WINTER 2011

ASCENT

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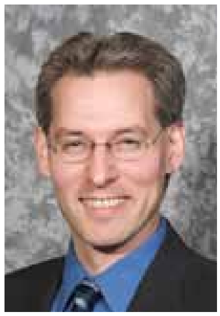
Change = Opportunity



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

We often hear that the only real constant is change, and this is especially true today. We live in a dynamic world where things move faster than we can anticipate. Factors such as the economy and sustainability have forced us to change how we live, spend, think, design, build, conduct business, and even view the world.

We all have to deal with change whether we like it or not. Personally, I am preparing for my almost 16-year-old son to drive, which means I'm wrestling with the ideas of greater insurance rates, increasing stress levels knowing he's out there with two tons of steel at his control, and the fact that my son is growing up. Where did that little boy go who used to want me to read him bedtime stories? However, I am sure this pales in comparison to the day my now eight-year-old little girl comes home with her first boyfriend — hopefully not for another 10 years!

No doubt, change can be scary. However, it can also provide us with great opportunities. Change makes us move out of our comfort zones. It forces us to question, to re-evaluate, and to think outside of the box and consider new options—which may offer more benefits than we expected! It forces us to take a different perspective. This can be a healthy process that helps us advance and evolve. We simply must find those opportunities and embrace them.

There are many architects, engineers, owners, etc. that have not worked with precast concrete, or have only used it for specific applications. But today's economy and emphasis on sustainability encourage us to try new things. Precast concrete is a great option for all types of projects, including multi-family housing, schools, universities, healthcare facilities, bridges, offices, retail centers, and of course, parking structures, while providing incredible opportunities to contribute to sustainable goals.

As this issue's articles show, more military projects — both domestic and international — are taking advantage of the benefits of precast concrete. Precast concrete's inherent strength can be used to protect our loved ones in the military. Recently, the Marine Corps used precast concrete for the first time. Parris Island is in the process of completing several barracks constructed from structural precast concrete. You can read more about the project on page 32.

Ascent magazine is changing, too. This is our first issue as the magazine returns to its quarterly production schedule, and we will be making changes based on your feedback. You will see that *Ascent* has some new sections, including **Sustainable Insights**, which focuses on a particular area of sustainable design, and **Perspective**, where industry professionals provide their viewpoint and experience on a topic of interest. We welcome your feedback as we continuously improve *Ascent*, and strive to provide you with a valuable, insightful, and enjoyable resource.

I encourage you to embrace change and seek out the opportunity that enviably comes with it. As for me, I'll just have to get used to being able to send my son to the store the next time we need milk on a cold Chicago winter day, while I wait warmly by the fireplace. Change really can be for the better.

PCI
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ASCENT

On the cover: Wright Patterson AFB Sensor Lab (see page 16)

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Dulles Metrorail Starts Construction
DENVER, PENNSYLVANIA

High Concrete Group LLC has been named to produce architectural-cladding enclosures for the new Dulles Corridor Metrorail project. Planned for completion in 2013, the 325,000-square-foot transit project includes thermally efficient precast enclosures for five metro-station buildings, six entrance pavilions, and two ventilation structures. Erection of the pieces will start in the spring.

The precast panels and related components are being produced at High Concrete's Denver, Pa., plant. The cladding will feature a utility-size brick-veneer finish in two colors. About one-third of the panels will feature CarbonCast brand insulated sandwich wall panels to provide continuous insulation for thermal efficiency.

The $20 million contract, awarded by Dulles Transit, is part of the first phase of the Metropolitan Washington Airports Authority's two-phase, 23-mile extension of the existing Metrorail system from East Falls Church, Va., to the airport west of Ashburn, Va.

PCI Launches SmartBrief Newsletter
CHICAGO

The Precast/Prestressed Concrete Institute has teamed with the **SmartBrief** email news service to provide a free weekly e-newsletter to architects and other A/E/C professionals. The free service provides a summary of building news, trends, and best practices.

The e-newsletter offers updated schedules of continuing education opportunities, such as webinars, seminars, workshops, lunch and learns, and more. Included will be a variety of PCI programs available for professional learning credit.

"This service ensures architects, engineers, and contractors have access to a quick overview of key information in the building industry, geared to their needs, every week," says James G. Toscas, P.E., president of PCI. "It's a convenient way for them to receive the most relevant and important information in a quick digest."

Nearly 3 million professionals in 25 key industries use SmartBrief each week. More than 100 trade associations, professional societies, nonprofits, and corporations offer these targeted news briefs.

To register, visit www.pci.org and click on the SmartBrief icon or go directly to www.smartbrief.com/pcibi.

Gate Concrete Products Changes Name
JACKSONVILLE, FLORIDA

The Gate Construction Materials Group has announced that all eight of its facilities manufacturing architectural and structural precast concrete products will now operate under the name **Gate Precast Co**. The name has been used by the company's structural-precast concrete plants in Jacksonville, Fla., and Pearland, Tex.

Underground Vaults Built at Bennett College
GREENSBORO, NORTH CAROLINA

Oldcastle Precast Inc.—Fuquay-Varina was contracted by Hardin Construction Company LLC to design, engineer, and manufacture two custom underground precast concrete-panel vaults used as sand filters for storm-water runoff at the new Global Learning Center and Honors Housing Project at Bennett College. **HADP Architecture** is the architect of record on the $22 million project, scheduled for completion later this year.

Oldcastle Precast has frequently used this technique for constructing storm-water management systems in the western United States, but it is a newer approach for the Carolinas, a spokesperson said. Some of those existing systems are almost as large as a football field at 280 feet long and 85 feet wide. The designs for this project comprise a vault 16 feet wide by 33 feet long by 9 feet high for the housing project and 16 feet wide by 44 feet long by 12 feet high for the learning center.

AltusGroup's CarbonCast Earns ICC Acceptance
BETHLEHEM, PENNSYLVANIA

CarbonCast High Performance Insulated Wall Panels made by **AltusGroup** members have received International Code Council Evaluation Service (ICC-ES) acceptance criteria for the C-Grid carbon-fiber-grid truss system used to connect the inner and outer wythes of precast concrete wall panels.

The acceptance means that the ICC-ES has approved a method for evaluating product samples from each AltusGroup precaster licensed to fabricate the system. Successful completion of the tests, such as load capacity and freeze-thaw cycling, will result in ICC-ES issuing an Evaluation Service Report (ICC-ESR) number certifying that the manufacturer is producing the CarbonCast precast concrete sandwich wall panel system according to established standards.

Many municipalities and building jurisdictions require an ICC-ESR certification before allowing the use of a structural building product. Ongoing product-testing success by the 13 AltusGroup precasters is expected to result in ICC broadening its acceptance criteria to include the entire precast assembly, not just the carbon-fiber-grid connector.

Science Center's Precast Walls Beat Deadline
DENVER, COLORADO

Stresscon Corporation, one of EnCon Companies' fabrication plants, has completed erection of the precast concrete walls for the new Fort Collins Museum and Discovery Science Center. **Hensel Phelps**, the general contractor, used EnCon's 7-inch-thick Structural Plus walls in a cinnamon color for the shell.

The walls, manufactured at the company's Dacono, Colo., plant, consist of 97 individual precast concrete sections, the largest of which is 42 feet tall. The panels were erected by January 12, six days ahead of schedule.

The museum building is laid out to resemble a piano, according to Project Manager Mike Rettig. "The angles of the serpentine walls and shape of the roofline make for some very complex angles, but the use of Stresscon's Structural Plus wall panels and the close coordination between trades helped the project avoid field issues."

The City of Fort Collins Museum and the nonprofit Discovery Science Center, which merged in 2009, are planning to install several exhibits in the 47,000-square-foot building shell. They will include the world's most technologically advanced large-format 360-degree theater, called a digital dome. It will feature interactive educational shows, planetarium-style programs, and movies on science, history, and cultural subjects.

PCI Opens e-Learning Center
CHICAGO

The Precast/Prestressed Concrete Institute will soon open the **online PCI e-Learning Center**. This web-based continuing education resource provides architects and other construction professionals with access to short educational courses 24 hours a day, seven days a week. Most of the courses are free and contribute to continuing education credits.

PCI is a registered continuing education provider with the American Institute of Architects, National Council of Examiners for Engineers and Surveyors, and U.S. Green Building Council. Visit www.pci.org/education to learn more about the courses.

Mixed-Use Project Uses Precast System
CLEARWATER BEACH, FLORIDA

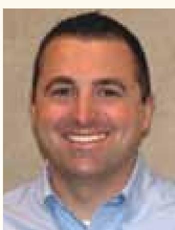
Finfrock is providing complete design-build services for Surf Style Retail Management's new mixed-use facility in Clearwater Beach. The $11.5 million retail and restaurant complex includes 175,300 square feet of space and parking for 344 cars. The building is scheduled to open in May.

Photo courtesy of Finfrock.

Personnel Moves

– *Mo Wright*

Mo Wright has been added to the sales and marketing staff at **Gate Precast Co.** Wright, who has worked in the construction industry for 15 years, will be responsible for servicing clients for architectural precast concrete systems in Alabama and Georgia.



– *Mitch McCaulley*

Thermomass has promoted Mitch McCaulley to national accounts manager. Previously, he served as regional sales manager for the upper Midwest.

– *Chuck Gilbert*

Chuck Gilbert has joined **Spancrete** as regional sales manager for Illinois, where he will work with architects and other clients to maximize use of the company's value-engineering and design-assist capabilities.

Rotondo Weirich has hired Mike Sexton in its business-development department to develop relationships with clients and business partners.

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

Metromont Acquires Royal Concrete Concepts

GREENVILLE, SOUTH CAROLINA

Metromont Corp. has acquired a majority interest in **Royal Concrete Concepts** in West Palm Beach, Fla. RCC was founded in 1989 and manufactures custom precast concrete modular building systems for residential, educational, commercial, and military projects.

RCC also provides turnkey construction services for domestic and international markets. The company recently expanded its manufacturing facility on a 180-acre site in Okeechobee, Fla.

"The investment in RCC allows us to further diversify our business with additional building systems and grow in other market segments," says Rick Pennell, president/CEO of Metromont. "This partnership will strengthen both companies."

PCI Seeks Student Designers

CHICAGO

PCI invites architectural students to participate in the **2011 Architectural Student Design Competition**. Entries are due by May 27, 2011, and Design Award winners will be announced in July 2011.

Submitted projects should address total-precast concrete design solutions for multi-unit housing, including concepts for duplex, apartment, senior, and extended-care housing projects, as well as hotels, motels, dormitories, and military barracks. Awards for selected submissions will be presented at the PCI 2011 Annual Convention & Exhibition, taking place October 22–25 in Salt Lake City, Utah.

For more information, visit www.pci.org and click on Education, then Architectural Competition, or contact Roger Becker at rbecker@pci.org or (312) 360-3213.

Target Store Design First for Colorado

LAKEWOOD, COLORADO

The new Belmar Target store in Lakewood, opening in March, was built on a precast concrete elevated podium, allowing for parking beneath the store. The store, the first of its kind in Colorado, is situated on 5 acres of land, creating a relatively small construction site. That restriction dictated the podium approach, according to Dave Mahan, business development manager at **Stresscon Corporation**, which is providing the precast concrete components.

The project is designed to achieve a LEED Silver certification, to which the precast concrete components will contribute for their use of regional materials and other factors. The precast concrete components include more than 130,000 square feet of double tees, more than 2000 linear feet of beams, more than 5600 square feet of spandrels, more than 56,000 square feet of wall panels, and other components.

Oldcastle Produces 2,100 Prison Cells

TELFORD, PENNSYLVANIA

Oldcastle Precast Modular has been awarded the precast cell contract for the new State Correctional Institution Graterford East and West project in Pennsylvania. The $365 million prison will be one of the largest correctional projects in progress in the United States. The East facility will incorporate more than 2,100 Level-4/Level-5 maximum-security beds and the West facility will include 2,000 Level-3 medium security beds.

Oldcastle will design, engineer, manufacture, and erect 2,112 single- and double-occupancy precast concrete cells and 68 bare shower modules for the main housing units. The cells will feature a secure ceiling monolithically cast with the upper cell modules to prevent inmate access to the mechanical areas. Oldcastle also is installing detention furniture, sliding-door frames, lights, window, interior wall paint, exterior wall insulation, and formliner finish.

Walsh Construction and **Heery International** (Walsh/Heery Joint Venture) are the principal builders, while **Astorino, Heery Design Group**, and **KZF Design** are the architects of record.

PCI Continuing Education

Approved Provider

PCI is a registered continuing education provider with the American Institute of Architects, the National Council of Examiners of Engineers and Surveyors , and the U.S. Green Building Council. PCI provides several options for you to engage in continuing education programs including webinars, seminars, lunch-and-learns, and the new PCI E-Learning Center. To learn more, visit www.pci.org/education.

Webinars

PCI webinars are presented live each month by industry experts on a variety of topics, from design and construction to sustainability and more. All webinars are FREE, one - hour long, and scheduled to provide a 12:00 noon start time in each time zone in the continuous United States. Webinars provide an inexpensive way to keep up to date on new materials, products, concepts, and more while earning continuing education credits. Next webinars:

Designing Building Envelopes to Meet Sustainable and Aesthetic Goals

- Part 2 – February 15 & 17, 2011

The International Green Construction Code: A Preview

- March 29 & 31, 2011

Seminars

PCI also provides in-person continuing education via seminars and lunch-and-learns.

The next seminar series is:

PCI Structural Design Seminar This is an advanced course for those who have designed with precast/prestressed concrete in the past. This course will guide the attendee through the design of a three-story, integrated precast office building with the *PCI Design Handbook* (7th edition) as a reference. Attendees will run calculations, review erection drawings, and learn how collaborations with the producer of structural concrete products can streamline the relay of technical information to the production floor to ensure a final product that strictly adheres to specification and design. Don't miss this highly interactive course! Visit www.pci.org/dhbseminar for dates, locations, and more information.

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CONTINUING EDUCATION AIA

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USGBC EDUCATION PROVIDER

The International Green Construction Code Is Coming—Are You Ready?

— Greg Winkler, AIA, LEED AP

When the U.S. Green Building Council (USGBC) introduced the LEED™ ratings system in 2000, it revolutionized the sustainability movement. For the first time, the building industry in the United States could measure sustainability against a simple rating system that spanned a wide range of environmental goals. Today, more than 6,300 buildings are LEED certified, and more than 21,500 buildings are registered with the USGBC to become LEED certified. Sustainable design has become one of the most influential factors in today's buildings industry, and has continued to grow–even through a slowed economy.

In the last few years, however, the LEED rating system has faced some criticisms, particularly over the fact the system does not include a means for measuring the energy performance of new facilities. The LEED program is essentially predictive in nature. It relies on the premise that the ratings structure will produce buildings with better energy performance and life-cycle cost characteristics, but does not include incentives that make energy performance a priority in accumulating points, or requirements to measure the actual performance after construction (LEED 2009 does require sharing of "all available data" with USGBC for a period of five years following certification).

Today, LEED's popularity and status as the acknowledged leader among green rating systems have resulted in more than 200 jurisdictions benchmarking components of LEED as part of their construction code or zoning ordinances. Although this represents a small fraction of the approximately 12,000 code jurisdictions nationwide, the trend is obvious: cities and municipalities across the country are seeking a way to promote green practices in construction and waste management.

Surveying the prospect of an increasingly fragmented code environment, the International Code Council (ICC) launched the creation of the International Green Construction Code (IgCC) in 2008. Their initial partners in this effort were the American Institute of Architects (AIA) and the American Society for Testing and Materials (ASTM). This group was later joined by the USGBC; the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) and the Illuminating Engineers Society (IES) as part of an alliance that accepted ASHRAE's Standard 189.1 as a compliance alternative to the IgCC.

The IgCC is organized into six performance chapters addressing 37 specific areas of sustainability. Written in both performance and prescriptive (regulatory) language, the IgCC is an overlay code that should work well with the existing family of ICC codes.

Local jurisdictions will find much to like in the IgCC:

- Their existing code enforcement administration can enforce compliance through standard procedures, though additional expertise may be required to review the compliance documents.
- Mandatory language sets minimum levels of compliance in each category, but some requirements are scalable to allow jurisdictions to increase the standards.
- Jurisdictions are not required to accept the entire code. They can adopt only those sections that are beneficial to their locale.

Whether owners and design professionals will find the code as desirable is an open question. Architects who have grown accustomed to working with the LEED requirements will likely find the IgCC to be a brave new world with both advantages and disadvantages compared with the sustainability world they now know:

- The IgCC places a premium on calculating building performance during design and measuring it afterwards. How design professional liability will be affected when a building does not meet expectations remains to be seen.
- A whole-building life-cycle assessment can be selected by the owner as an IgCC project elective, one route to comply with overall jurisdictional requirements. This assessment could

– Greg Winkler, AIA, LEED AP is the executive director of the Mid-Atlantic Precast Association (MAPA), a precast concrete trade organization representing twelve diverse manufacturers in six states and the District of Columbia. A graduate of Georgia Tech with a Master of Architecture degree, Greg has over 27 years of experience as an architect and project manager. He is the author of three construction-related books, and is currently writing a book on the International Green Construction Code for McGraw-Hill Professional.

potentially be a value-added resource for owners, as well as a way for architects or engineers to provide an additional service that helps owners understand the ultimate cost of a building's operation and maintenance.

- In contrast to LEED's template-based system, calculations to document IgCC compliance in a category are usually short and based on established engineering criteria.
- Buildings must be designed around a 60-year expected life.
- If adopted by the jurisdiction, buildings must be commissioned, owners must be provided full operation and maintenance data, and equipment training and building energy consumption must be monitored after occupancy.

Jurisdictions, at their option, may allow design professionals to use ASHRAE Standard 189.1 as an alternative to complying with the IgCC. ASHRAE describes Standard 189.1 as follows:

> "Standard 189.1 provides a 'total building sustainability package' for those who strive to design, build and operate green buildings. From site location to energy use to recycling, this standard sets the foundation for green buildings by addressing site sustainability, water use efficiency, energy efficiency, indoor environmental quality, and the building's impact on the atmosphere, materials and resources."[2]

Public Version 2.0 of the IgCC is now available for download and comment on the ICC website (visit www.iccsafe.org). Final revisions to the code will be made at a conference in November 2011, and the IgCC is scheduled to be issued in March 2012. Interestingly, Rhode Island has already adopted the code even before its completion.

The IgCC holds the potential to fundamentally change the focus of sustainability in the United States. It should promote more energy-efficient, durable, and maintainable construction. The future of LEED, and its relationship to the IgCC, remain uncertain. Some believe that LEED will work to raise the performance ceiling while IgCC raises the code-required floor of sustainability. Because it contains scalable requirements that can be adjusted by each jurisdiction, others believe that the IgCC holds the potential to accomplish both goals. What seems clear, however, is that the future of green construction lies in paying much closer attention to building operation and performance, where costs and environmental impact far outweigh those of construction. Sustainable codes and programs seem to be moving in the direction of more high-performance-based standards, where energy consumption is considered the predominant measure of greenness. This, perhaps, is where the true heart of sustainability lives. ■

Notes:

1. Murphy, Pat. "Leading from Behind." *New Solutions* #18.1, May–June 2009. The Arthur Morgan Institute of Community Solutions.
2. American Society of Heating, Refrigeration, and Air-conditioning Engineers (ASHRAE). The Green Standard. http://www.ashrae.org/publications/page/927. Accessed January 4, 2011.

Precast Aids Uncle Sam

Precast concrete structural and architectural systems are being used more and more by the military in all types of construction

— Craig A. Shutt

Designing military projects for the federal government can be challenging work, owing to additional restrictions, paperwork, and other obstacles. But those who can thrive under those conditions find a wide range of projects being constructed. In many cases, those projects are using precast concrete components more often, as government agencies become aware of the benefits and designers and contractors show how efficiently these designs can be produced.

"Working with the military is not necessarily a disadvantage, you just have to know how they want to work," explains James Cheng, design principal for project design at Emersion Design in Cincinnati, Ohio. The company, three years old, has grown from seven to 25 people in part due to its military work, an impressive feat considering the tough economic times.

"The government has a very structured process. If you're used to doing things in a quick and streamlined fashion, it can be frustrating. But if you can deal with their system, there are benefits." One of the benefits is a clear structure for engaging the many stakeholders from whom input must be gained and balanced during the design process, he explains. "The military system creates a process for building consensus with some very large and complex client groups with multiple parties involved."

Steve Moller, senior architect and project manager at PBS&J, an Atkins company, based in Austin, Texas, agrees. He helped design a recently completed Armed Forces Reserve Center in San Marcos, Texas, which used a total-precast concrete system for the structural frame. "The challenge of military projects is often not the building itself, it's demonstrating to multiple parties, each with its own specialization, that all aspects of multiple—overlapping, sometimes conflicting, sometimes ambiguous—regulatory documents are satisfied."

In more cases, he notes, precast concrete components are helping to meet those challenges. "Precast concrete very quickly satisfies issues of durability, sustainability, and Anti-Terrorist Force Protection (AT/FP). It's perfect for AT/FP needs. Its great mass means that you don't have to demonstrate the testing and engineering analysis that's often required to ensure a lighter design meets the standards."

> 'The military system creates a process for building consensus with some very large and complex client groups.'

Those standards also help precast concrete projects meet stringent needs for hurricane protection along the Gulf Coast, he adds. "Hurricane needs are very similar to AT/FP requirements, and precast concrete can meet both of them easily. The material also provides inherent fire protection and insulation."

Precast concrete contributes to a host of credits for achieving Leadership in Energy & Environmental Design (LEED), due to its benefits toward sustainable design. Those benefits are critical for military projects, as all government construction must meet a Silver (level two of four) rating.

"Precast concrete is very favorable for gaining LEED points," says Moller. "It's a renewable material, recyclable, and locally manufactured. It also provides great thermal mass that can greatly contribute increasing energy efficiency. Those are all big points."

It also aids the designer in achieving aesthetic goals, adds Cheng. "In general, precast can be an advantageous material because it's so versatile," he explains. "Many projects are adding to existing bases, where a certain character has been established. Some of the new buildings may be utilitarian, while others will be more prominent. The aesthetic versatility of precast concrete can be useful because it has such a range of expression. With military projects, it's important to pay attention to the subtleties of expression while remaining within the same palette of materials."

Design-Build Favors Precast

A key reason that precast concrete's benefits are becoming more apparent stems from the government's long use of design-build processes to speed schedules and leverage the designer and contractor's unique expertise. Federal projects have been using this concept for about 15 years, designers report.

Typically, a lead designer prepares a Request for Proposal (RFP) that includes a schematic floor plan and a project book with performance specifications and expectations, plus options for structural framing and other systems, explains Moller. "Today, those structural options include precast concrete components."

On its recent project, PBS&J worked with Satterfield & Pontikes Construc-

Fact Sheet

Project: *Swimmer & Fitness Center at Pensacola Naval Air Station*

Location: *Pensacola, Fla.*

Architect/Engineer: *C. H. Guernsey & Co., Oklahoma City, Okla.*

Contractor: *Dick Corp., Pittsburgh, Pa.*

Owner: *U.S. Navy, Pensacola, Fla.*

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

Precast Specialty Engineer: *PTAC Consulting Engineers, Pensacola, Fla.*

Project Size: *153,439 square feet*

Precast Components: *Total-precast concrete structural system, including load-bearing wall panels and double tees*

The Navy training facility at Pensacola, Fla., features architectural precast concrete panels, a double-tee roof system and hollow-core floors. The system met the architectural requirements as well as AT/FP and structural-durability needs.

A total-precast concrete structural system was used to create the building shell for the 34,844-square-foot Navy training facility at Pensacola, Fla.

Precast concrete double tees allowed an open plan for the swimming center at the Navy training facility and provided a base for overhead equipment to aid in training exercises.

tion in Austin, Texas, which served as the prime contractor on the design-build project. PBS&J produced documents to about 30% of the full design based on the RFP while S&P presented the team qualifications, along with its guaranteed maximum price and the planned schedule (always shorter than what is allowed in the documents). S&P's concept using a total-precast concrete system was selected for the project due to its speed, value, durability, and other benefits.

Naval Air Station

The range of capabilities that precast concrete can provide for a military project can be seen in several completed recently around the country. The Swimmer & Fitness Center at the Naval Air Station in Pensacola, Fla., was so distinctive that it won the 2009 PCI Design Award from the Precast/Prestressed Concrete Institute for its use of a total-precast concrete structural system to meet a number of key challenges. The building had to withstand both external moisture and wind threats, especially from hurricanes, as well as interior moisture concerns about mildew and mold due to the high humidity in the pool area.

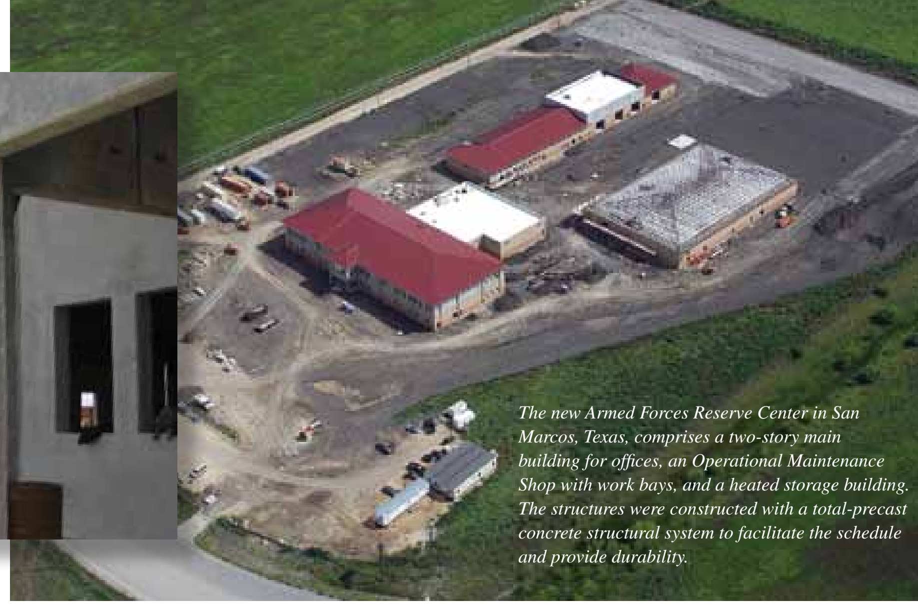
The 34,844-square-foot building provides a facility to train Navy personnel to rescue swimmers. It includes an indoor wave pool that is 82 feet long and 168 feet wide (large enough to hold two opened parachutes). Above the pool are two simulators, each with a hoist and platform. An adjacent 53,857-square-foot Physical Fitness Center provides students with recreation facilities, including two basketball courts, a fitness/aerobic center, racquetball and handball courts, a multipurpose room, a martial arts room, and more.

To span these complex spaces and complete the project in rapid time, designers at C. H. Guernsey & Co. in Oklahoma City, Okla., specified a total-precast concrete structural system that incorporates architectural precast concrete panels, a double-tee roof system, and hollow-core floors. The system met the architectural requirements as well as AT/FP and structural-durability needs for building in Florida weather conditions, according to David Oman, director of architecture.

"The architectural precast concrete walls serve multiple roles within the building system," explains Jim Lewis, LEED AP, director of architectural systems at Gate Precast Co. in Jacksonville, Fla. "The walls are designed to carry the loads from the double-tee roof system and provide hurricane protection."

The panels feature an inlaid thin-brick system that allowed the designers to enhance the architectural expression using brick quoin corners, he says. The 10-inch-thick walls contain 2 inches of Isocast-R polyisocyanurate

The panels at the Armed Forces Reserve Center were erected in a vertical fashion, facilitating the design of bays and other penetrations.



The new Armed Forces Reserve Center in San Marcos, Texas, comprises a two-story main building for offices, an Operational Maintenance Shop with work bays, and a heated storage building. The structures were constructed with a total-precast concrete structural system to facilitate the schedule and provide durability.

Clear spans were provided for the facilities at the Armed Forces Reserve Center by using 24-inch-deep double tees to span the spaces. The double tees rest on corbels cast into the interior face of the load-bearing precast concrete wall panels.

Fact Sheet

Project: *Armed Forces Reserve Center*

Location: *San Marcos, Texas*

Design-Build Contractor: *Satterfield & Pontikes Construction Inc., Austin, Texas*

Lead Architect/Engineer: *PBS&J Architecture, an Atkins company, Austin, Texas*

Owner: *Texas State Army Reserve and National Guard*

Precaster (structural components and panels): *Heldenfels Enterprises, San Marcos, Texas*

Precaster (hollow-core slab): *Gate Concrete Co., Pearland, Texas*

Precast Structural Engineer: *Schwab Structural Engineering Inc., New Braunfels, Texas*

Precast Concrete Erector: *Precast Erectors Inc., Hurst, Texas*

Project Size: *109,000 square feet*

Precast Components: *Total-precast concrete structural system, including columns and beams, double-tee beam, hollow-core slabs, load-bearing wall panels*

Project Cost: *$29 million*

'The precast concrete design facilitated the fast-track schedule.'

insulation, which provides an R-value of 13. The vapor barrier is built into the facer, eliminating the risk of condensation forming on the building's interior.

During the erection process, the 31-foot-tall wall panels were braced until the 103-foot-long double tees were set on them. The double tees span the entire roof structure in the pool portion of the building, avoiding any additional column supports that would create obstacles. A recessed slot was cast into the back of the panels to support the stems of the double tees, which rested on the corbels.

A 150-ton crane was used to erect the first 101 brick-inlaid architectural panels around the pool's perimeter, including 58 insulated panels. The panels had electrical boxes and conduit cast into them at the plant to speed installation at the site. Four double tees were erected per day once the panels were erected and braced.

"The total-precast concrete structural system helped to create a building that is aesthetically pleasing, environmentally responsible and functional for the owner's needs," says Lewis.

Armed Forces Reserve Center

A total-precast concrete system also was used to construct the Armed Forces Reserve Center in San Marcos, Texas, which consists of three main buildings. "Each building serves a specific purpose and had unique design requirements," says Gil Heldenfels, vice president and general manager at Heldenfels Enterprises Inc. in San Marcos. The company provided structural precast concrete components, while Gate Precast Co. in Pearland, Texas, provided precast concrete hollow-core slab.

The project comprises a 56,000-square-foot, two-story main building for offices, training facilities, and an attached one-level assembly center; a 25,700-square-foot Operational Maintenance Shop (OMS) with work bays; and a 29,700-square-foot heated storage building and vault. All three were designed with total-precast concrete structural systems, consisting of grade beams, hollow-core slabs and double-tee beams, column-and-beam structural framing, and load-bearing exterior CarbonCast high-performance insulated wall panels.

The main reason for selecting the total-precast concrete system was the need for quick completion, explains Moller. "The precast concrete design facilitated the fast-track schedule. This project to a great degree was driven by the goal to meet the tight schedule deadline. The speed with which a precast concrete building shell can be constructed is a significant advantage. Additionally, the Heldenfels precast plant is within a few miles of the project site, which provided tremendous savings over typical transportation costs."

The precast concrete components could be cast while site preparation was under way, he explains. Much of that work centered on providing a secure foundation, as the site had poor soil for construction. The location is near a geological fault that rises 200 feet near the site's edge, leaving black clay soil at the site and high rock nearby. Approximately seven feet of soil was removed beneath each foundation to create a void, and a precast concrete suspended foundation was installed.

The double-tee slabs used in the foundation rest on cast-in-place piers an average of 35 feet deep into the clay soils, explains Heldenfels. The tees transferred vertical and shear load to the foundation via three connection types. For continuous beam-to-beam connections, the beams bear directly on the piers. For corner or junction connections, a pier cap distributes the loads into the piers. For load-bearing columns, the grade beams were set into haunches on the column directly bearing on the piers.

BIM Aids Design

The project used a building information modeling (BIM) system to help coordinate the architectural design, structural elements, and MEP components early in the process. "Institutional clients more and more are requiring BIM on their projects, and we have an internal dictate at PBS&J to use it whenever we can," Moller says. Satterfield & Pontikes also has been using it for five years, making it easy for the designers and the contractor to develop buildings together. "It's a help for designing the structural systems, and it's a great aid for conflict resolution when adjustments have to be made at the site."

Early communication was critical, Moller notes, due to the total-precast concrete system being cast while other site work progressed. "The structural package had to be submitted early so the precaster could fabricate the pieces. That meant many decisions we made early could not be changed. This early coordination helped to ensure the MEP fit properly when the pieces arrived. They had to fit, because adjusting the location of penetrations was not an option."

Although this approach locked in certain decisions, it proved advanta-

The new office building constructed as part of the sensors-lab project at Wright Patterson Air Force Base serves as the high-profile gateway to the campus. Precast concrete panels helped it achieve a dramatic appearance.

In addition to the high-profile office building, the new complex at Wright Patterson Air Force Base includes two high-tech sensors laboratories that offer a monolithic appearance. The precast concrete architectural panels helped to tie the two styles together while achieving the functional goals of each.

This overview of the Wright Patterson Air Force Base project shows the new construction, with white roofs. The work included a high-profile office complex (at bottom) and indoor/outdoor ranges (center).

Fact Sheet

Project: *Sensors Lab at Wright Patterson Air Force Base*

Location: *Dayton, Ohio*

Project Designers: *Emersion Design, Cincinnati, Ohio, (architecture); Advanced Engineering Consultants, Columbus, Ohio (MEP); and Barge Waggoner Sumner & Cannon, Dayton, Ohio (civil).*

Design/Build Contractor Team Architects: *Edged & Tinney Architects, Dayton, Ohio, and Kling Stubbins, Philadelphia, Pa.*

Structural Engineer: *THP, Cincinnati, Ohio*

Contractor: *Butt Construction Co., Dayton, Ohio*

Owner: *Army Corps of Engineers*

Precaster: *High Concrete Group Midwest Region, Springboro, Ohio*

Project Size: *98,000 square feet*

Precast Components: *113,000 square feet of architectural wall panels*

Project Cost: *$50 million*

geous from a speed standpoint, he adds. "Once the precast components were designed and approved, there was no reason to review those design elements again. There was no second-guessing or reconsiderations of the roof slope or window configuration or those types of decisions that often arise. That saved time."

In the office facility, 8- and 10-inch hollow-core slabs serve as flooring where additional structural capacity was needed to support heavy MEP components, with raised access flooring used in some locations. The attached assembly area features 24-inch-deep double tees for both flooring and roofing, where a 70-foot clear span was needed.

The double tees also were used to meet clear-span requirements for the OMS building, while the same cross-section with a 2-inch thickened deck handles floor loading. Load-bearing precast concrete columns were used to support the bridge-crane tracks over the maintenance bays.

The vault section of the storage building was constructed with cast-in-place concrete on precast grade beams. The rest of the structure consisted of precast concrete components, including grade beams with double-tee floor and roofing beams.

The panels were erected in a vertical fashion, with no connection complications. "All of the structural elements for the office building were delivered and erected in 14 days. The roof system of double tees was placed on all three buildings to finalize the assemblies.

"We kept the appearance simple," Moller says of the panel designs. "We wanted to have the building's massing reflect its composition of precast concrete and not hide its function."

Adds Heldenfels, "The fully integrated design-build approach led to a very energy-efficient building that was constructed at a rapid pace, yet it will maintain its durability for an extended lifecycle. All of the precast components were perfectly suited for the needs, and by taking an integrated approach to the design, cost savings were realized in both the design and construction."

Air Force Sensors Lab

The versatility of architectural precast concrete panels can be seen in the range of expression they provided for drastically different buildings at the Wright Patterson Air Force Base in Dayton, Ohio. A total of 113,000 square feet of precast concrete wall panels were used in the project, which includes a 56,000-square-foot, four-story office building and two connecting indoor/outdoor range buildings containing 19,000 and 23,000 square feet, where sensitive equipment is tested.

"Precast concrete panels were used to provide architectural compatibility with other structures in the complex," explains Emersion Design's Cheng. "The existing buildings had a specific 1960s character that consisted of precast concrete panels, and the base officials wanted to extend that character and ensure the new buildings created an enhanced but coherent campus with the existing buildings." That appearance featured horizontal reveals and protrusions that new panels could replicate easily.

Precast's capabilities came into play due to the dissimilarities in the buildings' uses, he explains. "The range buildings are windowless and internally focused, with a crisp functional appearance to them, whereas the office building is a high-tech facility for researchers that serves as a new gateway to the campus and required a high profile. Precast concrete allowed us to meet the needs of both ends of that spectrum in this one project."

'Precast concrete panels were used to provide architectural compatibility with other structures in the complex.'

Achieving the specific look for the office building required a careful balance, he notes. "The command headquarters needed to have an elevated design statement, but, as a publicly financed building, it couldn't look frivolous or extravagant. It had to convey strength and stability while also projecting an image of sophistication and contemporary dynamics to represent the type of work done here. Precast concrete offered a lot of advantages in balancing those needs."

The panels feature two face mixes and two finishes, with acid etching and exposed-aggregate designs to create contrast. The headquarters building also required insulated sandwich wall panels, which included C-Grid carbon-fiber wythe connectors, according to Dwayne Robinson, project manager at High Concrete Inc. in Denver, Pa. The connective system provides a non-corrosive, non-thermally conductive connection and has a higher tensile strength than steel, he says.

Precast Aided Schedule

Using precast concrete on the project also helped meet the construction schedule, which was tight, adds Chuck Cheadle, project manager for Butt Construction Co. in Dayton. "The panels could be installed quickly, and since there are no other construction materials on the exterior, they could be erected and the windows installed on the office portion quickly. That meant we were done with the exterior and could move inside."

The panels also were less dependent on weather conditions than other types of structural systems, he says. "They go up quickly regardless of the weather. We could erect them in any weather, which we needed on this project."

The panels on one of the ranges were erected in a vertical fashion, covering the 70-foot height quickly. The ranges feature smooth textures on the interior, while the office complex was furred out, insulated, and finished with drywall to provide a traditional office appearance.

Butt Construction has worked on a number of projects that featured precast concrete panels in addition to the $50 million sensors-lab project, Cheadle says. Those include construction of offices and lab space for the 711th Human Performance Wing that is now under construction at the base. That $200 million project also features architectural precast concrete panels, with construction to be completed in March. To date, the project has been running ahead of schedule.

Armed Forces Retirement Home

After living and working in and around many precast concrete buildings during their military service, it only makes sense that military personnel would continue to be around the material after they retire. The new Armed Forces Retirement Home in Gulfport, Miss., allows that to happen and will help ensure it remains

The new Armed Forces Retirement Home in Gulfport, Miss., features four pavilions clad in architectural precast concrete panels that house 582 units serving as continuing-care retirement living for veterans.

Moisture penetration in the wake of Hurricane Katrina focused attention on the connection system.

Architectural precast concrete wall panels at the new Armed Forces Retirement Home were designed to fit snugly around balconies and other projections. The design is the first along the Mississippi coast designed to withstand winds of more than 200 mph in a Category 5 hurricane.

Fact Sheet

Project: *Armed Forces Retirement Home*
Location: *Gulfport, Miss.*
Architect: *URS Corp., New York*
Contractor: *W. G. Yates & Sons Construction Co., Philadelphia, Miss.*
Owner: *General Services Administration, Washington, D.C.*
Precaster: *Tindall Corp., Mississippi Division, Biloxi, Miss.*
Project Size: *660,000 square feet*
Precast Components: *1,075 architectural wall panels*
Project Cost: *$193 million*

serviceable for many decades. The project replaces a center severely damaged by Hurricane Katrina that ultimately was demolished in 2007.

The center features four pavilions rising from the main floor, with a parking level on the ground floor. A waterfront landscaped green area with walking paths, bicycle trail, reflecting, and swimming pool surround the 660,000-square-foot main building, which provides 582 units as continuing-care retirement living for veterans. The complex was clad with architectural precast concrete wall panels, consisting of 1,075 white panels with minimal color variations. The panels, averaging 15 feet tall, 8 feet wide, and 6 inches deep, feature architectural reveals and a medium sandblast. The design was created to achieve LEED Gold certification and withstand winds of more than 200 mph in a Category 5 hurricane, the first structure built on the Mississippi coast to meet that standard.

To achieve that status required overcoming several key obstacles, according to Alex Guthrie, engineering manager at Tindall Corp.'s Mississippi Division in Biloxi, Miss. "Several post-Katrina construction projects using conventional wall-panel mounting methods had experienced water penetration," he explains. "That concern, plus the massive number of post-tensioned tendons used in the cast-in-place framing system, necessitated the development of a novel system for the cladding-hanging connections."

Working with architect Igor Labuda of URS Corp in Washington, D.C., the precaster designed connections to fix the panels to the roof slab or the bearing point of the balcony's edge and ensured that no penetrations could compromise the waterproofing barrier placed in the cavity of the building envelope. "Tindall took extensive efforts to use the outline of what we needed to achieve and developed an extremely effective system."

About 95% of the panels were erected with four tower cranes, requiring the panels to be designed below a maximum weight to ensure they did not exceed the maximum capacity of two different crane arc charts.

These projects from around the country, providing a variety of functions and levels of security, give an indication of ways that precast concrete is being used in military construction today. Its use no doubt will continue to grow as more design-build options open and designers become more aware of the options and capabilities for using both total-precast concrete and architectural precast concrete wall panels.

Precast Aids the Parking Wars

Benefits in durability, speed of construction, and ability to replicate a variety of aesthetic needs have made precast concrete a popular choice for a range of military campuses.

The Veterans Administration in particular has used precast concrete for a number of parking structures. In Florida alone, the VA has four projects under way using precast concrete components.

In Tampa, work is under way on a 493,000-square-foot, six-story structure for the James A. Haley Veterans Administration campus, adding space for 1,500 cars. The precast concrete components, provided by Coreslab Structures (TAMPA) Inc., comprise double tees, flat slabs, conventional inverted tee beams, and perimeter spandrel beams and columns. Open precast concrete lite walls were used in ramp areas.

Precast concrete was chosen for the project due to its speed of erection, says John Ashby, senior project architect for HDR in Tampa, the architect of record. "They had a very tight time frame for construction, and precast concrete could best meet that schedule and ensure the project was completed in time."

The structure, which began construction last September and is scheduled to be completed in September 2011, is being built over a dry storm-retention pond, which drains storm water for approximately half of the campus. "It's an excellent site location for the parking structure," notes Ashby. "Parking garages usually are built on the site of existing surface parking, so those spaces are lost during construction. This will add completely new parking."

Even so, constructing it over the retention pond added challenges. Flat precast concrete slabs were installed on the first floor, after vibro-compacting the soil. This created an 8-foot "crawl space" beneath the first parking level to provide a cover for the retention pond below. "It didn't change our design or the construction, except for having to elevate the first level above the crawl space," Ashby says.

The parking space is needed both because current demand frequently reaches capacity and also because a Polytrauma center is being built nearby. Scheduled for completion by the end of 2012, that 160,000-square-foot building also features precast concrete architectural panels as its cladding. The parking structure's spandrels will be painted after completion to match the design for the new center. Plans for a walkway connecting the parking structure to the center also are being discussed.

"HDR has done a lot of projects with the military, including a number of precast concrete parking structures," Ashby says. Coreslab also is providing components for a project still in the design stage at the Bay Pines VA facility in St. Petersburg. The parking structure will be four or five levels with approximately 205,000 square feet for at least 500 cars.

Meanwhile, Metromont Corp. in Bartow, Fla., is providing components for a five-story precast concrete parking structure for 660 cars at the Malcom Randall VA Medical Center in Gainesville, Fla. The 224,815-square-foot project features a modular design using a total-precast concrete structural system.

Another VA project currently completing construction involves two eight-level, 515,500-square-foot parking structures at the new VA Medical Center in Orlando. The $656 million state-of-the-art medical complex will include a 134-bed hospital, a 120-bed community living center, a 60-bed domiciliary, an outpatient clinic, and a veterans benefits mini service center. The structures will provide parking for 1,300 cars.

Precast concrete components for the two parking structures comprise wall panels, lite panels, double tees, columns, inverted tee beams, spandrels, and column covers. The spandrels will be finished with a light sandblast, while the column covers will receive an acid etching. Erection was completed by mid-December, and the structures are expected to be open in February, according to Brandy Combs, senior project manager at Durastress Inc. in Leesburg, Fla., which provided the precast concrete components. ■

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

This rendering of the new precast concrete parking structure at the James A. Haley Veterans Administration facility in Tampa, Fla., shows tall vertical elements that will help visitors locate the parking facility upon arrival. Horizontal elements will shade the entries and carry through as design elements in the rest of the construction project.

Erection was completed in December on two eight-level, 1,300-car parking structures at the new Veterans Administration Medical Center in Orlando. The exterior finish includes a light sandblast on upper levels with an acid etching to achieve a different texture on column covers.

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What You Need to Know About Procuring Government Contracts

Overcoming challenges in contracting for design and construction work with the Federal Procurement System can open a new category of projects

— Tom Christensen, Dewberry

Working with the federal government creates challenges unlike those on any other type of design project. But overcoming those challenges can open up a new category of commissions that can greatly boost a company's capabilities and profits. The good news is that some of the more difficult aspects of the work are being changed to make it easier for companies to work through the process.

The benefits of gaining government work are apparent. Federal agencies and the military undertake many projects of all sizes and types, and the work often remains unaffected by construction downturns impacting other markets. Due to the Base Realignment & Closure (BRAC) actions initiated in 2005, for instance, the current downturn is not affecting construction planned by the Department of Defense, which is separated from other budgets.

More Demanding Work

Understanding the specific needs of the federal government's different building owners is critical to succeeding with this work. There are many aspects to the projects that are more demanding and more precise than with other designs.

Government projects often have a variety of social programs written into their processes. These include requirements for providing a percentage of the subcontracts to small businesses, such as those owned by minorities, women, or service-disabled veterans. These subcontractor requirements must be spelled out by the bidder in representations and certifications submitted during the bid-proposal process. In some cases, outlining these requirements can require 20 pages of documentation.

The key obstacle is determining which companies that meet these requirements will be needed to perform functions on a specific project. Bidders often have a group of companies that meet the prerequisites, but they are not necessarily the best companies to handle specific portions of the project being bid. That creates more difficult calculations for awarding subcontracts. Failure to meet the goals can lead to liquidated damages in some contracts and can affect selections for future work.

It is critical for companies interested in working with the government to continually network, recruit, and perform due diligence on small businesses that do quality work in a variety of disciplines and meet the federal requirements, so those firms can be allotted work in bid proposals as needed. Waiting until an RFP is issued to search for companies to handle a percentage of the work will be too late.

More Quality Assurance

Quality-control issues also are a concern that the contractor must expect to handle. While the contractor remains responsible for quality control, the government has many levels of quality-assurance personnel that will oversee the project. The quantity will be far more than the owner and architect normally employ in the private sector.

Some of the quality-assurance people are in fact contractors hired by the owners to oversee the project, and their responses to issues can be proscriptive rather than specific to the project. That results in more bureaucracy and notices of noncompliance, as these quality-assurance personnel often want to do everything exactly by the book.

Adding to this challenge is that each agency has its own supplemental regulations in addition to the voluminous Federal Acquisition Regulations (FAR), which are contractually binding and intended to ensure pricing and procurement remain competitive. Federal contracting often takes the approach of "don't do anything wrong" rather than finding the best approach, to ensure all requirements are met. But the FAR don't cover every possibility, creating dissension over what approach is compliant with the regulations.

Record keeping and documentation for federal contracts in general are more onerous than for a commercial contract. Some of the documentation also has statutory weight, such as meeting requirements of the Truth in Negotiation Act. For many projects, as many as nine copies of submittals must be included. This adds labor and paperwork to the process.

– Tom Christensen is the director of federal program management at Dewberry in Fairfax, Va. The firm provides architectural, engineering, and consulting services to a range of clients and has extensive background working on government projects. Prior to joining the firm, Christensen worked for many years with the Navy Civil Engineers Corps.

Companies must continually network, recruit, and perform due diligence on small businesses to find subcontractors.

More Product Demands

Also affecting bids is the need to meet higher levels of criteria with product installations. Design criteria in government projects typically exceed code requirements in a number of areas. These upgrades increase the cost of materials and labor and can affect schedule with a longer material lead time for the "government model."

Government specifications also typically require more testing, material submittals, and shop drawings. Those materials also must be reviewed and approved by more people than on commercial projects. All of these requirements add administrative costs and schedule risk that must be factored into scheduling and bid requirements.

Federal buildings also require additional needs for antiterrorist controls. Meeting the requirements to protect against progressive collapse of a multistory structure due to a bomb blast, for instance, can add significantly to a project's design criteria and construction techniques, adding more cost than for a project on a major seismic fault. (For more on blast considerations, see the accompanying article.)

The government's embrace of the Leadership in Energy & Environmental Design (LEED) standards also can add cost to a project and create more labor in designing sustainable systems and procuring products. Typically today, all government projects must be certified for LEED Silver standards. Initially, the government required that the project needed to be "certifiable," but it determined that standard was too loose, allowing for considerable fudging and overestimation. It now requires formal submission to the U.S. Green Building Council.

To be sure, the government's role is helping to build the sustainable market, encouraging new products and helping designers understand how to achieve sustainable goals more easily. Today, many government projects comfortably achieve the Silver rating, leading some designers to push harder to qualify for Gold. In many cases, filling out the documents required to achieve specific LEED points provides the most challenging aspect for designers and construction contractors.

Schedules also can be critical, such

The new National Geospatial Agency campus being built on the former Engineer Proving Grounds at Fort Belvoir, Va., consists of two 1,100-foot-long, eight-story buildings connected by a six-story atrium. Built by the joint venture of Clarke/Balfour-Beatty, the project includes a large central utility plant, a parking structure, and a technical/data center.

As a Base Realignment & Closure (BRAC) project, the National Geospatial Agency complex was on a fast track. To speed construction, precast concrete panels complete with wall assemblies were used to enclose the buildings. The design created distinctive architecture while meeting AT/FP requirements.

The new Fort Belvoir Community Hospital, a 1.3-million-square-foot facility, contains 120-inpatient beds and more than 650,000 square feet of out-patient clinical services. The campus also includes a six-story parking structure (left) and a five-story parking structure (right) with space for 3,000 cars.

To ensure the parking structures fit into the aesthetic design for the Fort Belvoir Community Hospital, the structures were clad with precast concrete spandrel panels. Colored precast concrete panels were used on the stair towers to tie in with the terra-cotta finish on the hospital complex.

as with BRAC projects for DOD. In many cases, it is assumed buildings will be ready for occupancy on schedule, so activities are planned for those buildings ahead of time. Soldiers may be assigned to barracks to be completed by their arrival date, and hospitals may begin making appointments for patients after the scheduled completion date. Missing these dates can cause havoc.

The Good News

Government project owners are aware of these drawbacks, and they are working to alleviate them where possible. A key improvement has been the growing trend to use existing commercial and industry standards, especially the IBC and ASTM requirements, rather than specialized proscriptive materials and methods. By moving away from military specifications, the government is aiding designers who work more often with the traditional standards.

In addition, government projects overwhelmingly are being awarded on the basis of producing the best value rather than providing the lowest cost through a sealed bid. This encourages design-build approaches.

Other key factors in determining the best value in evaluating bids are the company's past performance on projects, which encourages a close and strong relationship with the owners that creates closer and more effective communication. The qualifications and experience of key personnel on the project and experience working together on other successful projects also receives major weight. The company's safety record is weighted more heavily than in the past, too, providing procedure-driven companies with more incentive to maintain those processes.

Centers of Excellence have been established in the Naval Facility Engineering Command (NAVFAC) and the U.S. Army Corps of Engineers (USACE), the two agencies with command over most construction projects for DOD. These groups communicate with industry experts in a number of forums and through participation in professional organizations such as the Society of American Military Engineers. Such communication on all subject matters is helping to create continuity across the enterprise, so best practices can be incorporated more readily than in the past.

The agencies also have established standard designs for facilities that are common to all projects by that construction agent (such as NAVFAC or USACE), including barracks within the Department of Defense and embassies for the Department of State. They provide latitude to meet exterior architectural guidelines suitable for the cultural differences among various installations or countries, but they simplify the design and construction processes by replicating concepts and material lists.

Working on government projects creates unique challenges that make many companies wary. But this work can be rewarding in many ways. It provides a cushion against other business cycles, and it can differentiate the firm from other designers. It also provides new areas of expertise that other clients can draw on for their projects.

Creating projects for the government also offers a chance to work closely with public servants and military personnel who sacrifice for our country. Contributing to their safety and service adds a distinction to a project unlike that achieved with any other type of design. ■

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

Blast-Resistant Design Considerations

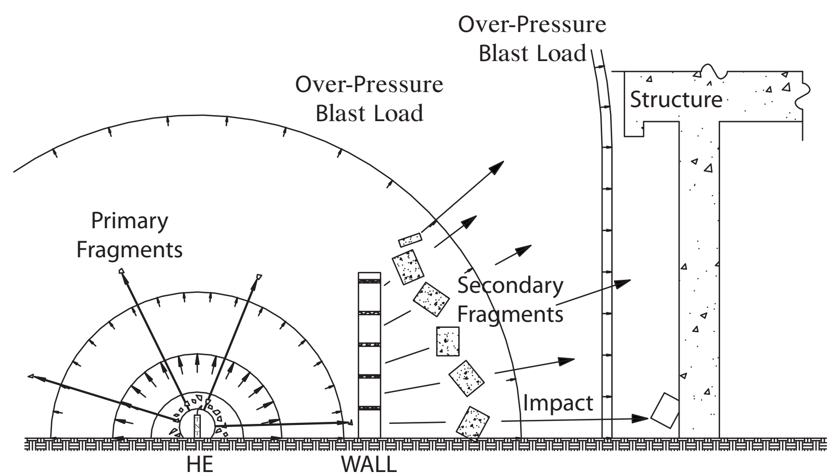
What architects need to know to meet federal blast-resistance requirements

— Clay Naito, Ph.D, P.E., Lehigh University

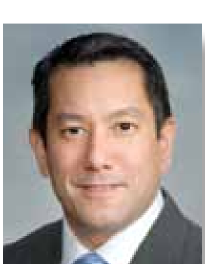
Most government and military structures in the United States are required to consider blast demands and structural integrity as part of the design process. To effectively meet these requirements, a proper understanding of the design process is helpful for all members of the design team, including the architect and owner.

Due to the heightened potential for intentional high-explosive detonations in or adjacent to the buildings we work and live in, buildings are often designed to meet structural-integrity requirements and to provide direct blast resistance. These two approaches are independent of each other and are not always conducted in tandem.

To understand the basis of these approaches requires a basic understanding of the blast event. Detonation of a high explosive such as TNT or ammonium nitrate and fuel oil (ANFO) releases a pressure wave that radiates outward from the detonation's source. When the wave meets objects in its path, the demand is reflected off the surface. This is similar conceptually to a wind load on a building, creating a higher pressure demand.



Detonation of a high-explosive device releases a pressure wave that creates a higher pressure demand, similar conceptually to a wind load on a building. The magnitude and duration are proportional to the scaled distance and origination of the object relative to the blast wave.



– Clay Naito, Ph.D., P.E., is associate professor of engineering in the Department of Civil Engineering at Lehigh University in Bethlehem, Pa. He has written extensively on the performance of precast concrete to achieve proper seismic and blast-resistant designs. In 2008, he was named the recipient of the Precast/Prestressed Concrete Institute's Young Educator Achievement Award.

The magnitude and duration of this reflected pressure demand are proportional to the scaled distance and the orientation of the object relative to the expanding blast wave. The scaled distance is the ratio of the distance from the detonation (also referred to as the standoff distance) to the weight of explosive to the one-third power. Consequently, a linear increase in weight of explosive will not produce a linear increase in demand.

Structural-Integrity Requirements

For low values of scaled distance, most structural components will be lost. For example, at a scaled distance of 1.5 ft/lb$^{1/3}$ or smaller, conventionally reinforced concrete elements will be completely destroyed. These close-in blast detonations are referred to as "near-field events." Bombings of this nature are most likely to occur with structures in locations such as city centers, where a protected perimeter is not possible. The damage is often local, resulting in the failure of one or two columns or exterior elements at the ground or second floor.

In most cases, the location of the potential detonation would be unknown. Consequently, structural protection would require individual armoring of all lower-level structural elements. The cost implications are high and, due to the nature of most armoring/hardening methods, the architectural aesthetics of the structure would be lost.

Instead of hardening the building against this demand, structural-integrity requirements are used. These requirements provide methods of design for the potential loss of structural elements as opposed to strengthening methods for the components themselves.

The goal of structural-integrity design is to provide enough strength and redundancy to the building so the failure of one component does not result in a disproportionate collapse of the remaining structure. An unfortunate example of such a collapse occurred during the bombing of the Murrah Federal Building in Oklahoma City, where the loss of first-floor columns resulted in the progressive collapse of a large portion of the building.

Structural-integrity requirements do not directly account for the dynamics of the blast event. Instead, additional integrity is provided through static-design methods and detailing recommendations. One common method assumes that select structural elements no longer exist, and the remaining structure is checked using standard static-strength approaches to determine if it has adequate capacity to carry the building loads through a new load path. Other methods require the addition of reinforcement in the floor and roof elements to allow the floor to span lost elements or special detailing to handle possible load reversals due to blast demands.

Structural-integrity design ensures the failure of one component does not result in a total collapse.

Structural integrity is addressed in current design through both general requirements and specific progressive collapse recommendations. General requirements for structural integrity are included in both ASCE 7 Minimum Design Loads for Buildings and Other Structures [2010] as well as the ACI 318 Code Requirements for Structural Concrete [2008].

Two specific approaches for progressive collapse have developed for government and military structures. They comprise:

- U.S. Department of Defense, "Unified Facility Criteria – Design of Building to Resist Pro-

Recent tests by the Air Force Research Laboratory on precast, prestressed sandwich wall products will help determine the blast resilience of conventional off-the-shelf insulated concrete sandwich wall construction. Visit our website at www.pci.org/education/resources/index.cfm to view the video.

Air Force Tests Precast Panels

— Jason Krohn, P.E., FACI

The first phase of a collaborative research program between the Air Force Research Laboratory and the Portland Cement Association was recently completed that examined the blast resilience of conventional off-the-shelf insulated concrete sandwich wall construction.

The Air Force program was supported by resources from PCI; precast manufacturers; and practicing engineers and researchers from Lehigh University, Auburn University, and the University of Missouri. The study included experiments on precast, prestressed concrete sandwich wall products as well as concrete masonry products, tilt-up products, and insulated stay-in-place concrete form panels.

The precast concrete products were evaluated under full-scale blast demands in a three-story reaction structure. The performance was compared with existing predictive methods and prevailing acceptable response limits used in the United States for blast design. The initial program was conducted in two phases.

The first phase, completed in 2007, performed blast tests on 30-foot span panels. The second phase, completed in late 2010, provided more comprehensive study, including static testing of over 50 single-span and multispan panels, evaluation of tie connectors, and blast evaluation of multispan panels with realistic connections to the building structure.

"This research will provide valuable information concerning each product's ability to withstand explosive blasts," says Robert Dinan, past program manager. "It will help accurately predict behavior for threats often included in the design criteria for government facilities."

Insulated concrete products have at times been excluded as construction options because they lack the required research data, he explains. The process of validating predictive models with full-scale experiments is essential to obtain valid force-protection results.

Validity is primarily determined by measuring wall deflection and reflective pressures during the full-scale experiments. By measuring pressures, the engineers are able to rerun the models using the actual pressures, seen during the experiment and compare the model deflections with the measured deflections to ensure accuracy.

Initial evaluations show that the precast concrete panels performed well, according to reports still being finalized by Clay Naito, Mark Beacraft, John Hoemann, Jonathan Shull, Bryan Bewick, and Mike Hammons for the Air Force Research Laboratory. It is expected that all reports will be released in 2011.

These efforts will help expand the options for designers in specifying blast-resistant materials and help to make building easier to design and safer for users.

gressive Collapse," UFC 4-023-03, January 2010.

- U.S. General Services Administration (GSA), "Progressive Collapse Analysis and Design Guidelines for New Federal Office Buildings and Major Modernization Projects," June 2003.

The Unified Facility Criteria are used for new construction, major renovations, alterations, and leased buildings. The criteria are specifically applied to facilities used by military departments, the defense agencies, and the Department of Defense (DoD) field activities. When DoD personnel occupy more than 25% of the net building space, the criteria must be applied to the entire structure.

The GSA guidelines are used for designing federal facilities. The guide is specifically used for new facilities, assessment of existing facilities, and development of upgrades where needed. Exemption is allowed for facilities with extremely low occupancy and extremely low likelihood for progressive collapse. An exemption evaluation process is provided.

Both methods provide a comprehensive guideline for achieving structural integrity. Either the UFC or GSA approach can be used as guidance for buildings outside of the U.S. government and military ownership where progressive collapse may be of concern.

Blast Design Requirements

For large-scaled distances, structural components can be readily designed to resist most blast demands. These demands are typically generated from a vehicle bomb detonated in the far field (i.e., at a moderate standoff from the structure). Under this load case, the exterior components of the structure are subject to the effects of the reflected pressure. This consists of a short duration positive pressure followed by a negative pressure phase.

Typical high-explosive threats produce positive-pressure durations that are very short, on the order of 5 to 20 milliseconds. For most structural elements, this short duration demand is seen as an impulse. In other words, the component (e.g., wall, beam, or column) does not reach its peak response until after the pressure demand is past.

Two specific approaches for progressive collapse have developed for government and military structures.

Due to the impulsive nature of most blast events, the design of structural components must account for the structural dynamics of the response. The standard design approach of having the capacity of the member be greater than the demand becomes a much more complex dynamic evaluation.

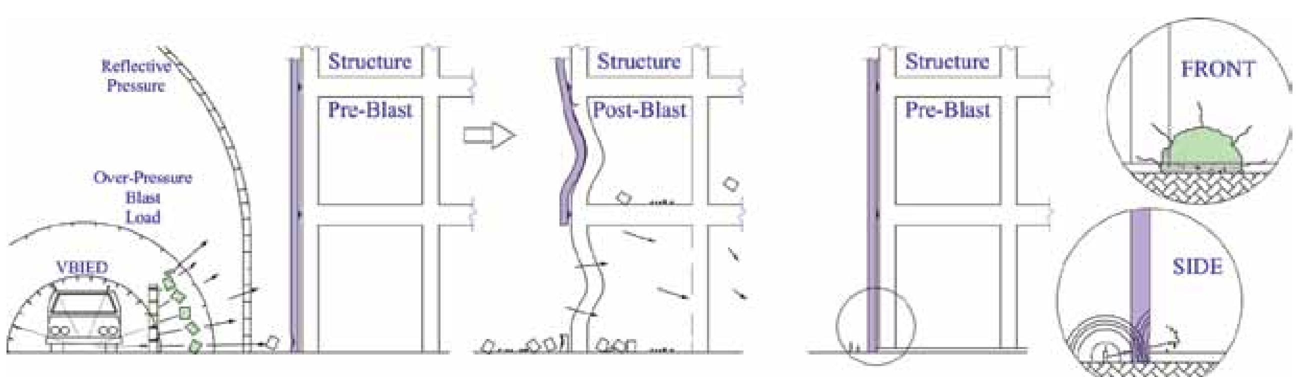
Under dynamic loading, the strength of the system can be considered a combination of the component's resistance and the inertial force generated as the mass of the component is accelerated. This analysis can be conducted using complex finite-element analyses; however, simplified methods provide adequate accuracy at modeling the response.

The predominant method used in blast design is a single degree of freedom (SDOF) approach. Using SDOF methods, the structural component's response is simplified to that of an equivalent mass-spring system, in which the equivalent mass is related to the distribution of mass on the component and the spring characteristics are related to the resistance of the component. Many tools have been developed to automate this evaluation, the most prevalent being the Single-Degree-of-Freedom Blast Effects Design Spreadsheets (SBEDS), available from the U.S. Army Corps [2008].

Two Key Aspects

Two aspects of a blast design make it quite different from standard structural design. The first is that the response of the system must be analyzed using dynamic response. Engineers unfamiliar with blast design often incorrectly assume they can use an equivalent static load.

Simply designing for the dynamic blast pressures as static loads produces unrealistic and uneconomical designs. Also, it is too conservative of an approach due to the inertial resistance of the component. For example, a typical wind demand may be on the order of 200 lb/ft^2, while a peak reflected pressure due to an explosion may be on the order of 7000 lb/ft^2. Depending on the characteristics of the component (i.e., height, reinforcement, thickness, weight), it may have adequate mass and inherent resistance to support the blast demand without any change from



1) Vehicle borne improvised explosive device. Resulting in large deformation of wall panels and potentially flexural failure and/or fragmentation.

2) Near contact satchel or mortar size detonation resulting in spall and breach.

the original wind design. Designing the same system for a static load 35 times that of the wind load would require a considerably larger system.

The second deviation from standard design is that blast evaluation is conducted with respect to deformation of the component as opposed to the standard force-based approach (i.e., applied demands are less than capacity). The evaluation of acceptance is based on a true performance-based design methodology. The amount of deformation and damage allowed under the blast demand are tied to the level of protection required for the structure and the type of component under evaluation.

Design levels of protection (LOP) are broken into four categories: very low, low, medium, and high. As an example, consider a building clad with 12-foot-tall, non-load-bearing reinforced concrete walls. If a medium LOP is required, the walls would be limited to a deflection of 2.5 inches. For a very low LOP, the allowable deflection increases to 12.7 inches. This performance-based approach is prescribed in detail by the U.S. Army [2008].

For structures subject to a possible reflected blast pressure, two points of information are required for the design engineer: (1) pressure-time demand and (2) LOP. Due to the dynamics of the blast, the change in reflected pressure as a function of time must be defined. This can be accomplished by a statement of the quantity of TNT and standoff, or the peak positive reflected pressure and corresponding positive impulse (i.e., energy under the pressure-time demand curve).

The explosive threat and standoff can be easily used to determine the pressure-time response. However, unsecure transfer of this information is not recommended. Unlike a bridge where statement of the allowable design truck load is needed for safe operation, an open statement of the design-blast charge and standoff provides information to the terrorist as to what bomb to detonate. Consequently, demands are often defined as pressures and impulses, and protection of the design loads should be maintained.

The second piece of information needed is the LOP and the prevailing response limits. As an example, the following statement can be used as a model. Obviously, the actual demand and protection level are to be determined by a risk analysis and finalized by the owner on a case-by-case basis:

"All exterior elements of the structure are to be designed for a right triangular reflected pressure demand with a peak of 10 psi and impulse of 40 psi-msec. Under these demands, the building is required to meet a Medium Level of Protection in accordance with U.S. Army 2008."

It is important to note that this article provides only a general overview of design requirements. Proper implementation of the prevailing criteria is critical and should be conducted with the assistance of an engineering consultant with appropriate experience. The consultant must ensure communication of design expectations and responsibilities. Ideally, the consultant should be brought on early in the project to provide effective coordination among the owner, architect, structural engineer, and subcontractors.

Understanding the basic concepts of blast-resistant design is useful to all members of the design team. This will help to ensure that the appropriate design criteria are applied and executed throughout the design and construction process, producing a building capable of resisting the expected blast demands with an adequate level of protection to the occupants. ■

For large-scaled distances, structural components can be readily designed to resist most blast demands.

References

These references will provide more details about blast resistance:

1. ACI Committee 318. Building Code Requirements for Structural Concrete and Commentary. American Concrete Institute. Farmington Hills, MI. 2008. www.concrete.org.
2. American Society of Civil Engineers (ASCE), "Minimum Design Loads for Buildings and Other Structures," ASCE Standard ASCE/SEI 7-10, 2010, ISBN 978-0-7844-1115-5.
3. U.S. Army Corps of Engineers, "Single Degree of Freedom Structural Response Limits for Antiterrorism Design," Protective Design Center Technical Report, PDC-TR 06-08, Rev. 1, January 2008.
4. U.S. Army Corps of Engineers. "User's Guide for the Single-Degree-of-Freedom Blast Effects Design Spreadsheets (SBEDS)." Report PDC TR-06-02 Rev 1. September, 2008.
5. *PCI Journal*, Nov.-Dec., 2007, pg. 53.
6. Designer Notebook, *Ascent* Spring, 2004-Winter, 2005.

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

To learn more about the precast concrete tests performed by the Air Force mentioned in the sidebar, keep an eye out for the availability of the following references:

1. Naito, C., Hoemann, J., Shull, J., Beacraft, M., Bewick, B., and Hammons, M. "Dynamic Performance of Non-Load Bearing Insulated Concrete Sandwich Panels Subject To External Demands," Air Force Research Laboratory Report, 2010 (Under Review).
2. Naito, C., Hoemann, J., Shull, J., Saucier, A., Salim, H., Bewick, B., and Hammons, M. "Static Performance of Non-Load Bearing Insulated Concrete Sandwich Panels Subject To External Demands," Air Force Research Laboratory Report, 2010 (Under Review).
3. Naito, C., Hoemann, J., Bewick, B., and Hammons, M., "Evaluation of Shear Tie Connectors for Use in Insulated Concrete Sandwich Panels," Air Force Research Laboratory Report, AFRL-RX-TY-TR-2009-4600, December 2009.
4. Naito, C., Dinan, R., Hoemann, J., and Fisher, J., "Precast/Prestressed Concrete Experiments – Series 1 (Volume I)," Air Force Research Laboratory Report, AFRL-RX-TY-TR-2008-4616, November 2008.

Marines Recruit Precast

Parris Island training facility uses total-precast concrete system to meet diverse goals

— Craig A. Shutt


All of the precast concrete components were erected with a 300-ton crane with no difficulties and no safety problems.


A total-precast concrete structural system is being used to construct three formidable barracks buildings at the Marine Corps' Parris Island complex.

Designers faced multiple challenges in creating a new barracks complex at the Marine Corps' facility at Parris Island, S.C. The buildings had to provide housing space for recruits while also meeting hurricane, seismic, and antiterrorist standards, plus meet the government's required LEED Silver rating. At the same time, the structures had to fit into the existing appearance and aesthetic specifications for the complex, which is dominated with red-brick buildings. All of this, of course, had to be accomplished on a tight schedule to ensure the facilities were ready when recruits arrived.

To achieve these goals, designers specified a total-precast concrete structural system. It consists of double tees for the floors and roof base, along with insulated load-bearing wall panels for the exterior shell. The walls had a field-applied waterproofing coating added to it as well as full-bed-depth field-applied brick to match the existing structures. Precast concrete flat slabs also were used for the breezeways and covered corridors that connect the portions of each two-module building.

The project consists of three 95,000-square-foot, three-story connected barracks that include administrative and reception areas; open squad bays; shower, toilet and laundry facilities; and electrical/mechanical rooms. The interiors of the concrete wall panels feature a smooth, steel-form finish, with no interior partitions and little drywall, mostly around mechanical rooms. Some areas were painted, while others had a ceramic-tile wainscot applied. The design is durable but remains attractive from both the exterior and interior.

Design-Build Aids Plan

The barracks, which are to be completed and furnished by May, were undertaken as a design-build project, which the Department of Defense prefers, explains Tom Matzke, associate principal with VOA in Orlando, Fla.,

'Precast concrete offered a better approach with thermally efficient walls and a fast construction schedule.'

the architects on the project. "The military has been full force on design-build methods for 15 years. They encourage a creative approach that creates more efficient designs that can be constructed quicker."

Using this delivery format ensures both designer and contractor can leverage their unique expertise to address challenges, he explains. "It lends itself to a lot of creative structures and approaches to whatever arises. It lets us look at the entire picture and take everything into account while meeting all of the owner needs and contractors' goals."

Although some designers are wary of the levels of review and paperwork entailed in designing government projects, Matzke enjoys working with the military. "They are a very knowledgeable client," he says. "It makes the process more efficient when you are dealing with professionals. There's a definite advantage to it." (For more on working with the military, see the accompanying story on page 24.)

Fact Sheet

Project: *Recruit Training Battalion Complex*

Location: *Parris Island, S.C.*

Architect: *VOA, Orlando, Fla.*

Engineer: *Allan and Conrad Inc., Winter Park, Fla.*

Contractor: *Walton Construction Co., Pensacola, Fla.*

Owner: *Department of Defense*

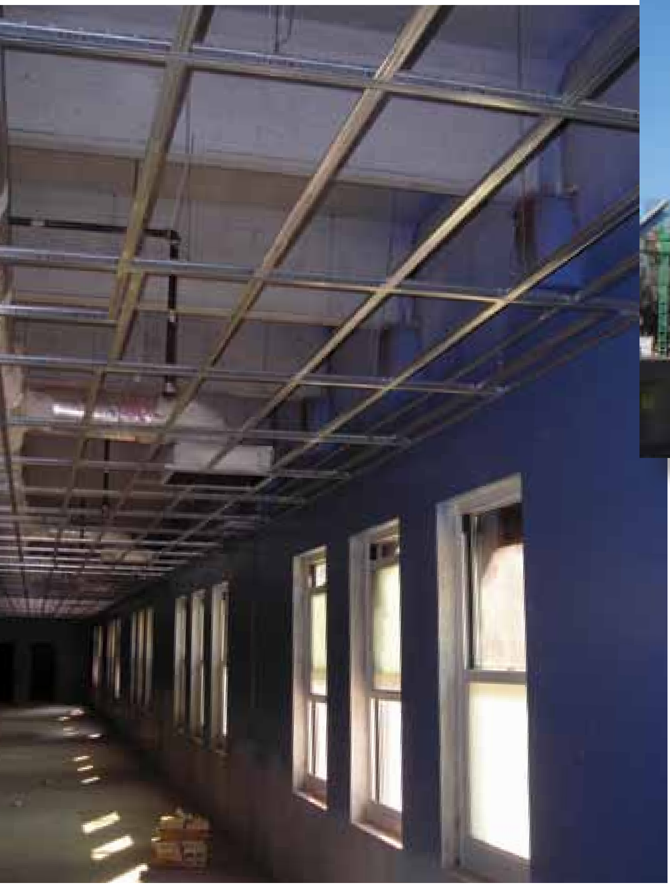
Precaster: *Metromont Corp., Greenville, S.C.*

Project Size: *285,000 square feet*

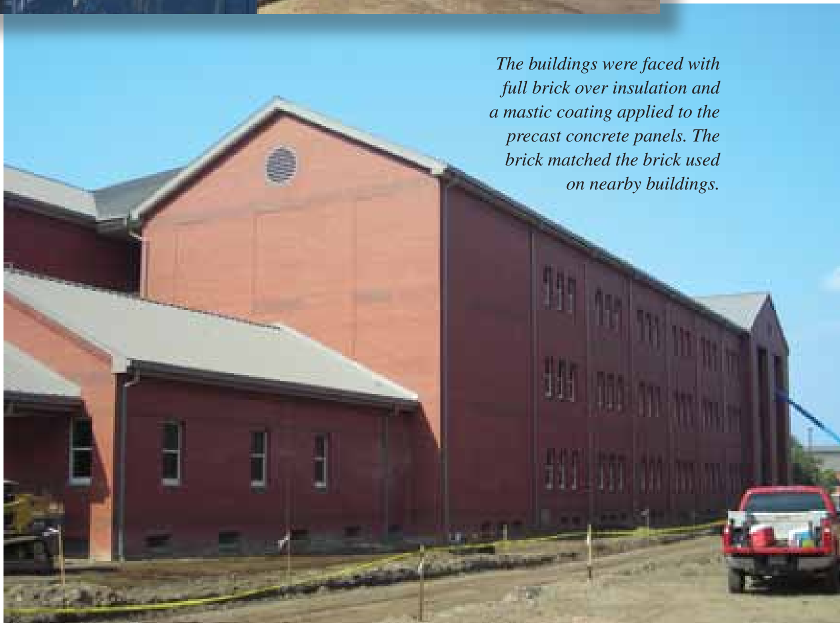
Precast Components: *Total-precast concrete system, including load-bearing exterior walls, 24-inch-deep double tees and flat slabs*

Project Cost: *$80 million*

The precast concrete panels were installed vertically, to allow one panel to span the entire three-story height.



Suspended drywall below the shallow depth of the precast concrete double tees provided a finished ceiling on each level.



The buildings were faced with full brick over insulation and a mastic coating applied to the precast concrete panels. The brick matched the brick used on nearby buildings.

To aid efficient bunking of recruits, interiors feature long clear spans, which were achieved with the help of 24-inch-deep double tees.

VOA has a long history of partnering with Walton Construction Co. in Pensacola, Fla., with which the architect teamed on this design-build proposal. The two had not often used precast concrete structural systems before, however. "We brainstormed several structural systems for this project, and the total-precast concrete design proved to be the most efficient from a time standpoint."

The structural engineers also agreed with that assessment—and with the benefits of working on military projects. "We do a lot of design-build projects with the military, especially barracks, headquarters buildings, and office buildings," says Steve Shelt, vice president at Allan & Conrad Inc. in Winter Park, Fla. In some cases, especially medical facilities, the projects are bid as typical design-bid-build projects due to their complexity and equipment needs. Even in those cases, the schedule has gotten much tighter.

Material specifications vary based on the type of project, he notes. "Low-rise buildings are open to a variety of options, but we tend to find that multiple-story projects are ideal for precast concrete components." In addition to its size, the Parris Island project also had a tight timetable that was complicated by the need to establish MEP requirements early to complete the foundation plan.

Schedule Drove Decisions

The driving force in the project was the schedule, Matzke says. VOA had used the precast concrete system on a similar project at Corpus Christie, Texas, with another contractor. "That worked very well and went together quickly, so we decided that we could use it on this project as well."

The project initially was designed with masonry blocks, but a local precaster, Metromont Corp. in Greenville, S.C., teamed up with the designer to create a precast design. "It offered a better approach with thermally efficient walls and a fast construction schedule," explains Jay Cariveau, director of business development and marketing.

A key reason for that efficiency is the single-source supplier for the full structural system, explains Matzke. "As an integral component, precast concrete provides the entire structure. It's a superior system because it's durable and flexible to allow for the designs we need, and it installs quickly."

The precast concrete structure also helped engineers meet the restrictive Anti-Terrorism/Force Protection (AT/FP) requirements for all government projects. "In many cases, if you meet construction-standoff needs with barriers, you can build any type of low-rise building with no additional blast design per se," Shelt explains. That is not the case with projects of three stories or more, requiring some consideration for AT/FP and progressive collapse factors.

For example, the effects of an explosion on a lower floor and its impact on the entire structure must be considered. It requires a change in mindset for dealing with the specifics of the structural system. "Typically, prestressed components are reinforced for gravity loads, so they're designed to be heavy in the bottom portion, especially double-tee beams. But when planning for blast protection, we also have to design for potential increased uplift."

The requirement accounts for the force of a blast on a lower floor that could push the overhead framing upward, causing it to collapse as it falls back again. "It's a fairly significant consideration and not something that comes up when looking at wind loading or other typical forces," he says. "The biggest difference on these projects is that we are not in control of these design adjustments. We provide the criteria and then review the design in the shop drawings and make any changes then." Designers also added $1^1/_2$ times the typical topping to increase reinforcement.

The easiest way to allow for progressive collapse needs is to use the tie-force method, which defines the perimeter and internal forces that need to be considered. "The building has to be reinforced for these considerations with enough robustness to distribute the loads in case of the loss of a column or wall," says Shelt. Some of these measures have been revised since the Parris Island barracks were designed, and designers must stay current with requirements. (For more on blast considerations in military projects, see the accompanying article.)

The designers also had to account for the area being in a high seismic zone, he notes. "It mostly required us to ensure that the shear walls were tied down properly."

Panels Set Vertically

The contractor initially intended to use the precast concrete panels in a horizontal position, with each level essentially framed separately. However, Metromont could provide a three-story-tall panel that was 12 feet wide. "It matched the double-tee configuration used for flooring, so we designed it to take advantage of that capability," says Shelt. That created narrower walls that reduced options for tying together the panels, requiring more attention to avoid uplift at the ends of the panels.

To meet these needs, Metromont supplied a bar with a plate on its end to fit into foundation excavations. The foundation pour included a metal sleeve/blockout to create a void. It was grouted and filled after the walls were erected. The bar was threaded into the precast concrete wall and dropped into the hole, after which the hole was closed. "It provided some tolerance for setting the precast, because it could be secured at varying depths," says Shelt.

> The precast concrete structural system will help achieve a Silver LEED rating in a number of ways.

That variability was necessary because the design-build nature of the project meant that foundation design had to be completed early so that the panels could be cast. That was accomplished before other architectural details were developed, Shelt notes. "Some of the details had to be massaged during the construction phase as much as possible due to adjustments that occurred after the panel design was set."

Tolerances on setting the walls were tight, agrees Matzke. "The three-story height of the panels required close coordination and good communication to ensure all of the systems were worked out before erection, because we couldn't adjust positioning on mechanicals or anything once the design was set. We planned ahead to create the penetrations where they were needed and place the shear walls so there wouldn't be any conflicts."

Having a single-source provider helped especially with the erection of the panels, says Shelt. "The single source aided calculations because we didn't have to adjust for differences between materials and how they'd interact."

The double tees were designed with a 24-inch-deep profile to reduce material needs while providing sufficient clearance on each floor. A crawl space was provided under the first floor, with a steel truss and metal roof installed above the double-tee components on the top floor. Flooring was adjusted with the use of topping to offset the camber provided in the double tees. The components were erected with a 300-ton crane with no difficulties and no safety problems.

Once the walls were erected, mastic was applied to the concrete, with insulation laid over the panels. Then full brick veneer was field installed. The designers considered thin-brick insets into the precast panels, which could have alleviated some of the concerns for laying the brick as a final step, but the specifications called for precisely full-bed-depth, field-applied brick.

LEED Silver Rating Met

The precast concrete design helped the project meet the LEED Silver requirements demanded of all military projects, notes Matzke. "It helped in a number of ways, especially due to its recyclability and use of recycled steel, as well as by the proximity of the precast plant to the project." It also helped with energy efficiency due to its thermal mass and the addition of insulation in the barracks walls.

The project features a number of other sustainable-design concepts, including a full solar photovoltaic system to aid with operational electrical needs and a full solar hot-water system to ensure there is always hot water for showers. The solar panels are installed adjacent to the buildings to provide maximum exposure.

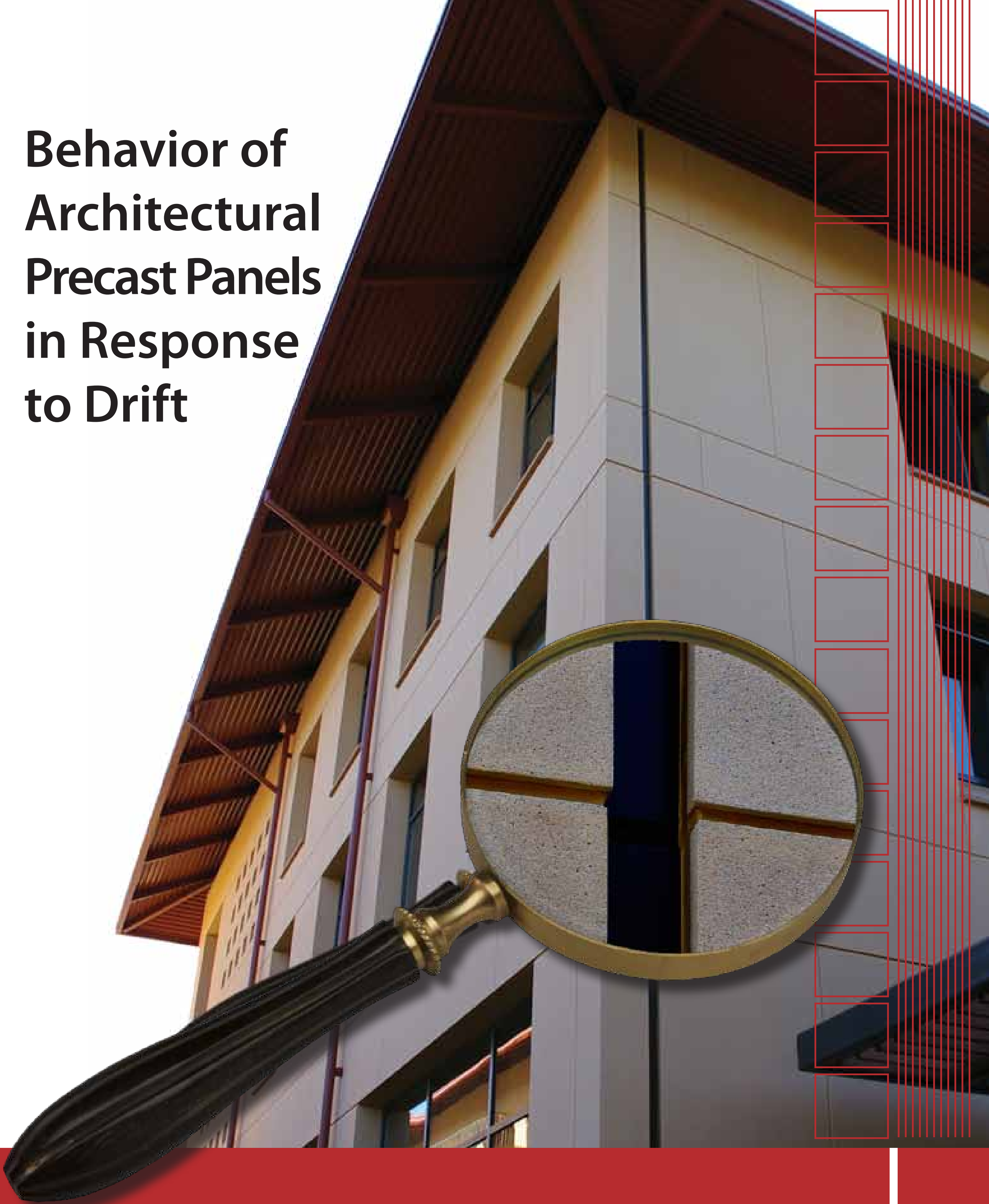
"The Department of Defense is working toward sustainable design wherever they can," Matzke says. "They have really stepped up their use and are encouraging it in every project, including geothermal and solar applications."

VOA also is using precast concrete in more projects, including one currently being designed with a total-precast concrete system for a border-patrol station in Kingsville, Texas. The material's use with military projects also will grow, as more projects show the benefits that can be offered.

"Allowing us to create a total-precast concrete system for this installation was a huge move for the Marines," says Metromont's Cariveau. "Precast concrete was not the designated material in the design specifications. But they allowed us to improve on the existing design while meeting the performance specifications. The scope was for the use of 'hardened materials,' and we could work with that to create a better environment." ■

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

Behavior of Architectural Precast Panels in Response to Drift



designer'snotebook

Introduction

The effects of an earthquake on architectural precast cladding come from two actions. First, the inertia of the panels develop forces due to the acceleration of their mass. Second, the horizontal movement of the building structure from lateral drift imposes forces through the connections. The performance of cladding systems depends on the interaction between the cladding and building structural frame during a seismic event.

Building Motion

Most of a building's mass is concentrated at the floor levels. During a seismic event, the building's structure transmits forces generated by the floors down to the foundation. The flexibility of the structure determines how much each floor moves. Seismic motions occur in both directions on all three axes. Seismic effects result in interstory story drift, which is horizontal movement (lateral displacement or drift) of one floor with respect to those above and below.

It is desirable to limit the amount of horizontal movement (drift) to restrict damage to partitions, shaft and stair enclosures, glass, and other nonstructural elements, and, more importantl to minimize differential movement demand on the structural elements. The limitations on interstory drift in the International Building Code (IBC), Uniform Building Code (UBC), and Minimum Design Loads for Buildings and Other Structures, ASCE 7, generally become more restrictive for the higher use (occupancy) groups. The limits also depend on the type of structure. The design story drifts must not exceed the allowable code values, which are generally between 1% and 2% of the story height. Cladding connections for a building with a floor-to-floor height of ten feet can require up to two-and-a-half inches of movement allowance between floors.

Precast concrete panels are more rigid in-plane than out-of-plane. They may even be more rigid than the structure. The goal in configuring and connecting architectural precast cladding panels is to prevent the panel system from participating in the lateral load -resisting system of the structure. In other words, when the building moves, forces should not pass through the panels.

Precast Panel Configuration

For fabrication, handling, and erection economy, the use of the largest possible panels (subject to weight and transportation restrictions) is recommended. However, seismic requirements are often at odds with use of very large panels because of the accumulated deformations in the main structure that must be accommodated. While in non-seismic areas two- or three-story-height panels are used, the usual practice in higher seismic zones is to use panels that are limited to one story in height and seldom more than one horizontal bay in width.

Codes require that connections and panel joints allow for the story drift caused by relative seismic displacements. Connection details, and joint locations and sizes between cladding panels. should be designed to accommodate any shrinkage, story drift, or other expected movement of the structure, such as sway in tall, slender structures. Panel geometry and joints must be configured so that panels do not collide with one another or with the supporting structure when it moves. If collisions occur, over-loading of the connections may result as well as damage to the body of the panel. Story drift must be considered when determining joint locations and sizes, as well as connection locations and their directions of resistance. If a connection can resist a force in a given direction then it can also cause panel motion in that direction.

Almost all non-structural (cladding) precast concrete panels are supported vertically at one floor only. This allows floors to deflect without transferring building gravity loads through the panel. The types of connections used to support the panel will ultimately determine the motion a panel will experience during a seismic event. Connection types are discussed in detail further on.

Panel-connection-structure interaction

The way cladding panels behave in response to displacement of the supporting structure can be summarized as shown in **Fig. 1**.

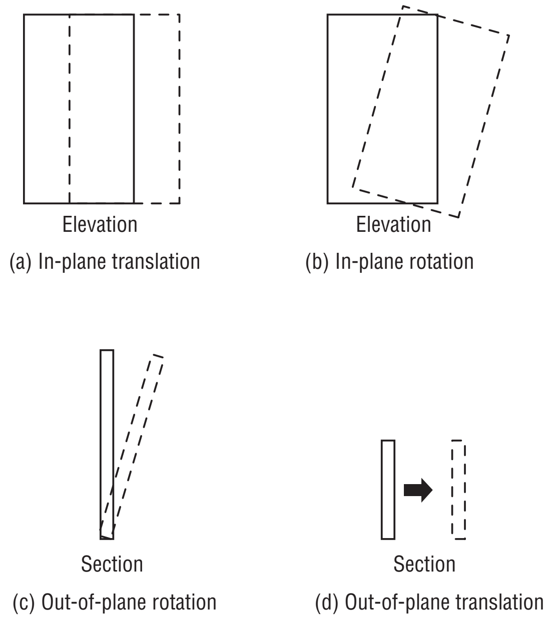


Figure 1 Modes of panel response to displacement.

In-plane translation (**Fig. 1-a**) occurs when the panel is "fixed" in-plane to one level. The panel translates laterally with that level, remaining vertical. Spandrel panels and wall panels are typically designed to behave this way.

In-plane rotation, also known as "rocking" (**Fig. 1-b**), occurs when the panel is supported in-plane at two levels of framing. When the structure displaces, the lateral connections drag the panel laterally, causing it to rotate in-plane and rest entirely on one bearing connection. This rotation requires bearing connections that allow lift-off. Narrow components such as column covers are often designed this way because of their aspect ratio (height to width) and the location of their connections.

Out-of-plane rotation (**Fig. 1-c**) is the tilting of a panel perpendicular to its face. This motion is common whenever a panel is connected to the structure at different levels of framing. The tie-back connections that support the panel for wind and seismic loads will also cause the panel to tilt out-of-plane during story drift. Bearing connections should be designed to accommodate this out-of-plane rotation, although it is generally so small that it is usually ignored with ductile connections.

Out-of-plane translation (**Fig. 1-d**) is common for spandrel panels that are attached to a single level of framing, since the movement is the same as the supporting beam to which it is attached.

With this in mind, we will examine how each type of motion is accompanied by specific connection requirements and joint treatments.

Panels supported laterally at one floor only

Story drift is rarely an issue on spandrel panels because bearing connections and tie-back connections are lo¬cated on the same floor beam. The tie-backs are not affected by story drift because the top and bottom of the floor beam move together (see **Fig. 2-b**). Therefore, all panels connected to a given level will move with that level. The panels respond to building displacement as shown in **Fig. 1-a** because they are supported in-plane at one level only and **Fig. 1-d** because they are supported out-of-plane at one level only. Vertical panel joint widths can be kept to a minimum because there is no differential movement between panels and connections need only accommodate small movements from shrinkage or temperature changes.

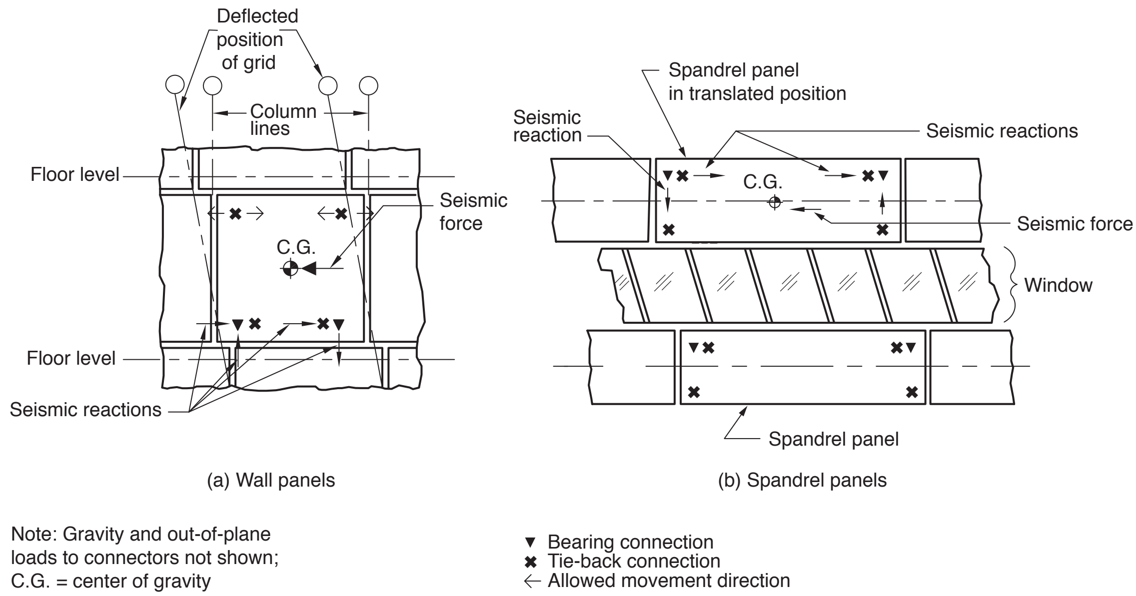


Figure 2 Cladding panel connection concepts–Seismic drift effect (Translating panels)–low aspect ratios.

Panels supported at two levels of framing

When a panel is arranged such that it requires out-of-plane support from two levels of the structure, its connection system can make the panel rotate in-plane or translate without tipping or rocking (**Figs. 2 and 3**). It is essential that the potential movements be studied and coordinated with regard to the connection system and the joint locations and widths as well as adjacent construction. Such considerations often govern the connection design or the wall's joint locations and widths. The following discussions will address each type of motion in detail.

Panels connected out-of-plane at two levels and in-plane at one level (Translating)

Connections that resist imposed loads in all directions are referred to as rigid or fixed connections. Rigid bearing connections are generally used in panels that translate in-plane as shown in **Fig. 1-a**. Fixed bearing panels are vertical cantilevers in the in-plane direction. The two bearing connections resist the direct in-plane seismic force, as well as the resulting overturning moment. The moment is resisted by a couple formed by the bearing connections. When combined with panel self-weight, the tie-down forces may result in a net uplift on one connection and added downward force on the other. The bearing connections hold the panel down and prevent it from tipping (**Fig. 4-a**).

The upper tie-back connections, or "slip connections," that allow horizontal and vertical movement of the panel relative to the supporting structure (**Fig. 4-c**), must only resist out-of-plane forces. If they were to resist in-plane forces, then they would also transmit in-plane movement. This would create a tug-of-war between the structure and the rigid bearing connections. These connections should be flexible or slotted in-plane to allow the structure to drift without over loading the connection. The panel will translate with the level of framing that the rigid bearing connections are attached to, and will remain vertical through this translation.

Proper orientation and length of slotted inserts are necessary but not always sufficient to allow movement without binding. This is especially true if the connection parts are in compression against the connection body, or have high tensile forces that result in large friction forces against the fastener as slippage may be restricted. Corrosion protection of these sliding connections should also be considered to ensure their long-term performance so the sliding effect can occur without binding.

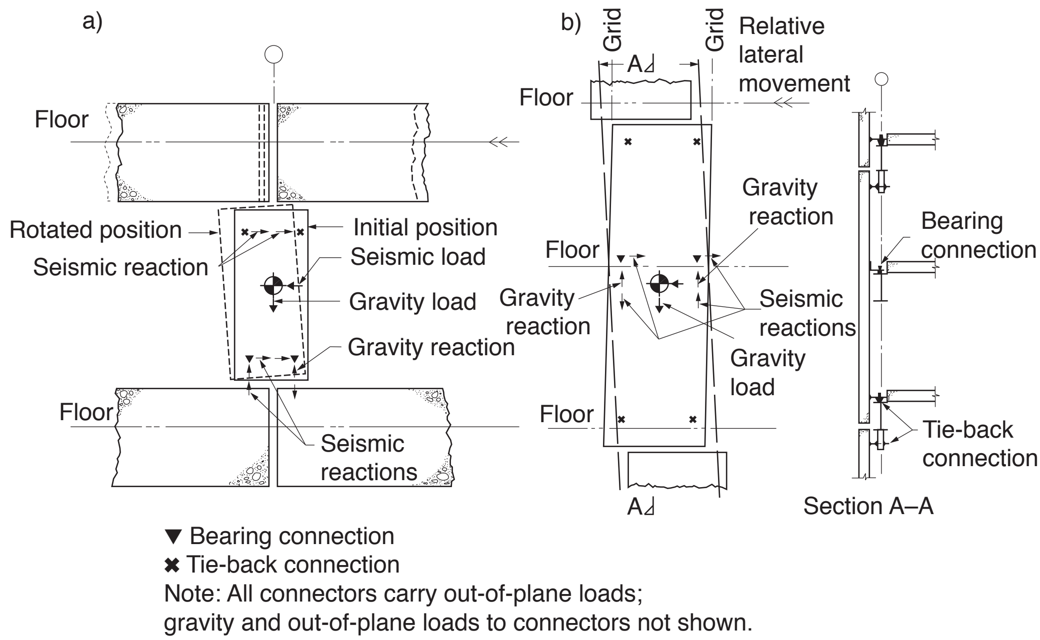


Figure 3 Tall/narrow units—high aspect ratios.

Flexible connections must have ample rod or plate length to truly bend and flex under drift without failing. All components of the connection system must be designed to allow either bending or sliding within the connection with slotted or oversized holes. The bottom connections will also have to be designed to handle the force that it takes to yield the upper connections. Careful installation and inspection are required to ensure that construction tolerances do not negate the available movement in a way to make the connection ineffective.

When panels are designed to translate, the horizontal joint at each level should remain at a constant elevation whenever possible, as it tracks around the perimeter of the building. This will permit the panels attached to one floor to move with that floor's drift relative to the panels above and below them. Elevation changes (**Fig. 5**) will require seismic joints at the transitions and detract from the aesthetics of the cladding.

A common way to avoid panel collisions is to increase the joint width, positioning adjacent panel beyond the limit of movement. A common case is shown in **Fig. 6,** where wall panels form the corner of the building. Wall panels are typically connected at two framing levels and consequently rotate out-of-plane in response to structure drift. In the case of the corner, building motion will be perpendicular to one panel while it is parallel to another, resulting in the joint between the two either opening or closing up. To avoid a collision, at outside corners the corner joint width must be increased relative to the magnitude of drift. Mitered panels may be used to reduce the width of the seismic joint required in this situation.

Panels connected out-of-plane at two levels and in-plane at two levels (Rocking)

Bearing connections that allow vertical upward movement (lift-off) may be referred to as rocker connections. This type of connection would allow the panel to rotate in-plane as shown in **Fig. 4-b**. Rocking panels are vertical, in-plane simple spans. The upper connections must provide in-plane as well as out-of-plane support for the panel. The applied seismic force is resisted by horizontal reactions in the bearing connections and the upper lateral connections. The lower (bearing) connections must allow lift-off. The simple-pan reactions provide overturning stability, so there is no need for the bearings to resist tie-down forces (drift compatibility prohibits this).

In **Fig. 3-a** connections with in-plane and out-of-plane restraint at the top of the panel, together with lift-off allowance at the bottom connections, force the panel to rock when subject to building drift. Its entire weight

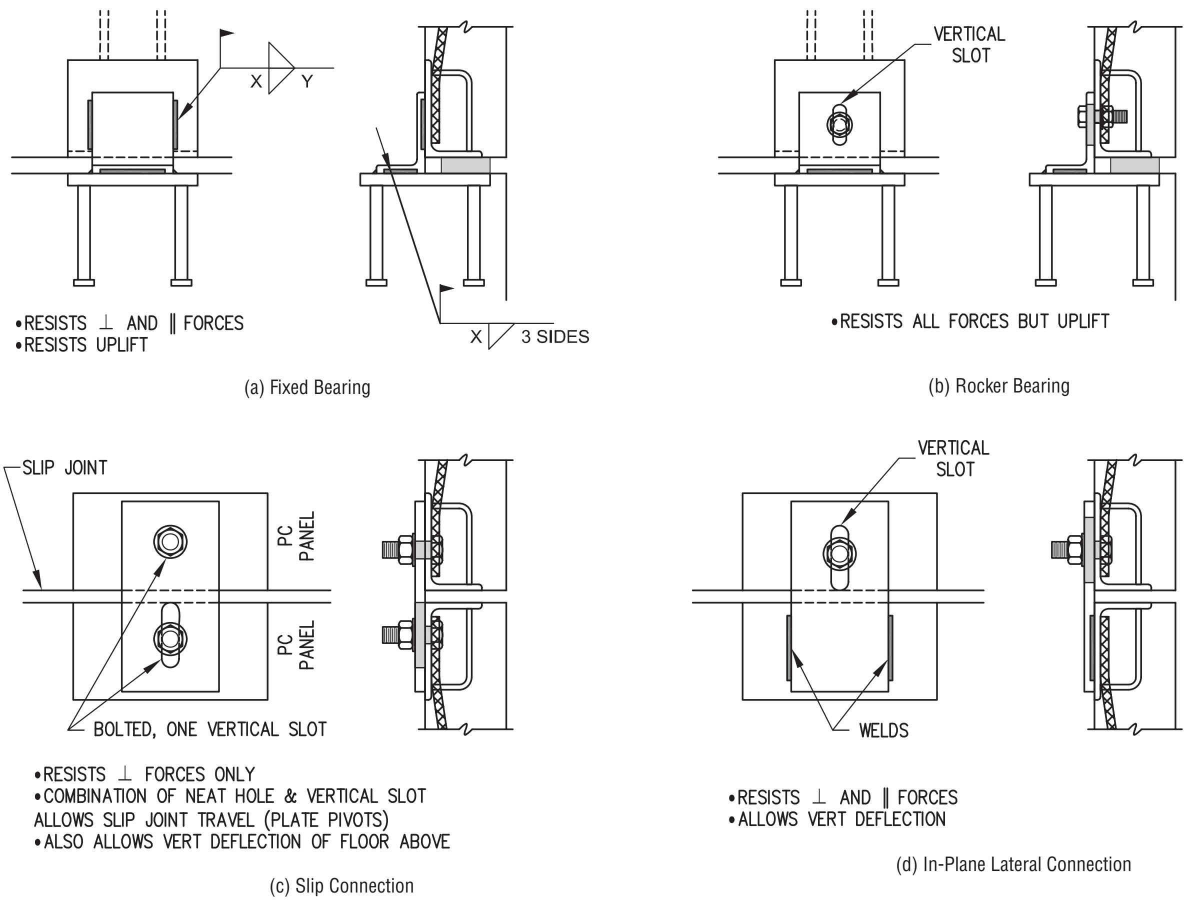


Figure 4 Four basic seismic connection types.

is then being carried on one lower bearing connection. Because the movement occurs in both directions, each bearing connection must have the capacity to carry the full weight of the element and allow lift-off.

The bearing connections as well as the upper lateral connections must provide freedom for vertical motion of the panel as it rocks (see **Figs. 4-b** and **4-d**). The same rules apply as for the horizontal slots or yielding connections in the translating panels above, but in this case, the slots would be vertical.

The possible area for panel collisions now is no longer at the corners of the building because both panels are rocking in the same direction. The horizontal joint is at the top of the panel. It will open and close as the panel lifts up. One way to minimize vertical motion is to set the bearing connections closer together. Otherwise, the horizontal joint size may need to be increased.

How to choose between the two types of motion

A panel whose aspect ratio is small (height is similar to or significantly smaller than its width) is best designed for in-plane translation. If the panel were designed with rocking bearing connections and allowed to rotate, the upper horizontal joint would have to be sized to allow for large vertical movement of the panel. Depending on the specific geometry, this horizontal joint width could become quite large and affect the aesthetics of the cladding. More importantly, the force required to lift up the panel could easily become quite large. For these reasons, the panel should be designed to translate in-plane. The horizontal joint would be held to a nominal size and the overturning loads could reasonably be handled by taking advantage of the low aspect ratio of the panel.

Panel rotation (rocking) should be considered and rigid connections should be avoided in situations where the

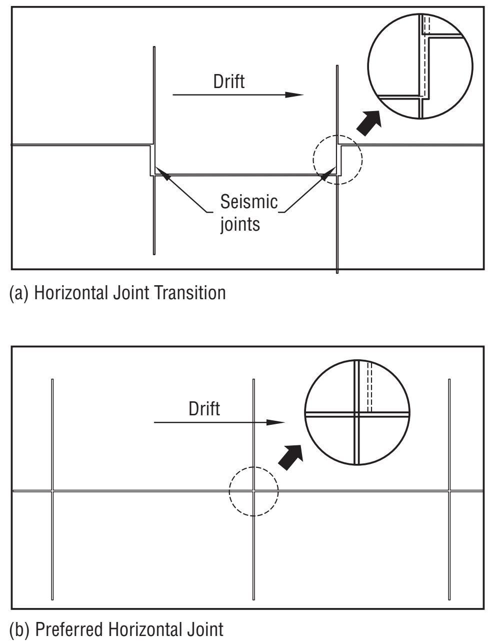


Figure 5 Joint elevation changes.

panels' aspect ratio is high (height significantly greater than width) because the resulting large overturning forces could become unmanageable. Instead of trying to resist the overturning force, rocker connections can be used to allow the panel to freely rotate to accommodate story drift. In this case, the bottom connections would be designed as rocker connections and the top connections would be designed as in-plane lateral connections.

Interface with adjacent finishes

Glazing systems installed in seismic areas are usually rigidly connected at the top and bottom so the window systems rock and do not translate. This condition is illustrated in **Fig. 2-b**. If this window arrangement were adjacent to the rocking panel shown in **Fig. 3-a**, the two systems could be compatible. If this window type is adjacent to a translating panel like the one shown in **Fig. 2-a**, then a large joint or vertical crush zone on the side of the window is required to prevent breaking the window.

The window system can be designed to accommodate translation with the use of sliding connection details, but that is not the common detail. This would be advantageous when windows are adjacent to translating panels, and it would also be likely that the window system would rely on a reaction from the panel to keep it rigid. The windows would also require special consideration for sealant application.

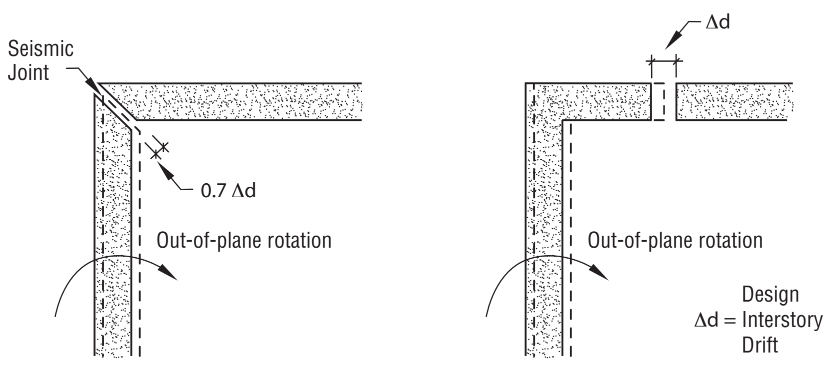


Figure 6 Corner joint made wider to avoid collision.

In all cases, the precast engineer and the glazing engineer should coordinate their efforts early in the design phase to avoid conflicts.

Other configurations

If the panel that spans two floors is tall and narrow (high aspect ratio), bearing connections can be located so the unit translates with the level of the bearing connections. If they are vertically close to the panel's center of gravity, as in **Fig. 3-b**, the seismic overturning couple is minimized and the bearing connections would carry all gravity and in-plane seismic loads. The tie-backs would then isolate both the top and bottom of the panel from their respective floors, (**Fig. 3-b**). An alternative seismic connection sometimes used for tall, narrow units is a single bearing connection, along with sufficient tie-backs for stability.

Connections for load-bearing wall panels are an essential part of the structural support system, and the stability of the structure may depend on them. Load-bearing wall panels may have horizontal and/or vertical joints across which forces must be transferred. Load-bearing panel connections should be designed and detailed in the same manner as connections for other precast concrete structural members. It is desirable to design load-bearing precast concrete structures with connections that allow lateral movement and rotation, and to design the structure to achieve lateral stability through the use of floor and roof diaphragms and shearwalls. Designers are referred to an extensive treatment of design methods in the *PCI Manual on Design and Typical Details of Connections for Precast and Prestressed Concrete* and the *PCI Design Handbook*.

AIA Learning Units

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Instructions

Review the learning objectives below.

Read the AIA Learning Units article.

Answer the 11 questions at the end of the article and submit to PCI. Submittal instructions are provided on the Learning Units form. You will need to answer at least 80% of the questions correctly to receive the 1.0 HSW Learning Units associated with this educational program. You will be notified when your Learning Units are submitted to AIA.

Learning Objectives

After reading this article, readers will be able to explain how a building behaves during a seismic event.

Readers of this article will be able to define "drift" and its importance during the design phase.

After reading this article, readers will be able to recite the different types of precast connections.

Readers will be able to define the interaction between precast concrete panels and the building structure during seismic events.

Ascent 2011 – Behavior of Architectural Precast Panels in Response to Drift

Name (please print): ______________________________

Company Name: ______________________________

Address: ______________________________

City ____________________ **State** ________ **Zip** __________

Phone Number: ____________ **Email Address:** ____________________

Title: ______________________________

Background (circle one): Architect – Engineer – Business – Marketing/Sales – Finance – Other

1. Precast concrete panels are more rigid:
   a. In-plane than out-of-plane
   b. When braced against other panels
   c. When floor heights are lower
   d. When they are cast slightly thicker

2. Out-of-plane translation is common for what type of panel?
   a. Spandrel panels connected at one level
   b. Wall panels connected at three points
   c. Wall panels spanning more than one bay horizontally
   d. Spandrel panels spanning vertically between two floors

3. Out-of-rotation is common for what type of panel?
   a. Panels that are connected at different levels of framing
   b. Panels that are rigidly connected only at one point
   c. Column panels that tilt outward from their bases
   d. Spandrel panels connected at one level

4. Connections that resist imposed loads in all directions are referred to as:
   a. Rigid connections
   b. Solid or strong connections
   c. Resistive connections
   d. Shear connections

5. If panels are intended to translate, the horizontal joints must:
   a. Remain at constant elevation
   b. Remain flexible to endure anticipated movement
   c. Limit movement in all other directions
   d. Remain infrequent to minimize costs

6. A common method for limiting panel collisions at corners involves:
    a. Mitering the panel edges
    b. Staggering the panels on opposite building faces
    c. Cutting back the corners must likely to collide
    d. Adding sliding connections connecting the panels

7. Rocking connections provide for what type of movement?
    a. Vertical upward movement
    b. In-plane translation
    c. Rotation back and forth at one connection point
    d. Horizontal movement between floors

8. A small aspect ratio panel should be designed to move with what type of motion?
    a. In-place translation
    b. Out-of-plan rotation
    c. Horizontal disconfiguration
    d. Panel up-lift

9. A high aspect ratio panel must be designed to free move in what way?
    a. Free rotation in-plane
    b. Free translation in-plane
    c. Free rotation out-of-plane
    d. Free translation out-of-plane
    e. None of the above
    f. Half of the above

10. It is preferred that horizontal panel joints should be arranged such that:
    a. All horizontal joints are in one continuous line
    b. All horizontal joints are offset for a maximum movement allowance
    c. All horizontal joints are arranged in an ascending pattern to allow for maximum horizontal in-plane translation
    d. The joints' arrangement is immaterial if the correct connections are chosen

11. Drift is what type of movement?
    a. Vertical movement of one floor with respect to those above and below it
    b. Rotation in place characterized by one floor plate spinning around a central axis not necessarily shared with adjacent floors
    c. Horizontal movement of one floor with respect to those above and below it
    d. Both vertical and longitudinal movement of one single floor or group of floors

To receive credit, please submit completed forms to:

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designer's notebook

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- **The International Green Construction Code: A Preview**
  March 29 and 31, 2011

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  April 7, 2011, Oklahoma City, Okla.
  April 12, 2011, New York City, N.Y.
  April 13, 2011, Baltimore, Md.
  April 20, 2011, Grandville, Mich.
  April 28, 2011, Boston, Mass.
- **Quality Control School**
  Level 1, March 28, 2011, Nashville, Tenn.
  Level 2, March 29, 2011, Nashville, Tenn.
  Level 3, March 30–April 2, 2011, Nashville, Tenn.
  CFA, March 28–30, 2011, Nashville, Tenn.
  CCA, March 31, 2011, Nashville, Tenn.
- **Precast Parking Design Techniques and History**, presented by PCI of Illinois and Wisconsin, www.pci-iw.org/index.cfm/education/technology
  March 1, 2011, Chicago, Ill.

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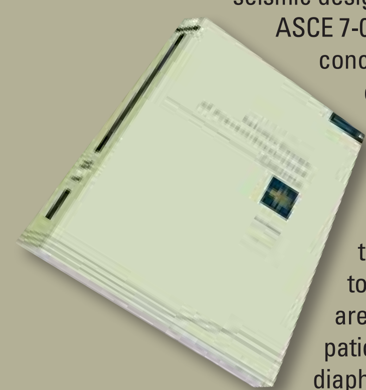
More Sustainable Than Ever: *Architectural Precast Concrete,* 3rd edition

This fully revised edition of *Architectural Precast Concrete* includes new sections on sustainability, condensation control, and blast resistance. You'll get extensive updates in the areas of color, texture, finishes, weathering, tolerances, connections, and windows, along with detailed specifications to meet today's construction needs. With more than 400 beautiful, full-color photographs and a bonus DVD, no architecture firm, design-build firm, or precaster should be without a copy.

Architectural Precast Concrete, Third Edition
MNL-122-07. ISBN: 978-0-937040-78-3
$180 / AIA Members $135 / PCI Members $90

Breaking Down the Code: *Seismic Design of Precast/Prestressed Concrete Structures*

This book provides engineers with approaches for applying the seismic design provisions of ACI 318-02, ASCE 7-02, and IBC 2003 to precast concrete structures. The authors examine various styles or classifications of precast concrete lateral force-resisting systems, review code and behavior requirements, and then apply these requirements to realistic examples. Included are examination of energy-dissipation, review of ongoing research, diaphragm design, and anticipated code developments.



Seismic Design of Precast/Prestressed Concrete Structures, First Edition
MNL-140-07. ISBN: 978-0-937040-77-5
$350 / PCI Members $175

Other Available Titles:

***PCI Design Handbook*, Sixth Edition**. The standard for the design, manufacture, and use of structural precast/prestressed concrete and architectural precast concrete.
MNL-120-04. ISBN: 0-937040-71-1 / 0978-0-937040-71-7
$260 / PCI Members $130

***Manual for the Evaluation and Repair of Precast, Prestressed Concrete Bridge Products*, First Edition**. Includes information on imperfections or damage that can occur during production, handling, transportation, and erection.
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(as of January 2011)

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

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

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

Guide Specification

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

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

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

Product Groups and Categories

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

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

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

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

GROUPS

GROUP A – *Architectural Products*

Category AT – Architectural Trim Units

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

Category A1 – Architectural Cladding and Load-Bearing Units

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

GROUP B – *Bridges*

Category B1 – Precast Concrete Bridge Products

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

Category B2 – Prestressed Miscellaneous Bridge Products

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

Category B3 – Prestressed Straight-Strand Bridge Members

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

Category B4 – Prestressed Deflected-Strand Bridge Members

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

GROUP BA – *Bridge Products with an Architectural Finish*

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

GROUP C – *Commercial (Structural)*

Category C1 – Precast Concrete Products

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

Category C2 – Prestressed Hollow-Core and Repetitive Products

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

Category C3 – Prestressed Straight-Strand Structural Members

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

Category C4 – Prestressed Deflected-Strand Structural Members

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

GROUP CA – *Commercial Products with an Architectural Finish*

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

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

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

ALABAMA

Gate Precast Company, Monroeville (251) 575-2803 **A1, C1A**
Hanson Pipe and Precast Southeast, Birmingham (205) 663-4681 **B4, C4**
Standard Concrete Products, Theodore (251) 443-1113 **B4, C2**

ARIZONA

Coreslab Structures (ARIZ) Inc., Phoenix (602) 237-3875 **A1, B3, C4A**
CXT Concrete Ties, Tucson (520) 644-5703 **C2**
TPAC, Phoenix (602) 262-1360 **A1, B4, C4A**

ARKANSAS

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

CALIFORNIA

Bethlehem Construction, Inc., Shafter (661) 391-9704 **C3A**
Clark Pacific, Fontana (909) 823-1433 **A1, C3A, G**
Clark Pacific, West Sacramento (916) 371-0305 **A1, C3A**
Clark Pacific, Woodland (916) 371-0305 **B3, C3**
Con-Fab California Corporation, Lathrop (209) 249-4700 **B4, C4**
Con-Fab California Corporation, Shafter (661) 630-7162 **B4**
Coreslab Structures (L.A.) Inc., Perris (951) 943-9119 **A1, B4, C4A**
Hanson Structural Precast, Irwindale (626) 962-8751 **C4**
Hanson Structural Precast, San Diego (619) 423-9030 **C4**
Kie-Con Inc. - Kiewit Corporation, Antioch (925) 754-9494 **B2, C3**
Mid-State Precast, L.P., Corcoran (559) 992-8180 **A1, C3A**
Pomeroy Corporation, Perris (951) 657-6093 **B4, C2A**
StructureCast, Bakersfield (661) 833-4490 **A1, B3, C3A**
Walters & Wolf Precast, Fremont (510) 226-5162 **A1, G**
Willis Construction Co., Inc., San Juan Bautista (831) 623-2900 **A1, C1, G**

COLORADO

EnCon Colorado, Denver (303) 287-4312 **B4, C2**
Plum Creek Structures, Littleton (303) 471-1569 **B4, C3A**
Rocky Mountain Prestress, Inc., Denver (303) 480-1111 **B4, C4**
Rocky Mountain Prestress, Inc., Denver (303) 480-1111 **A1, AT**
Rocla Concrete Tie, Inc., Denver (303) 296-3505 **C2**
Stresscon Corporation, Colorado Springs (719) 390-5041 **A1, B4A, C4A**
Stresscon Corporation, Dacono (303) 659-6661 **C4A**

CONNECTICUT

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

DELAWARE

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

FLORIDA

CDS Manufacturing Inc., Gretna (850) 875-4651 **B4, C2**
Cement Industries, Inc., Fort Myers (239) 332-1440 **B3, C3**
Colonial Construction Company, Inc., Placida (941) 698-4180 **C2**
Coreslab Structures (MIAMI) Inc., Medley (305) 823-8950 **A1, C4A**
Coreslab Structures (ORLANDO) Inc., Orlando (407) 855-3191 **C2**
Coreslab Structures (TAMPA) Inc., Tampa (813) 626-1141 **A1, B3, C3A**
Dura-Stress, Inc., Leesburg (800) 342-9239 **A1, B4A, C4A**
Finfrock Industries, Inc., Orlando (407) 293-4000 **A1, C4A**
Florida Precast Industries, Inc., Sebring (863) 655-1515 **C2**
Florida Rock and Sand Prestress Precast Co., Inc., Florida City (305) 247-9611 **B3, C3**
Florida Rock and Sand Prestress Precast Co., Inc., Miami (305) 247-9611 **B3**
Gate Precast Company, Jacksonville (904) 757-0860 **A1, B4, C4**
Gate Precast Company, Kissimmee (407) 847-5285 **A1**
Metromont Corporation, Bartow (863) 440-5400 **C3**
South Eastern Prestressed Concrete, Inc., West Palm Beach (561) 793-1177 **B3, C3**
Stabil Concrete Products, LLC, St. Petersburg (727) 321-6000 **A1**
Standard Concrete Products, Inc., Tampa (813) 831-9520 **B4, C3**
Stress-Con Industries, Inc., Fort Myers (239) 390-9200 **B3**
Structural Prestressed Industries, Medley (305) 556-6699 **C4**

GEORGIA

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

HAWAII

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

IDAHO

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

ILLINOIS

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

INDIANA

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

IOWA

Andrews Prestressed Concrete, Inc., Clear Lake (641) 357-5217 **B4, C4**
IPC, Inc., Des Moines (515) 243-5118 **B3, C4**
IPC, Inc., Iowa Falls (515) 243-5118 **A1, B4, B4-IL, C4A**
MPC Enterprises, Inc., Mount Pleasant (319) 986-2226 **A1, C3A**

KANSAS

Coreslab Structures (KANSAS) Inc., Kansas City (913) 287-5725 **B4, C4**
IPC, Inc., Pleasanton (913) 352-8800 **B3, C3**
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 **C3A**

KENTUCKY

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

LOUISIANA

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

MAINE

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

MARYLAND

Atlantic Metrocast, Inc., LaPlata (301) 870-3289 **B3, C1**
Larry E. Knight, Inc., Glyndon (410) 833-7800 **C2**
Oldcastle Precast Building Systems Div., Edgewood (410) 612-1213 **A1, C3A**

MASSACHUSETTS

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

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

MICHIGAN

Grand River Infrastructure, Inc., Grand Rapids (616) 534-9645 **B4, C1**
International Precast Solution, LLC, River Rouge (313) 843-0073 **A1, B3, C3**
Kerkstra Precast Inc., Grandville (800) 434-5830 **A1, B1, C3A**
National Precast Structural, Inc., Shelby (586) 247-1201 **B1A, C3A**
National Precast, Inc., Roseville (586) 294-6430 **A1, B2A, C3A**
Nucon Schokbeton / Stress-Con Industries, Inc.,
Kalamazoo (269) 381-1550 **A1, B4, C3A**
Stress-Con Industries, Inc., Detroit (313) 873-4711 **B3, C3**
Stress-Con Industries, Inc., Saginaw (989) 239-2447 **B4, C3**

MINNESOTA

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

MISSISSIPPI

F-S Prestress, LLC, Hattiesburg (601) 268-2006 **B4, C4**
Gulf Coast Pre-Stress, Inc., Pass Christian (228) 452-9486 **B4, C4**
J.J. Ferguson Prestress-Precast Company, Inc., Greenwood (662) 453-5451 **B4**
Jackson Precast, Inc., Jackson (601) 321-8787 **A1, C2A**
Rotondo Weirich Enterprises, Inc., Yazoo City (215) 256-7940 **C1**
Tindall Corporation, Moss Point (228) 435-0160 **A1, C4A**

MISSOURI

Coreslab Structures (MISSOURI) Inc., Marshall (660) 886-3306 **A1, B4**
County Materials Corporation, Bonne Terre (573) 358-2773 **B4**
Mid America Precast, Inc., Fulton (573) 642-6400 **A1, B1, C1**
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 (605) 718-4111 **B4, C3**

NEBRASKA

Concrete Industries, Inc., Lincoln (402) 434-1800 **B4, C4A**
Coreslab Structures (OMAHA) Inc., LaPlatte (402) 291-0733 **A1, B4, C4A**
CXT, Inc., Grand Island (308) 382-5400 **C2**
Enterprise Precast Concrete, Inc., Omaha (402) 895-3848 **A1**
Stonco, Inc., Omaha (402) 556-5544 **A1, AT**

NEW HAMPSHIRE

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

NEW JERSEY

Boccella Precast LLC, Berlin (856) 767-3861 **C2**
High Concrete Group LLC, Buena (856) 697-3600 **C3**
Jersey Precast Corp., Hamilton Township (609) 689-3700 **B4, C4**
Precast Systems, Inc., Allentown (609) 208-1987 **B4, C4**

NEW MEXICO

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

NEW YORK

David Kucera Inc., Gardiner (845) 255-1044 **A1, G**
Lakelands Concrete Products, Inc., Lima (585) 624-1990 **A1, B3A, C3A**
Oldcastle Precast Building Systems Div.,
South Bethlehem (518) 767-2116 **B3, C3A**
The Fort Miller Co., Inc., Greenwich (518) 695-5000 **B1, C1**
The L.C. Whitford Materials Co., Inc., Wellsville (585) 593-2741 **B3, C3**

NORTH CAROLINA

Gate Precast Company, Oxford (919) 603-1633 **A1, C2**
International Precast Inc., Siler City (919) 742-3132 **A1, C3A**
Metromont Corporation, Charlotte (704) 372-1080 **A1, C3**
Prestress of the Carolinas, Charlotte (704) 587-4273 **B4, C4**
S & G Prestress Company, Leland (910) 397-6255 **B4**
S & G Prestress Company, Wilmington (910) 763-7702 **B4, C3**
Utility Precast, Inc., Concord (704) 721-0106 **B3A**

NORTH DAKOTA

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

OHIO

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

OKLAHOMA

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

OREGON

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

PENNSYLVANIA

Castcon Stone, Inc., Saxonburg (724) 352-2200 **B1, C1A**
Concrete Safety Systems, LLC, Bethel (717) 933-4107 **B1A, C1A**
Conewago Precast Building Systems, Hanover (717) 632-7722 **A1, C2A**
Dutchland, Inc., Gap (717) 442-8282 **C3**
Fabcon East, LLC, Mahanoy City (570) 773-2480 **C3A**
Hanson Pipe & Precast, Pottstown (610) 970-2216 **B1A, C1A**
High Concrete Group LLC, Denver (717) 336-9300 **A1, B3, C3A**
J & R Slaw, Inc., Lehighton (610) 852-2020 **A1, B4, C3**
Newcrete Products, Roaring Spring (814) 224-2121 **B4, C4**
Nitterhouse Concrete Products, Inc., Chambersburg (717) 267-4505 **A1, C4A**
Northeast Prestressed Products, LLC, Cressona (570) 385-2352 **B4, C3**
Pittsburgh Flexicore Company, Inc., Donora (724) 258-4450 **C2**
Say-Core, Inc., Portage (814) 736-8018 **C2**
Sidley Precast, Youngwood (724) 755-0205 **C3**
Technopref Industries Inc., Royersford Plant,
Royersford (450) 569-8043 **B1, C1**
U.S. Concrete Precast Group Mid-Atlantic,
Middleburg (570) 837-1774 **A1, C3A**
Universal Concrete Products Corporation, Stowe (610) 323-0700 **A1, C3A**

SOUTH CAROLINA

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

SOUTH DAKOTA

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

TENNESSEE

Construction Products, Inc. of Tennessee, Jackson (731) 668-7305 **B4, C4**
Gate Precast Company, Ashland City (615) 792-4871 **A1, C3A**
Metromont Corporation, LaVergne (615) 793-3393 **A1, C4A**
Mid South Prestress, LLC, Pleasant View (615) 746-6606 **C3**
Prestress Services Industries of TN, LLC, Memphis (901) 775-9880 **B4, C3**
Ross Prestressed Concrete, Inc., Bristol (423) 323-1777 **B4, C3**
Ross Prestressed Concrete, Inc., Knoxville (865) 524-1485 **B4, C4**
Sequatchie Concrete Service, Inc., Chattanooga (423) 867-4510 **C2**
Southeast Precast Corporation, Knoxville (865) 524-3615 **A1**

TEXAS

Coreslab Structures (TEXAS) Inc., Cedar Park (512) 250-0755 **A1, C4A**
CXT, Inc., Hillsboro (254) 580-9100 **B1, C1**
Eagle Precast Corporation, Decatur (940) 626-8020 **A1, AT, C3**
Enterprise Concrete Products, LLC, Dallas (214) 631-7006 **B3, C3**
Gate Precast Company, Pearland (281) 485-3273 **C2**
Gate Precast Company, Hillsboro (254) 582-7200 **A1**
GFRC Cladding Systems, LLC, Garland (972) 494-9000 **G**
Heldenfels Enterprises, Inc., Corpus Christi (361) 883-9334 **B4, C4**
Heldenfels Enterprises, Inc., San Marcos (512) 396-2376 **B4, C4**
Lowe Precast, Inc., Waco (254) 776-9690 **A1, C3A**

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Manco Structures, Ltd., Schertz (210) 690-1705 **B4, C4A**
MobilGreen Precast, LLC, Midland (612) 801-3600 **C4**
North American Precast Company, San Antonio (210) 509-9100 **A1, C4A**
Rocla Concrete Tie, Inc., Amarillo (806) 383-7071 **C2**
Tindall Corporation, San Antonio (210) 248-2345 **C2A**

UTAH

EnCon Utah, LLC, Tooele (435) 843-4230 **A1, B4, C3A**
Hanson Structural Precast Eagle, Salt Lake City (801) 966-1060 **A1, B4, C4A, G**
Harper Contracting, Salt Lake City (801) 326-1016 **B1, C1**
Owell Precast LLC, Bluffdale (801) 571-5041 **B3A, C3**

VERMONT

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

VIRGINIA

Atlantic Metrocast, Inc., Portsmouth (757) 397-2317 **B4, C3**
Bayshore Concrete Products Corporation, Cape Charles (757) 331-2300 **B4, C4**
Bayshore Concrete Products/Chesapeake, Inc., Chesapeake (757) 549-1630 **B4, C4**
Coastal Precast Systems, LLC, Chesapeake (757) 545-5215 **A1, B4, C3**
Metromont Corporation, Richmond (804) 222-8111 **A1, C3A**
Mid-Atlantic Precast LLC, King George (540) 775-2275 **C2**
Rockingham Precast, Inc., Harrisonburg (540) 433-8282 **B4, C3**
Smith-Midland Corporation, Midland (540) 439-3266 **A1, B2, C3**
The Shockey Precast Group, Fredericksburg (540) 898-1221 **A1, C3A**
The Shockey Precast Group, Winchester (540) 667-7700 **A1, C4A**
Tindall Corporation, Petersburg (804) 861-8447 **A1, C4A**

WASHINGTON

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

WEST VIRGINIA

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

WISCONSIN

Advance Cast Stone Co., Inc., Random Lake (920) 994-4381 **A1**
County Materials Corporation, Eau Claire (800) 729-7701 **B4**
County Materials Corporation, Roberts (800) 426-1126 **B4, C3**
International Concrete Products, Inc., Germantown (262) 242-7840 **A1, C1**
MidCon Products, Inc., Hortonville (920) 779-4032 **A1, AT, C1**
Spancrete Industries, Inc., Waukesha (414) 290-9000 **A1, B2A, C3A**
Spancrete, Inc., Green Bay (920) 494-0274 **B4, C4**
Spancrete, Inc., Valders (920) 775-4121 **A1, B3, C3A**
Stonecast Products, Inc., Germantown (262) 253-6600 **A1, C1**

CANADA

ALBERTA

Armtec Limited Partnership, Calgary (403) 248-3171 **A1, B4, C4**
P. Kruger Concrete Products, Ltd., Edmonton (780) 438-2072 **A1, C1**

BRITISH COLUMBIA

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

MANITOBA

Armtec Limited Partnership, Winnipeg (204) 338-9311 **B4, C3A**
Lafarge Canada Inc., Winnipeg (204) 958-6381 **C2**

NEW BRUNSWICK

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

NOVA SCOTIA

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

ONTARIO

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

QUEBEC

Betons Prefabriques du Lac Inc., Alma (418) 668-6161 **A1, C3, G**
Betons Prefabriques du Lac, Inc., Alma (418) 668-6161 **A1, C1**
Betons Prefabriques Trans. Canada Inc., St. Eugene De Grantham (819) 396-2624 **A1, B4, C3A**
Prefab De Beauce, Sainte-Marie De Beauce (418) 387-7152 **A1, C3**
Schokbeton Quebec, Inc., St. Eustache (450) 473-6831 **A1, B4A, C3**

MEXICO

PRETECSA, S.A. DE C.V., Atizapan De Zaragoza (011) 52-1036077 **A1, G**
Willis De Mexico S.A. de C.V., Tecate (011) 52-665-655-2222 **A1, C1, G**

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PCI-Qualified & PCI-Certified Erectors

(as of January 2011

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

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

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

Guide Specification

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

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

Erector Classifications

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

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

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

GROUPS

Category S1 - Simple Structural Systems

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

Category S2 - Complex Structural Systems

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

Category A - Architectural Systems

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

Certified erectors are listed in blue.

ARIZONA

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

ARKANSAS

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

CALIFORNIA

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

COLORADO

Colorado Fabricators & Constructors, Inc., Centennial (303) 471-9902 — **S2**
Gibbons Erectors, Inc., Englewood (303) 841-0457 — **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**
Jacob Erecting & Construction LLC, Durham (860) 788-2676 — **S2, A**
The Berlin Steel Construction Co., Kensington (860) 828-3531 — **A**

FLORIDA

All Florida Erectors and Welding, Inc., Apopka (407) 880-3717 — **S2, A**
Concrete Erectors, Inc., Altamonte Springs (407) 862-7100 — **S2, A**
Finfrock Industries, Inc., Orlando (407) 293-4000 — **S2**
Florida Precast Industries, Sebring (863) 655-1515 — **S2, A**
Gate Precast Erection Co., Jacksonville (904) 757-0860 — **S2, A**
Gate Precast Erection Co., Kissimmee (407) 847-5285 — **A**
James Toffoli Construction Company, Inc., Fort Myers (239) 479-5100 — **S2**
Pre-Con Construction of Tampa Inc., Tampa (813) 626-2545 — **S2, A**
Randy J. Mellor Construction, Inc., Nokomis (941) 321-1826 — **S1**
Solar Erectors U. S. Inc., Medley (305) 825-2514 — **S2, A**
Specialty Concrete Services, Inc., Altoona (352) 669-8888 — **S2, A**
Structural Prestressed Industries, Inc., Medley (305) 556-6699 — **S2**
Summit Erectors, Inc., Jacksonville (904) 783-6002 — **S2, A**

GEORGIA

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

IDAHO

Precision Precast Erectors, LLC, Worley (208) 660-5223 — **S1**

ILLINOIS

Creative Erectors, LLC, Rockford (815) 229-8303 — **S2**
Mid-States Concrete Industries, South Beloit (800) 236-1072 — **S2**
Spancrete of Illinois, Inc., Crystal Lake (815) 459-5580 — **S2**

INDIANA

National Steel Erectors, Inc., Indianapolis (317) 481-0388 — **A**
Sofco Erectors, Inc., Indianapolis (317) 352-9680 — **S2, A**
Stres Core Inc., South Bend (574) 233-1117 — **S1**

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IOWA
Architectural Wall Systems Co., West Des Moines (515) 255-1556 ________ **A**
Cedar Valley Steel, Inc., Cedar Rapids (319) 373-0291 ________ **S2**
Topping Out Inc. / dba Northwest Steel Erection,
Des Moines (800) 247-5409 ________ **S2**

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

LOUISIANA
Lafayette Steel Erector, Inc., Lafayette (337) 234-9435 ________ **S2**

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

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) 877-0000 ________ **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,
Baltimore (518) 767-2116 ________ **S2, A**

MASSACHUSETTS
Concrete Structures, Inc., Marshfield (781) 837-1931 ________ **S1, A**
Prime Steel Erecting, Inc., North Billerica (978) 671-0111 ________ **S2, A**

MICHIGAN
Alpha Omega Development, Saginaw (989) 399-9436 ________ **S2**
American Erectors Inc., Waterford (248) 674-0060 ________ **S2, A**
Assemblers Precast & Steel Services, Inc., Saline (734) 429-1358 ________ **S2, A**
Devon Contracting, Inc., Detroit (313) 965-3455 ________ **S2**
G2 Inc., Cedar Springs (616) 696-9581 ________ **S2, A**
Pioneer Construction Inc., Grand Rapids (616) 247-6966 ________ **S2**

MINNESOTA
Amerect, Inc., Newport (651) 459-9909 ________ **A**
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**

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

MISSOURI
Acme Erectors, Inc., St Louis (314) 647-1923 ________ **S2**
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**
Moen Steel Erection, Inc., Omaha (402) 884-0925 ________ **S2**
Topping Out Inc. / dba Davis Erection Lincoln, Lincoln (800) 881-2931 _ **S2**
Topping Out Inc. / dba Davis Erection Omaha, Omaha (800) 279-1201 _ **S2**

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

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

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

NEW YORK
All Systems Precast, Inc., Farmingdale (631) 694-4720 ________ **S2**
Arben Group LLC, Pleasantville (914) 741-5459 ________ **S2**
Empire Constructors LLC, Pittsford (585) 586-1510 ________ **A**
Koehler Masonry, Farmingdale (631) 694-4720 ________ **S1**
Oldcastle Building Systems Div. / Project Services,
Manchester (518) 767-2116 ________ **S2, A**
Oldcastle Building Systems Div. / Project Services,
South Bethlehem (518) 767-2116 ________ **S2, A**

NORTH CAROLINA
Buckner Steel Erection Inc., Graham (336) 376-8888 ________ **S2**
Carolina Precast Erectors, Inc., Taylorsville (828) 635-1721 ________ **S2**
Rabon Erectors, Inc., Archdale (336) 434-3308 ________ **S2, A**

NORTH DAKOTA
Concrete, Inc., Grand Forks (701) 772-6687 ________ **S2**
Northwest Contracting Inc., Bismarck (701) 255-7727 ________ **S2**
PKG Contracting, Inc., Fargo (701) 232-3878 ________ **S2**

OHIO
Ben Hur Constructionn Company, Fairfield (513) 874-9228 ________ **A**
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
Allied Steel Construction Co., LLC, Oklahoma City (405) 232-7531 ________ **S2, A**
Bennet Steel, Inc., Sapulpa (918) 260-0773 ________ **S1**
Coreslab Structures (OKLA), Inc., Oklahoma City (405) 632-4944 ________ **S2, A**

PENNSYLVANIA
Century Steel Erectors, Kittanning (724) 545-3444 ________ **S2, A**
Conewago Enterprises, Inc., Hanover (717) 632-7722 ________ **S2**
High Concrete Group, Denver (717) 336-9300 ________ **S2, A**
Maccabee Industrial, Inc., Belle Vernon (724) 930-7557 ________ **A**
Nitterhouse Concrete Products, Inc., Chambersburg (717) 267-4505 ________ **S2**
Patterson Construction Company, Inc., Monongahela (724) 258-4450 ________ **S1**
Say-Core, Inc., Portage (814) 736-8018 ________ **S1**
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
Empire Steel Erectors LP, Humble (281) 548-7377 ________ **A**
Gate Concrete Products Company, Pearland (281) 485-3273 ________ **S1**
Precast Erectors, Inc., Hurst (817) 684-9080 ________ **S2, A**

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

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

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

WISCONSIN
Modern Crane Service, Inc., Onalaska (608) 781-2252 ________ **S1**
Spancrete, Valders (920) 775-4121 ________ **S2, A**
Spancrete, Waukesha (414) 290-9000 ________ **S2, A**
The Boldt Company, Appleton (920) 225-6127 ________ **S2, A**

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