestress Services Industries LLC / Melbourne Division, 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**
Rotondo Weirich, Pollock (215) 256-7940 — **C1**

MARYLAND

Atlantic Metrocast, Inc., LaPlata (301) 870-3289 — **B3, C1**
Larry E. Knight, Inc., Glyndon (410) 833-7800 — **C2**
Oldcastle Precast Building Systems, Edgewood (410) 612-1213 — **C3A**

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

MASSACHUSETTS

Oldcastle Precast, Inc. / dba Chase Precast, North Brookfield (508) 867-8312 — B2, C2A
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 — C2

MICHIGAN

Gerace Construction Company, Inc., Midland (989) 496-2440 — A1, B3, C3
Grand River Infrastructure, Inc. / The Premarc Corporation, Grand Rapids (616) 534-9645 — B4, C1
Kerkstra Precast Inc., Grandville (800) 434-5830 — C3A
National Precast Structural, Inc., Shelby (586) 247-1201 — C3
National Precast, Inc., Roseville (586) 294-6430 — A1, C3
Nucon Schokbeton / Stress-Con Industries, Inc., Kalamazoo (269) 381-1550 — A1, B4, C3A
Renaissance Precast Industries, Inc., River Rouge (313) 297-7700 — A1, B4, C3A
Stress Con Industries, Inc., Detroit (313) 873-4711 — B2, C3
Stress Con Industries, Inc. / Spancast of Michigan, Saginaw (989) 239-2447 — B4, C3

MINNESOTA

Cretex Concrete Products North, Inc. / Subsidiary of The Cretex Companies, Inc., Maple Grove (763) 545-7473 — B4, C2
Fabcon / Manufacturing and Sales, Savage (952) 890-4444 — C2A
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 Co., Wells (507) 553-3138 — A1, C4A

MISSISSIPPI

F-S Prestress, LLC, Hattiesburg (601) 268-2006 — A1, 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. / A Div. of GFRC Cladding, Jackson (601) 321-8787 — A1, C2A
Prestress Services Industries of MS, LLC, Ridgeland (601) 856-4135 — B4
Tindall Corporation / Mississippi Division, Biloxi (228) 435-0160 — C4A

MISSOURI

Coreslab Structures (MISSOURI) Inc., Marshall (660) 886-3306 — A1, B4, C4A
Egyptian Concrete Company, Bonne Terre (573) 358-2773 — B4
Mid America Precast, Inc., Fulton (573) 642-6400 — A1, B1, C1
Mid West Prestress, LLC / Mid South Prestress, LLC, Wright City (636) 745-7480 — C3
Prestressed Casting Company, Ozark (417) 581-7009 — C4
Prestressed Casting Company, Springfield (417) 869-1263 — A1, C3A

MONTANA

Missoula Concrete Construction, Missoula (406) 549-9682 — A1, B3, C3
Montana Prestressed Concrete, Billings (406) 656-4310 — B4, C3

NEBRASKA

Concrete Industries, Inc., Lincoln (402) 434-1800 — B4, C4
Coreslab Structures (OMAHA) Inc., LaPlatte (402) 291-0733 — A1, B4, C4A
CXT, Inc., Grand Island (308) 382-5400 — C2
Enterprise Precast Concrete, Inc. / Enterprise Properties, Inc., Omaha (402) 895-3848 — A1
GFRC, Inc., Lincoln (402) 466-3200 — G
Stonco, Inc. / Enterprise Properties, Inc., Omaha (402) 556-5544 — A1

NEW HAMPSHIRE

Architectural Cladding Systems, Inc., Hollis (603) 889-6310 — G
Newstress International, Inc., Epsom (603) 736-9348 — B3, C3

NEW JERSEY

DiSanti Concrete Products, Inc., Howell (732) 751-0900 — A1, C2A
High Concrete Innovations, LLC (Buena Plant), Buena (856) 697-3600 — C3
Jersey Precast Corp., North Brunswick (732) 249-8973 — B4, C3
Precast Systems, Inc., Allentown (609) 208-1987 — B4, C4
Universal Concrete Products of NJ, Inc., Folsom (609) 704-9400 — A1, C1

NEW MEXICO

Coreslab Structures (ALBUQUERQUE) Inc., Albuquerque (505) 247-3725 — A1, B4, C4
Ferreri Concrete Structures, Inc., Albuquerque (505) 344-8823 — A1, C4

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, Manchester (585) 289-3530 — C3
Oldcastle Precast Building Systems, South Bethlehem (518) 767-2269 — B3, C3
The L.C. Whitford Materials Co., Inc., Wellsville (585) 593-2741 — B3, C3

NORTH CAROLINA

Gate Precast Company, Oxford (919) 603-1633 — A1, C2
Metromont Corporation, Charlotte (704) 372-1080 — A1, C3
Oldcastle Precast, Inc / dba NC Products, Raleigh (919) 772-6301 — C1
Prestress of the Carolinas, LLC, Charlotte (704) 587-4273 — B4
S & G Prestress Company, Wilmington (910) 397-6255 — B4
S & G Prestress Company, Wilmington (910) 763-7702 — B4, C3
Utility Precast, Inc., Charlotte (704) 596-6283 — B3A

NORTH DAKOTA

Concrete Inc. / Subsidiary of Wells Concrete Products Co., Grand Forks (701) 772-6687 — C4A

OHIO

Fabcon LLC, Grove City (614) 875-8601 — C2A
High Concrete Technology, LLC, Springboro (937) 748-2412 — A1, C3
Hollowcore Midwest, LLC, Fairfield (513) 829-1555 — C2
KSA, Sciotoville (740) 776-3238 — C2
Mack Hollowcore Systems / Mack Industries, Inc., Valley City (330) 483-3111 — C2
Prestress Services Industries LLC / Grove City Division, Grove City (614) 871-2900 — B4
Sidley Precast / Division of R.W. Sidley, Inc., Thompson (440) 298-3232 — A1, C4A
United Precast, Inc. / Box-Beam Production Area, Mt. Vernon (740) 393-1121 — B4, C2
United Precast, Inc. / I-Beam Production Area, Mt. Vernon (800) 366-8740 — B4

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
Coreslab Structures (TULSA) Inc., Tulsa (918) 438-0230 — B4, C4

OREGON

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

PENNSYLVANIA

Architectural Precast LLC, Middleburg (570) 837-1774 — A1, C2A
Concrete Safety Systems, Bethel (570) 933-4107 — B1, C1
Conewago Precast Building Systems / Conewago Enterprises, Inc., Hanover (717) 632-7722 — C2A
Fabcon / Manufacturing, Mahanoy City (570) 773-2480 — C2A
Hanson Pipe & Products, Inc., Pottstown (610) 970-2216 — B1A, C1A
High Concrete Group, Denver (717) 336-9300 — A1, C3
High Concrete Group, Williamsport (570) 329-4228 — C3
J & R Slaw, Inc., Lehighton (610) 852-2020 — A1, B3, C3
Newcrete Products / Div. of New Enterprise Stone & Lime Co., Inc., Roaring Spring (814) 224-2121 — B4, C4
Nitterhouse Concrete Products, Inc., Chambersburg (717) 267-4505 — A1, C4A
Oldcastle Precast Building Systems, Morrisville (215) 736-9576 — C3
Pittsburgh Flexicore Company, Inc., Monongahela (724) 258-4450 — C2
Say-Core, Inc., Portage (814) 736-8018 — C2
Schuylkill Products, Inc., Cressona (570) 385-2352 — B4, C3
Sidley Precast / Division of R.W. Sidley, Inc., Youngwood (724) 755-0205 — C3
Top Roc Newcrete Products Company / A Div. of New Enterprise Stone & Lime Co., Inc., Erie (814) 838-2011 — B4, C1
Universal Concrete Products Corporation / Bodon Industries, Douglassville (610) 323-0700 — A1, C3A

RHODE ISLAND

Symmetry Products Group / SPG / Div. of Lance Industries International, Inc., Lincoln (401) 365-6272 — G

SOUTH CAROLINA

Coreslab Structures (COLUMBIA) Inc., Hopkins (803) 783-5460 — A1
Florence Concrete Products, Inc., Sumter (803) 775-4372 — B4, C3A

Metromont Corporation, Greenville (864) 295-0295 — A1, C4A
Tekna Corporation / Tekna Investments, Inc., Charleston (843) 853-9118 — B4, C2
Tindall Corporation / Spartanburg Prestress Division, Fairforest (864) 576-3230 — A1, C4A

SOUTH DAKOTA

Gage Brothers Concrete Products Inc., Sioux Falls (605) 336-1180 — A1, B4, C4

TENNESSEE

Construction Products, Inc. of Tennessee, Jackson (731) 668-7305 — B4, C4
CPI Concrete Products, Inc., Memphis (901) 775-9880 — B4, C3
Gate Precast Company, Ashland City (615) 792-4871 — A1
Metromont Corporation, LaVergne (615) 793-3393 — C4A
Mid South Prestress, LLC, Pleasant View (615) 746-6606 — C3
Ross Prestressed Concrete, Inc., Bristol (423) 323-1777 — B4, C3
Ross Prestressed Concrete, Inc., Knoxville (865) 524-1485 — B4, C4
Sequatchie Concrete Service, Inc., Knoxville (423) 867-4510 — C2
Southeast Precast Corporation, Knoxville (865) 524-3615 — A1

TEXAS

Coreslab Structures (TEXAS) Inc., Cedar Park (512) 250-0755 — A1, C4A
CXT Inc. / L. B. Foster, Hillsboro (254) 580-9100 — B1, C1
Enterprise Concrete Products, LLC / Enterprise Properties, Inc., Dallas (214) 631-7006 — B3, C3
Gate Concrete Products Company, Pearland (281) 485-3273 — C2
GFRC Cladding Systems, Inc., Garland (972) 494-9000 — G
Heldenfels Enterprises, Inc., Corpus Christi (361) 883-9334 — B4, C4
Heldenfels Enterprises, Inc., San Marcos (512) 396-2376 — B4, C4
Lowe Precast, Inc., Waco (254) 776-9690 — A1, C3A
Manco Structures, Ltd., Schertz (210) 690-1705 — B4, C4A
North American Precast Company, San Antonio (210) 509-9100 — A1, C4A
Rocla Concrete Tie, Inc., Amarillo (806) 383-7071 — C2
Rotondo Weirich Enterprises, Inc., Lubbock (215) 256-7940 — C1

UTAH

Eagle Precast Company, Salt Lake City (801) 966-1060 — A1, B4, C4A, G
EnCon Utah, LLC / Euro Partners, Inc. / EnCon United, Tooele (435) 843-4230 — B4, C3A

VERMONT

J. P. Carrara & Sons, Inc., Middlebury (802) 388-6363 — A1, B4A, C3A
William E. Dailey Precast, LLC, Shaftsbury (802) 442-4418 — A1, B2A, C3A

VIRGINIA

Atlantic Metrocast, Inc., Portsmouth (757) 397-2317 — B4, C3
Bayshore Concrete Products Corporation, Cape Charles (757) 331-2300 — B4, C4
Bayshore Concrete Products/Chesapeake, Inc., Chesapeake (757) 549-1630 — B4, C2
Coastal Precast Systems, LLC, Chesapeake (757) 545-5215 — B4, C3
Rockingham Precast, Inc., Harrisonburg (540) 433-8282 — B4, C3
Smith-Midland Corporation, Midland (540) 439-3266 — A1, B1, C3
Structural Concrete Products, LLC, Richmond (804) 222-8111 — C4A
The Shockey Precast Group, Fredericksburg (540) 898-1221 — A1, C3A
The Shockey Precast Group, Winchester (540) 667-7700 — A1, C4A
Tindall Corporation / Virginia Division, Petersburg (804) 861-8447 — C4A

WASHINGTON

Bellingham Marine Industries, Inc., Ferndale (360) 676-2800 — B4, C2
Bethlehem Construction, Inc., Cashmere (509) 782-1001 — B1, C3A
Central Pre-Mix Prestress Co., Spokane (509) 533-0267 — A1, B4, C4
Central Pre-Mix Prestress Co.-Pasco, Spokane (509) 998-6111 — B4, C1
Concrete Technology Corporation, Tacoma (253) 383-3545 — B4, C4
CXT, Inc. / Rail Division, Spokane (509) 921-7878 — C2
CXT, Inc. / Precast Division, Spokane (509) 921-8716 — B1
EnCon Washington, LLC, Puyallup (253) 846-2774 — B1, C2
Wilbert Precast, Inc., Yakima (509) 248-1984 — B4, C3

WEST VIRGINIA

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

WISCONSIN

County Materials Corporation / Prestress Division, 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
J.W. Peters, Inc. / Subsidiary of The Cretex Companies, Inc., Burlington (800) 877-9040 — C3A
MidCon Products, Inc., Hortonville (920) 779-4032 — AT, C1
Precast Concrete Specialties, Inc., Omro (920) 685-2727 — A1
Spancrete Industries, Inc. / Precast Operations, Waukesha (414) 290-9000 — A1, B2A, C3A
Spancrete, Inc., Green Bay (920) 494-0274 — B4, C4
Spancrete, Inc., Valders (920) 775-4121 — A1, C3A

CANADA

ALBERTA

Con-Force Structures Limited / Alberta Region, Calgary (403) 248-3171 — A1, B4, C4
Lafarge Canada Inc. / Construction Materials Group, Edmonton (780) 468-5910 — A1, C1
P. Kruger Concrete Products, Ltd., Edmonton (780) 438-2072 — A1, C1

BRITISH COLUMBIA

Con-Force Structures Limited / Pacific Region, Richomnd (604) 278-9766 — A1, B4, C3
Surespan Structures LTD., Duncan (250) 748-8888 — B4, C3

MANITOBA

Con-Force Structures Limited / Manitoba Region, Winnipeg (204) 338-9311 — A1, C3A
Lafarge Canada Inc. / Lafarge North America, Winnipeg (204) 958-6381 — C2

NEW BRUNSWICK

Strescon Limited, Saint John (506) 633-8877 — A1, B4, C4

ONTARIO

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

MEXICO

PRETECSA, S.A. DE C.V., Atizapan De Zaragoza (011) 52-10360777 — A1, G

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

PCI-Qualified & Certified Erectors

(as of April 2007)

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 to the right, 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 Qualified/Certified Erector is the first step toward getting the job done right the first time, thus keeping labor costs down.
- 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 to the right are found in the following manuals:

MNL-127-99 *Erector's Manual - Standards and Guidelines for the Erection of Precast Concrete Products*

MNL-132-95 *Erection Safety Manual for Precast and Prestressed Concrete*

GROUPS

Category S1 - Simple Structural Systems
This category includes horizontal decking members (e.g., hollowcore 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. architectural finishes)

* Certified Erectors

ARKANSAS

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

ARIZONA

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

CALIFORNIA

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

COLORADO

Colorado Fabricators & Constructors, Inc., Highlands Ranch (303) 471-9902	S2
Gibbons Erectors Inc., Parker (303) 841-0457	S2
Hardrock Structures Inc., Penrose (719) 372-6269	S2
Mehring Welding & Erection, Penrose (719) 372-6607	S2
Rocky Mountain Prestress, Denver (303) 480-1111	S2
S. F. Erectors Inc., Elizabeth (303) 646-6411	S2

CONNECTICUT

Blakeslee Prestress, Inc., Branford (203) 481-5306	S2
Echelon Erectors, LLC, New Haven (203) 562-1000	S2, A
Marikina Construction Corp., West Haven (203) 799-1013	S1

FLORIDA

All Florida Erectors and Welding, Inc., Apopka (407) 880-3717	S2, A
Concrete Erectors Inc., Altamonte Springs (407) 862-7100	S2
Coreslab Structures (ORLANDO) Inc., Orlando (407) 855-3191	S1
Finfrock Industries, Inc., Orlando (407) 293-4000	S2
Gate Precast Erection Co., Jacksonville (904) 757-0860	S2
James Toffoli Construction Company, Inc., Fort Myers (239) 267-7850	S2
Pre-Con Construction of Tampa Inc., Tampa (813) 626-2545	S2, A
Solar Erectors, Inc., Medley (305) 825-2514	S2
Specialty Concrete Services, Inc., Altoona (352) 669-8888	S2, A
Summit Erectors, Inc., Jacksonville (904) 783-6002	S2, A

GEORGIA

ConArt, Inc., Cobb (229) 853-5000	S1, A
Rutledge & Son's, Woodstock (770) 592-0380	S2

ILLINOIS

Egyptian Concrete Co., Salem (618) 548-1190	S1
Mid-States Concrete Products Company, South Beloit (800) 236-1072	S2
Spancrete of Illinois, Inc., Crystal Lake (815) 459-5580	S2

INDIANA

Sofco Erectors, Inc., Indianapolis (317) 352-9680	S2, A
Stres Core Inc., South Bend (574) 233-1117	S1

IOWA

Cedar Valley Steel, Inc., Cedar Rapids (319) 373-0291	S2

KANSAS

Building Erection Services Company, Inc., Olathe (913) 764-5560	S2, A
Carl Harris Co., Inc., Wichita (316) 267-8700	S2

MAINE

Reed & Reed, Inc., Woolwich (207) 443-9747	S2

MARYLAND

E & B Erectors, Inc., Pasadena (410) 360-7800	S2, A
E.E. Marr Erectors, Inc., Baltimore (410) 837-1641	S2, A
EDI, Inc., Upper Marlboro (301) 568-4585	S1, 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, Edgewood (410) 612-1213	S2, A

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The Whiting - Turner Contracting Company, Baltimore (410) 821-1100 — A

MASSACHUSETTS

Concrete Structures, Inc., Marshfield (781) 837-1931 — S1, A
Prime Steel Erecting, Inc., N Billerica (978) 671-0111 — S2

MICHIGAN

American Erectors Inc., Waterford (248) 674-0060 — S2
Assemblers Precast & Steel Services, Inc., Saline (734) 429-1358 — S2, A
G2 Inc., Cedar Springs (616) 696-9581 — S2, A
Kerkstra Precast Inc., Grandville (616) 224-6176 — S2
Moyle Construction, Houghton (906) 482-3000 — S1
Pioneer Construction Inc., Grand Rapids (616) 247-6966 — S2
Whaley Steel Corporation, Mio (989) 826-6541 — S2, A

MINNESOTA

Amerect, Inc., Newport (651) 459-9909 — S1, A
Hanson Structural Precast Midwest, Inc., Maple Grove (763) 425-5555 — S2, A
Molin Concrete Products Company, Lino Lakes (651) 786-7722 — S2
Wells Concrete Products Co., Wells (507) 553-3138 — S2, A

MISSOURI

J. E. Dunn Construction Company, Kansas City (816) 474-8600 — S2, A
Prestressed Casting Co., Springfield (417) 869-7350 — S2, A

NEBRASKA

Concrete Industries, Inc., Lincoln (402) 434-1800 — S2

NEW HAMPSHIRE

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

NEW JERSEY

Car-Win Construction, Eastampton (800) 352-1523 — S2
J. L. Erectors, Inc., Blackwood (856) 232-9400 — S2, A
JEM-Erectors, Inc., Shamong (609) 268-0332 — S2, A
Jonasz Precast, Inc., Westville (856) 456-7788 — S2

NEW MEXICO

Ferreri Concrete Structures, Inc., Albuquerque (505) 344-8823 — S2

NEW YORK

All Systems Precast, Inc., Farmingdale (631) 694-4720 — S2
Arben Group LLC, Pleasantville (914) 741-5459 — S1
Oldcastle Building Systems Div. / Project Services, Manchester (716) 289-3530 — S2, A
Oldcastle Building Systems Div. / Project Services, South Bethlehem (518) 767-2042 — S2, A

NORTH CAROLINA

Buckner Steel Erection Inc., Graham (336) 376-8888 — S2
Carolina Precast Erectors Inc., Taylorsville (828) 635-1721 — S2
T & M Concrete, Inc., Waxhaw (704) 843-3292 — S2
Tri State Erectors, Inc., Oxford (919) 603-0922 — A

NORTH DAKOTA

Concrete, Inc., Grand Forks (701) 772-6687 — S2, A

OHIO

Capital City Group, Inc., Columbus (614) 278-2120 — S2, A
Precast Services, Inc., Twinsburg (330) 425-2880 — S2, A
Sidley Precast Group, Thompson (440) 298-3232 — S2
Sofco Erectors, Inc., Cincinnati (513) 771-1600 — S2, A

OKLAHOMA

Coreslab Structures (OKLA), Inc., Oklahoma City (405) 632-4944 — S2, A

PENNSYLVANIA

Century Steel Erectors, Kittanning (724) 545-3444 — S2
Conewago Enterprises Inc., Hanover (717) 632-7722 — S2
High Concrete Group, Denver (717) 336-9300 — S2
Nitterhouse Concrete Products, Inc., Chambersburg (717) 267-4505 — S2
Structural Services, Inc., Bethlehm (610) 282-5810 — 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

TENNESSEE

Hoosier Prestress, Inc., Brentwood (615) 661-5198 — S2

TEXAS

Gate Concrete Products Company, Pearland (281) 485-3273 — S1
Precast Erectors, Inc., Hurst (817) 684-9080 — S2, A

UTAH

Eagle Precast Company, Salt Lake City (801) 966-1060 — S2, A

VIRGINIA

The Shockey Precast Group, Winchester (540) 665-3253 — S2, A
W. O. Grubb Steel Erection, Inc., Richmond (804) 271-9471 — A

WISCONSIN

County Materials Corp., Roberts (715) 749-3927 — S2
Spancrete Industries, Inc., Waukesha (414) 290-9000 — S2, A
Spancrete, Inc., Valders (920) 775-4121 — S2, A
The Boldt Company, Appleton (920) 225-6127 — S2, A

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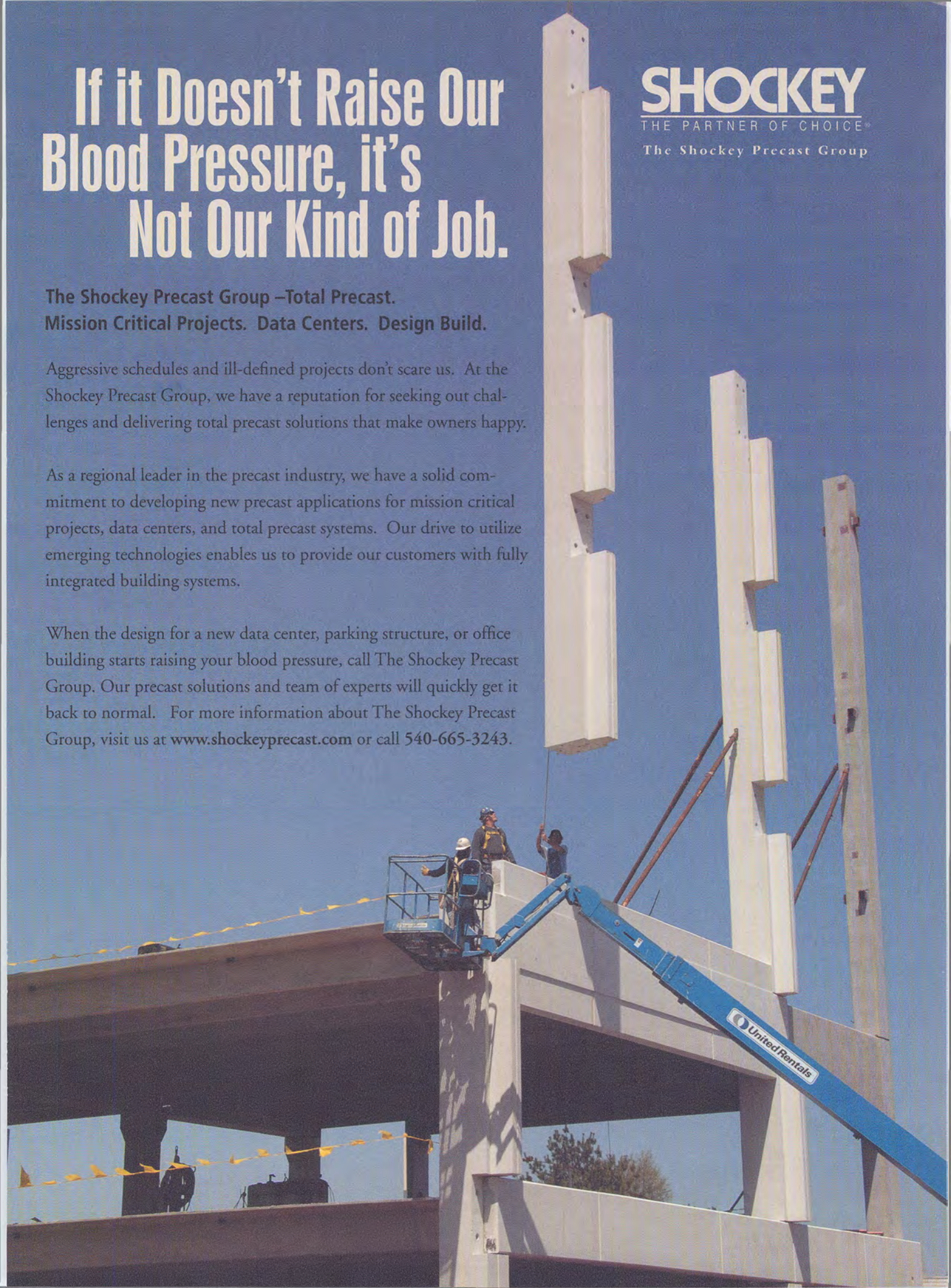
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