WINTER 2012

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CONTINUING EDUCATION AIA

AIA Education Program Inside

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To: Precasters, Design Firms, All interested parties
From: JVI, Inc.
Re: Nomenclature clarification

The third iteration of *The Vector Connector* has rendered previous iterations obsolete. Appropriately, these previous versions of *The Vector Connector* are hereby retired with a hearty "well done"! Henceforth, this third iteration, which until now has been called *The Mid-V*, will now be called - simply - *The Vector Connector*.

Along with *The Vector Connector*, JVI also offers *The Mini-V*, a scaled-down version of *The Vector Connector* for thinner applications.

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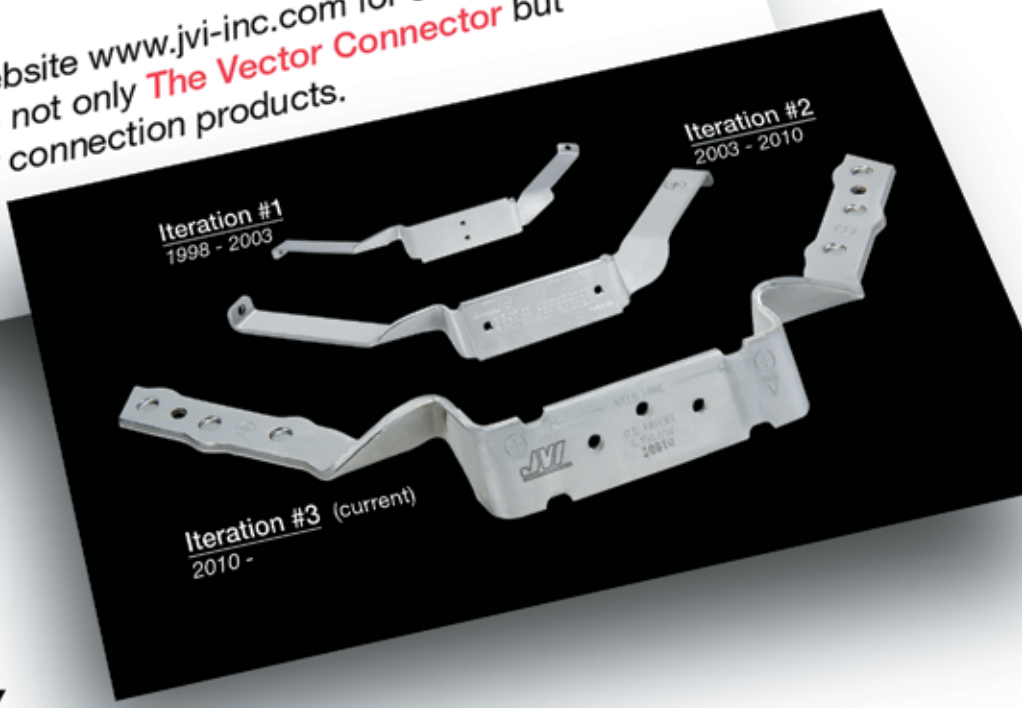

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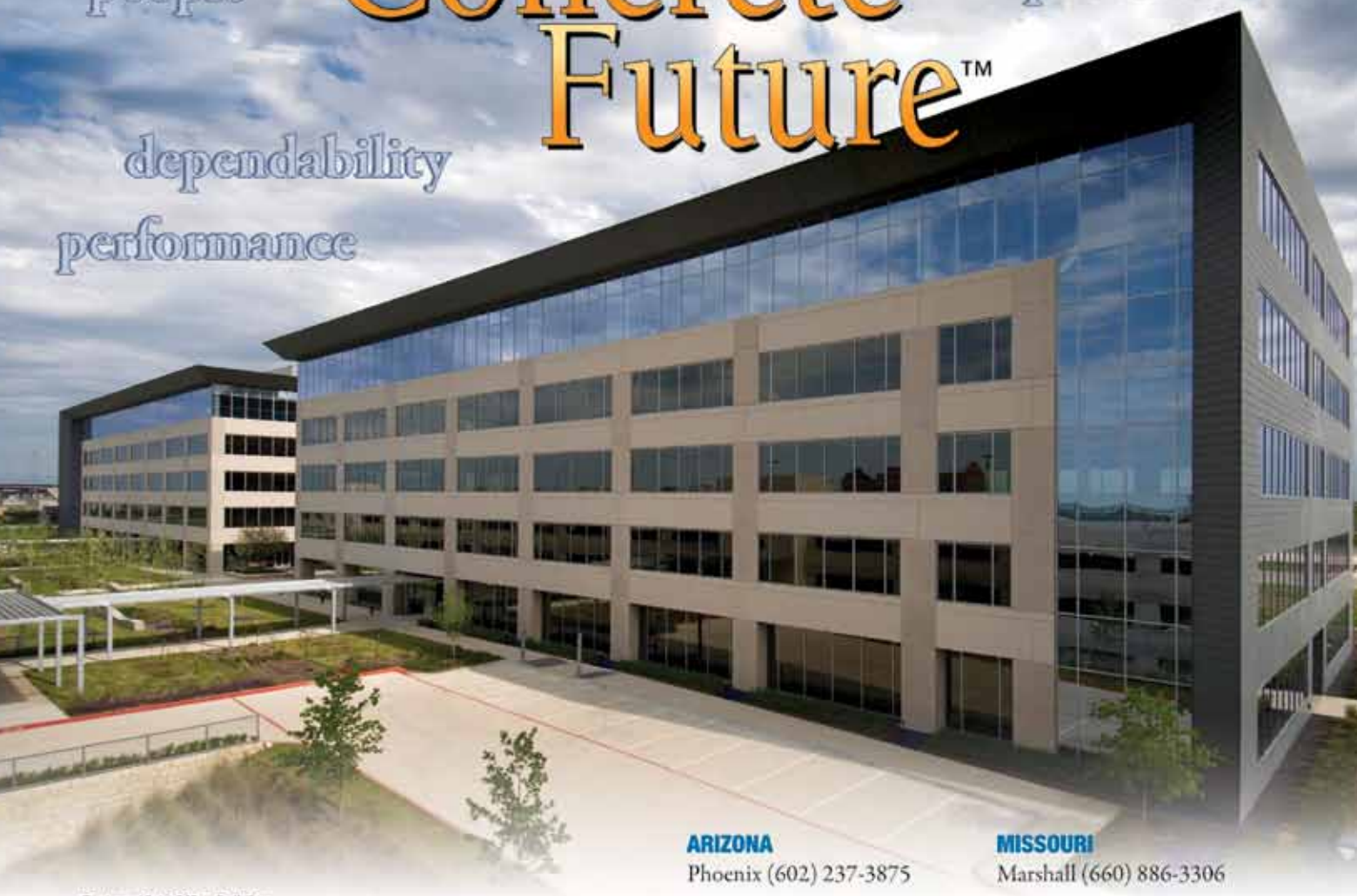

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Planned simultaneously with Comerica Park - home of Major League Baseball's Detroit Tigers - Ford Field opened in 2002 as part of a public project to replace both Tiger Stadium and the Pontiac Silverdome.

One unique aspect of this $500 million project was the rehabilitation and integration of the old Hudson's Warehouse which featured a concrete structure dating back to the 1920s. The newly restored warehouse and stadium now boast a seven-story atrium featuring brick-clad precast panels insulated by Thermomass with a unique arrangement of 65,000 seats and a number of lounges that service the premium seating. The combined space also includes banquet facilities, restaurants, office space, retail services and food courts.

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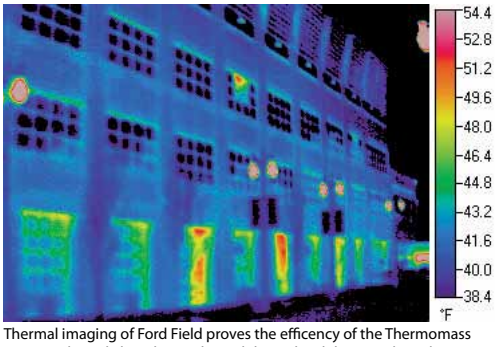
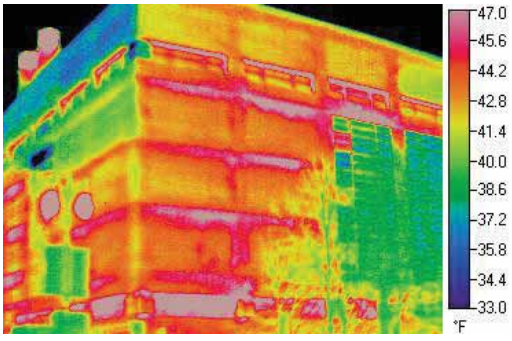
For more information please call us at (800) 232-1748 or visit us online at www.thermomass.com.



Thermal imaging of Ford Field proves the efficency of the Thermomass system. The only heat loss is through lower level doors and windows.



Thermal imaging of a neighboring building constructed with brick and block reveals significant heat loss.

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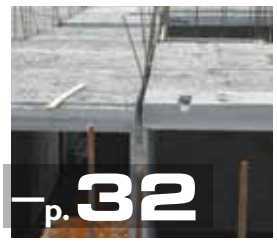
Points where materials come together create great challenges and require close attention to ensure long-term success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Building Vertically

Publix Supermarkets fits GreenWise shopping concept into tight urban historic space using total precast concrete system


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What's New in Your New Year?

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

Have you ever felt an excitement about the start of a new year? I think this is partially because it provides us with a fresh start. People often have certain activities, or "rituals," they perform at the beginning of each year. For example, how many of you started the New Year by cleaning your office or desk?

And, of course, many people make New Year's resolutions. Some vow to exercise more, quit smoking, lose weight or finally get that new Corvette they have always wanted. You may have already planned how to obtain your annual continuing education credits, which PCI webinars and our e-Learning center can help with, especially now that AIA requires at least 12 HSW credits. You may have also resolved to get more free recognition for yourself and your company this year, such as submitting your projects for the PCI Design Awards. The submission site is now open. As for me, I'm going to work at keeping my desk a bit more organized, although the Corvette sounds pretty good too.

Whether you have rituals or make resolutions, one thing is certain: Each new year comes with new challenges and opportunities, and 2012 will be no exception. The new International Green Construction Code (IgCC) is scheduled for release this year. Already several states, such as Florida and Maryland have adopted the new code upon its publication. PCI will provide more information on the IgCC in the coming months, including articles in the next issue of *Ascent* and a webinar in the spring.

We will also see the release of LEED 2012, and you may notice more discussion about "functional resilience." You can learn more in the article titled "Functional Resilience: A New Way to View Sustainability" on page 12 in this issue of *Ascent*.

While new codes and concepts are coming to life in 2012, so will new resources from PCI. PCI will be rolling out a new website toward the end of the year. This exciting project will provide many new features, including a user-dashboard page. Once users register, they can access their dashboard which contains their personal information, preferences, and history. Users will be able to review their PCI continuing-education history, receive notices and industry alerts, and save any page on the website for easy future access. Users will also be able to customize their dashboard page with "widgets" or functional applications. These will include apps like the Color and Texture Selection Guide, an industry calendar, and a widget to show the most recent postings related to your declared interests.

PCI will also be expanding the *body of knowledge* of the precast concrete structures industry by publishing new manuals and research. Some of these include the third edition of the PCI Bridge Design Manual, the second edition of the Seismic Design Manual, and the much-anticipated life-cycle assessment study for precast concrete.

With new codes, resources, resolutions and maybe some rituals, 2012 is off and kicking. Hopefully, the New Year brings you new projects and opportunities, and will be a prosperous one for you!

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ASCENT **On the cover: Publix Supermarket in Tampa, Fla. (see page 36)**

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- If you have a project to be considered, send information to Whitney Stephens,
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Finfrock Awarded Five Design-Build Parking Projects

ORLANDO, FLORIDA

Finfrock Construction, Inc. has recently been awarded five new parking structure projects. Design-build services will be provided for three new projects in Central Florida: a 617 stall garage for Adventist Health System/Sunbelt Healthcare Corp. in Altamonte Springs, Fla.; a 330 stall garage for Osceola Regional Medical Center in Kissimmee, Fla.; and an 808 stall garage serving the new Cruise Terminal 6 for the Canaveral Port Authority.

Additionally, complete design-build services will be provided to Alta Congress, LLC for a 587 stall garage project in Del Ray Beach, Fla., and to Metropolitan Life Insurance Co. for a 1,452 stall expansion to an existing Finfrock garage in Tampa, Fla. Construction costs for the five garages are expected to total nearly $30,000,000. Design work is underway on each project with all projects scheduled to begin construction in 2012.

Gate Precast to Produce Precast Concrete Wall System for new Fort Hood Hospital

HILLSBORO, TEXAS

Gate Precast Company has been selected by the Balfour Beatty / McCarthy joint venture design build team to provide a thermally efficient, pre-insulated, brick inlaid architectural precast concrete system for the U.S. Army Corps of Engineers' replacement hospital at Fort Hood.

The new $503 million, 944,000-square-foot medical facility is designed by HKS Architects and Wingler & Sharp. The facility will replace the existing Carl R. Darnall Army Medical Center.

Gate Precast in Hillsboro, Texas, will produce the blast-resistant precast concrete wall panels for the hospital. Presently, Gate is in the design and engineering phase of the precast elements which are being modeled in BIM. Gate Precast is 100% BIM compliant with 69 licensed users who have designed over 70 structures companywide.

The medical campus is designed to achieve the LEED Gold level. One of the sustainable measures includes a 30% reduction in energy use over ASHRAE Standard 90.1. The innovative precast wall panels feature a continuous layer of insulation between the building's interior and exterior preventing thermal bridging that can nullify the effect of the insulation.

Production of the precast components should begin April 2012 with installation of the precast slated to begin December 2012. Construction is expected to be complete in May 2014.

U.S. Debut of BubbleDeck® Technology at the University of Wisconsin-Madison's La Bahn Arena

MADISON, WISCONSIN

The La Bahn Arena, currently under construction in the heart of the University of Wisconsin-Madison's downtown campus, premiered the use of BubbleDeck® technology in the United States. BubbleDeck® is a unique patented integration system of linking air, steel and concrete in a two-way structural slab. The system is especially unique in the way it incorporates recycled plastic bubbles to eliminate concrete. The result radically improves building design and performance while reducing overall construction cost. **Spancrete** is the precast producer for the project's BubbleDeck® system.

The La Bahn Arena is a 98,250 assignable square feet (ASF)/ 120,000 gross square feet (GSF), four level facility adjacent to UW-Madison's Kohl Center Arena. The arena will house a 90 by 200 foot ice sheet for men's and women's hockey practice and women's hockey games as well as team locker rooms for both home and visiting teams. It will also feature office suites and support spaces for women's hockey and locker and team room functions for the men's and women's swimming programs. The arena will seat approximately 2,400 spectators.

The BubbleDeck® system virtually eliminates dead weight concrete from the middle of a floor slab by incorporating recycled plastic bubbles as a void. The system can facilitate up to 50 percent longer spans between columns, and the construction does not require beams, which allows architects greater design freedom. The slab is connected directly to cast-in-place concrete columns, producing a wide range of cost and construction benefits.

In addition to time and cost benefits, BubbleDeck® technology also reduced La Bahn Arena worksite risk through off-site manufacturing and a simple installation process, as well as supported the project's LEED Silver building specifications by reducing carbon emissions that typically arise from traditional construction methods.

The project, which officially broke ground in May 2011, has a projected completion and occupancy date of October 2012.

Fabcon Celebrates 40 Years of Innovation in Precast Manufacturing

SAVAGE, MINNESOTA

Fabcon, a manufacturer of high-quality precast concrete solutions, is celebrating 40 years of innovation. Founded in 1971, Fabcon provides wall panels, highway traffic barriers, columns and sound walls for commercial and residential construction.

Heldenfels Names New Division VPs

SAN MARCOS, TEXAS

– *Gary Gunter*

– *Blaine Withers*

San Marcos-based **Heldenfels Enterprises, Inc.** has named Gary Gunter as Vice President and General Manager of its Highway and Bridge Division.

Blaine Withers, formerly Vice President of Operations, has been named Vice President and General Manager of the Marine and Industrial Division overseeing the Heldenfels' plant in Corpus Christi, Tex.

Gil Heldenfels continues serving as Vice President and General Manager of the Building Systems division.

PCI Joins Twitter

CHICAGO, ILLINOIS

PCI has joined Twitter! The PCI Twitter account (@PCIprecast) will share relevant industry news, as well as information on PCI continuing education opportunities, new publications and articles, upcoming events, and more.

Follow us at www.twitter.com/PCIprecast.

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

Carl Walker, Inc. Announces Completion of Detroit Arsenal Parking Structure

WARREN, MICHIGAN

Carl Walker, Inc., a consultant in the parking industry, announced the completion of a 1,802-space parking structure located at the Detroit Arsenal facility in Warren, Michigan. This parking structure supports a new administration building that was built to house 1,100 federal employees. The precaster for this project was International Precast Solutions, LLC, River Rouge, Michigan.

The six-level, 583,750-square-foot precast parking structure provides parking for personnel employed at the new administration building and replaces surface parking spaces displaced by the new development. The design not only had to meet the requirements of the Michigan Building Code but also special criteria regarding security engineering. Additionally, this project incorporated sustainable design measures to achieve LEED Gold Certification.

This project was selected by CAM Magazine (Construction Association of Michigan) as one of the Top 12 projects of 2010 in the state of Michigan.

Thermomass® Achieves Four-Hour ASTM E-119 Fire Resistance Rating

BOONE, IOWA

Thermomass®, a manufacturer of building insulation systems for the concrete industry, has announced the successful completion of the ASTM E-119 fire test.

The fire test was conducted on a sandwich wall panel consisting of a 2-in exterior wythe of concrete, 2-in insulation core, and a 5-in interior wythe of concrete. The interior wythe was loaded to 4,000 pounds per foot gravity load and exposed to fire for a duration of four hours, with temperatures reaching 2,000 °F.

"During the four-hour test, the temperature on the exterior wythe of concrete increased by only 130 °F, which is only 50% of the allowed temperature increase per ASTM E-119," said Darryl Dixon, Director of Technical Services at Thermomass.

According to Thermomass, the successful four-hour mark is the first and only ASTM E-119 test on an integrally insulated sandwich wall using an energy-efficient FRP wythe connector.

Functional Resilience: A New Way to View Sustainability

— By Greg Winkler, AIA, LEED AP, Mid-Atlantic Precast Association

Each year in the United States, billions of dollars in direct property losses are caused by natural disasters. By the middle of 2011, 98 events (including storms, tornadoes, flooding, fires, and earthquakes) had resulted in $27 billion in economic losses—more than double the 10-year average of $11.8 billion, according to Munich Re, a multi-national that insures property insurance companies. Bob Hartwig, head of the Insurance Information Institute, says: "We are rewriting the financial and economic history of disasters on a global scale."

The durability of buildings—their ability to resist storm-related damage—has not often been at the fore of sustainability discussions. The focus of "green buildings" has mostly been on the materials, construction and energy performance of a structure, as well as occupant comfort. Today, the green building movement is extending this to include the overall life of a structure. Doug Gatlin of the U.S. Green Building Council notes that up to 85% of a building's life cycle cost results from operation and maintenance. It has long been accepted that buildings that perform better, require less maintenance, and incorporate more durable and easily-repairable components have lower life-cycle carbon footprints than those with fewer of these attributes. While not a central feature of the U.S. Green Building Council's LEED new construction certification, durability and maintainability are clearly understood to be aspects of a facility's sustainability.

However, what about buildings that suffer excessive storm and weather-related damage from natural events? The environmental impact of demolishing (often landfilling) damaged building materials, and producing, transporting, and installing new materials, is substantial.

The Congressional Research Service estimated in 2008 that Hurricane Katrina damage will ultimately generate more than 100 million cubic yards of disaster debris, costing $3.7 billion in public funds, with much of the demolished material flowing to area landfills. The Federal Emergency Management Agency (FEMA) alone provided hurricane-related support for 950,000 people, including more than $6 billion in aid and 101,000 travel trailers and mobile homes. Katrina was a substantial disaster, of course, but the epic costs of this hurricane across a wide region, and the risings costs of other natural disasters, call into question whether our national building stock is as durable as it should be.

Data developed by the Portland Cement Association (PCA) shows that buildings constructed within the last two decades have suffered more damage and were demolished at a far higher percentage than older structures. PCA assessed other possible causes for this phenomenon, including population migration to more disaster-prone areas, increased volume of residential and commercial construction in recent years, and increased frequency of serious natural disasters. While some of these factors were present, the trend line for property losses is dramatically more severe than can be explained by any factors other than the reduced durability of construction.

The rate of direct loss has dramatically increased over the last twenty years as building codes allowed greater building areas and lighter (Type V) construction in conjunction with the installation of fire protection systems. This "dumbing down" of facility durability is a fundamental fly in the sustainability ointment. The larger meaning of sustainability would seem to demand a building that is more resistant to the ravages of nature. This is nowhere more evident than in shore construction, where insurance companies have begun rebelling against repeat claims of damage from high winds and storm tides. FEMA estimates that such repetitive-loss properties account for 16% of all claims, totaling over $11 billion in losses since 1978, and place the viability of their flood insurance program at stake. These claims result from the simple act of replacing damaged construction with new code-compliant buildings that are no more durable than before. This is a tremendous waste of economic and material resources, and easily corrected by upgrading building and zoning standards to more durable construction. Steve Szoke, PCA's director of codes and standards states: "A sustainable building with a higher degree of durability can decrease the amount of materials going to landfills and use of community resources

– 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.

when disasters occur."

States and municipalities are seeking to adopt ordinances and new codes that require more sustainable construction, but they risk overlooking the benefits of promoting more disaster-resistant construction. There needs to be a new awareness of the importance of a structure's ability to withstand routine and predictable natural disasters such as wind, fire, and flood.

Functional Resilience is a term that expresses a structure's durability, competence to maintain its integrity, and ability to have its function restored following environmental change or disaster. First mentioned by the American Concrete Institute (ACI) as part of their *Joint Concrete Sustainability Initiative*, the term was picked up by the Portland Cement Association and incorporated as a concept into their 2010 High Performance Building Standard.

Ensuring that our building stock does not have to be replaced (and thus consume additional resources) may well become an extension of the current definition of sustainability developed specifically for construction. In addition to the benefits of enhanced functional resilience during normal operations, when disasters occur building components are often contaminated or irreparably damaged. The sustainability of high-efficiency building components is sabotaged when they are easily damaged as a result of natural occurrences (weather damage) or human actions (vandalism or sprinkler activation). Building equipment, siding, or finishes that end up in a landfill after such an event can hardly be considered green in the long term.

Functional resilience is a new way to view sustainability. It addresses a one-time attribute of building construction lost in the drive for lower first costs and lighter framing. It argues for a more durable, maintainable, and repairable American architecture. Functional resilience may well be the new heart of sustainability. ■

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

Mixed-Use Projects Creating Flexibility, Challenges

Precast concrete structural and architectural systems help meet a variety of needs as owners look to expand functionality and revenue-generating options

— Craig A. Shutt

Multi-use projects offer owners a variety of benefits, including revenue-generating functions, more pedestrian traffic and more activities for users. But fitting those different capabilities into one structure and balancing all the functions—while also meeting aesthetic criteria —creates challenges. Precast concrete components often can help achieve the myriad of goals.

These projects often blend offices, residences, retail, parking, entertainment, other functions, or all of them. Each has its own building code requirements and marketing strategies. These programmatic and legal needs can create challenges in interfacing functions and materials that can be difficult to meet. In addition, each may have its own desired image and designing an architectural statement that fits them all requires balance and artistry.

The following projects show ways in which precast concrete architectural and structural systems can help achieve the proper balance among all of the functions in a multi-use project and help to make it a successful project.

Medical Office Building

The Medical Midtown Office Building on the St. David's Medical Center campus in Austin, Texas, was designed to enhance the strengths

All photos in this article are courtesy of Gensler

The Medical Midtown Office Building on the St. David's Medical Center campus in Austin, Texas, features doctors' offices and parking designed with a total-precast concrete structural solution. Precast was used to minimize maintenance and allow for rapid shell construction, which was accomplished despite the tight site.

PROJECT SPOTLIGHT

Medical Midtown Office Building

Location: *Austin, Tex.*

Project Type: *Mixed-use (medical offices and parking)*

Size: *358,000 square feet (82,000 square feet of office)*

Cost: *$23.5 million*

Designer: *GSC Architects, Austin, Tex.*

Owner: *HealthCare Facilities Development Corp., Austin, Tex.*

Contractor: *Pepper-Lawson Construction Co., Austin, Tex.*

PCI-Certified Precaster: *Coreslab Structures (Texas) Inc., Austin, Tex.*

Precast Specialty Engineer: *Consulting Structural Engineering Services Inc., San Antonio, Tex.*

Precast Components: *Columns and beams, double tees, ramps and shear walls, stair risers, load-bearing architectural panels, and spandrels.*

and character of the surrounding facilities while adding space for doctors and parking for the building and campus. The new 358,000-square-foot project features five levels of above-grade parking and one below-grade level for 630 cars total and three stories (82,000 square feet) of offices beginning at the top level of the parking structure. In addition, a lecture hall and flexible classrooms were provided on the first office floor. A precast concrete roof covers the office area of 28,000 square feet, while a 2,836-square-foot mechanical deck covers the parking area. "The owners wanted the parking levels to be constructed with precast concrete to reduce maintenance concerns and budget over their lifetime," explains Buddy Goodson, project manager for Pepper Lawson Construction. "Looking at the overall building scenario, it made sense to build the entire project with precast concrete. It allowed for quick construction on a very constrained site and gave us the flexibility and aesthetics that the owners wanted."

The project features precast columns and beams, several depths of double tees, ramps and shear walls, stair risers, load-bearing architectural panels, and spandrels. The panels cladding the office floors were cast with embedded thin brick to match the style of the surrounding buildings. Coreslab Structures (Texas) provided the precast concrete components.

In addition to adjacent buildings continuing in operation during construction, the site was backed up to a major freeway with high-voltage power lines running overhead. That eliminated the capability to use a tower crane and restricted site maneuverability, adding challenges. At the same time, using embedded thin brick eliminated the need for eight stories of scaffolding on the tight site, Goodson notes.

"Having the brick in place on the skin when the panels arrived allowed us to put in the glass as soon as the panels were in place and allowed us to close in the building very quickly," he says.

The first floor office features 17' 8" floor-to-floor heights to accommodate the 160-seat auditorium and classrooms. The classrooms were designed as two large spaces with movable partitions to accommodate smaller teaching areas as needed. The upper office floors had a 14' 8" floor-to-floor height for flexibility of tenant spaces.

Precast Provided Clear Spans

"Following the bay sizing for the parking structure below allowed for the clear spans needed for these special uses," notes Ray Moreno, Project Manager for GSC Architects. The double tees for the office levels were 34 inches deep, according to Rick Penshorn, project engineer at Consulting Structural Engineers, the precast concrete specialty engineer on the project. The parking structure used 28-inch-deep double tees, while both 28- and 34-inch-deep double tees were used for the roof members.

The architectural precast concrete spandrels provide load-bearing elements to support the floors around the building's perimeter. Additionally, 10- and 12-inch-thick architectural precast concrete walls were used at stairs and elevators to provide the lateral stiffness to resist wind forces.

Special care was taken to find a brick mix that would resemble the existing color and style, notes Moreno. "The brick for the other buildings was a modular product that could not be used with the new building," he explains. Instead, the designers worked with the precaster to find a manufacturer who could create a three-brick blend of thin-brick to match the four-brick mix used in the brick modules on the existing buildings. The parking structure levels feature a standard architectural finish.

Special care was taken to find a brick mix that would resemble the existing style.

During erection, a crawler crane was positioned inside the structure's footprint, with trucks backed up to the site for picking and immediate erection of delivered panels. Detailed logistical planning was needed to position the crane and create truck routes to maneuver the deliveries to the proper location on the site to ensure easy loading and no disruptions to operations on the campus.

Retaining walls around the below-grade levels were created with cast-in-place concrete, after which the total-precast concrete structural system was erected. The building was erected up to the fourth floor on one end and then the crane was moved to the opposite end to erect that portion. That opened the other end for other trades. Ultimately, floors were being topped on one end as panel erection continued at the other.

Special care was taken during casting to ensure exact alignment of the brick runs between panels, made more complicated by the variety of facets and joints needed to align them in three dimensions. The largest panels, some 63 feet long, required close attention during stripping and handling. An added challenge came in creating a cut-stone limestone appearance for exterior stairways, which required creating an intricately detailed formwork pattern.

Parking Levels Open Early

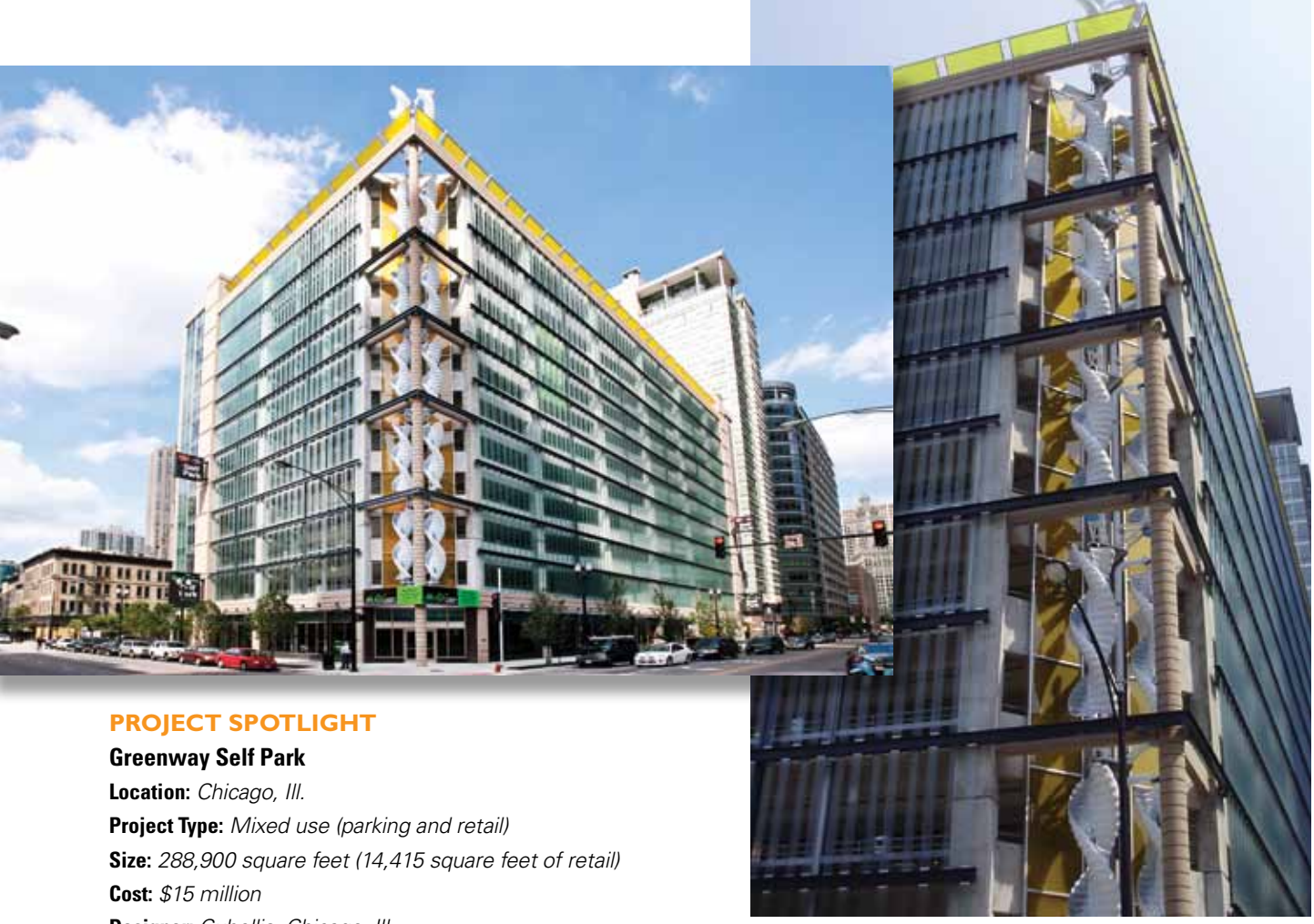
The fast erection time for the precast concrete paid off in bringing the building online quickly, Goodson notes. The parking levels were in operation before the office levels were completed, alleviating congestion even as construction continued.

A structural-steel bell tower was added as a final aesthetic touch, which complicated construction. It was fabricated on the ground inside the garage footprint while erection was underway and then lifted into place atop the precast concrete elevator tower. Timing was critical, as both structures were completed simultaneously and had to be completed before the crane had to move to its next position. Tolerances were precise, but the tower was lifted into place and welded to the precast concrete components while a cheering crowd and local press watched.

Greenway Self Park

Creating parking space in Chicago's high-end River North neighborhood provided a critical need, but constructing a 12-story building in a congested downtown area created challenges that were met in part with a precast concrete structural system. The 288,900-square-foot Greenway Self Park project emphasizes its sustainable initiatives while providing 715 public parking spaces and 14,415 square feet of retail space on the first floor.

The precast concrete system, comprising columns and beams, shear



PROJECT SPOTLIGHT

Greenway Self Park

Location: *Chicago, Ill.*

Project Type: *Mixed use (parking and retail)*

Size: *288,900 square feet (14,415 square feet of retail)*

Cost: *$15 million*

Designer: *Cubellis, Chicago, Ill.*

Parking Engineer: *Walker Engineering, Elgin, Ill.*

Owner: *Friedman Properties, Chicago, Ill.*

Contractor: *Bovis Lend Lease, Chicago, Ill.*

PCI-Certified Structural Precaster: *ATMI Precast, Aurora, Ill.*

PCI-Certified Architectural Precaster: *Lombard Architectural Precast, Alsip, Ill.*

Precast Specialty Engineer: *Precast Engineering Company, Waukesha, Wis.*

Precast Components: *Shear walls, double tees, columns, beams, spandrels, wall panels, stair units, and architectural wall panels.*

The Greenway Self Park in Chicago's upscale River North neighborhood features a distinctive appearance for its combination of retail and parking space. The total-precast concrete structural solution blended with translucent, green-tinted glass patterned with five designs and long structural tubes running the height of the building. The precast aided construction on the tight site and also helped the building achieve a LEED Silver rating.

During the final phases, trucks were routed under the building structure.

walls, double tees, stair units, and architectural spandrels, was chosen due to its economy and capabilities for meeting a tight schedule, according to David Ryan, director of operations for Walker Engineering in Elgin, Illinois. "The project was a high-end design with a high-end finish for this neighborhood, and it had to deal with a number of challenges, including a tight site."

The structural precast concrete components were provided by ATMI Precast in Aurora, Illinois, while the architectural spandrel panels were fabricated by Lombard Architectural Precast in Alsip, Illinois. HOK and DM Design Group served as the architects on the project, while Bovis Lend Lease was the general contractor.

The site was surrounded by other tightly-packed buildings, with a small lot owned by the developer located adjacent to the site that alleviated congestion and provided a staging area for construction materials. The structure essentially was built as four towers, positioning the crane to build each corner and then connect them, one floor at a time, walking the crane off the site and into the adjacent lot to complete the erection of the precast concrete components.

A "haul road" was created for the crane and delivery vehicles, which entered from the southwest corner and exited to the northeast. During the final phases, trucks were routed under the building structure. A small crane located on the roof installed the façade system, which consists of steel columns, beams and glass. The columns were welded to the metal embeds in the precast concrete panels, the beams were bolted to the columns and the channel glass was installed between each beam using a receiver clip.

The first floor contains retail spaces, with a higher floor-to-floor clearance than upper parking levels to provide elevated merchandising space for retailers. Above this level, a special weatherproof traffic coating was applied to the double tees, which feature a 2-inch-thicker flange to ensure weathertightness between the open parking levels above and the retail stores on the first floor.

Double Helix Ramp Used

A speed ramp was created to move vehicles quickly past the retail level to the parking levels above, with a double-helix ramp provided to raise cars two floors for every 360-degree circle they complete. Crossovers were provided on several levels to allow access to intervening floors without having to drive to the top and return.

The erection proceeded quickly within the confines of the congested downtown space. A key aesthetic element was added with etched channel glass serving as the main façade, supported by the precast concrete spandrels, with embeds cast into the panels to accept the glass connections. The translucent, green-tinted glass was formed into a 10-inch-wide C-shaped vertical plank supported at the top and bottom by an aluminum structural tube.

Five patterns of glass were created by varying spacing and orientation of the channels. The spacing between the glass units allows air to flow through while shielding views into the garage. The glass is accented with channel-glass inserts at each corner. Glass caps on each corner serve as contemporary cornices.

The retail spaces on the first floor feature energy-efficient glass with a black-granite base. The storefronts are accented with alternating columns clad in precast concrete and red granite with stainless-steel tubes for highlights.

The project features a number of sustainable-design concepts that helped the project achieve a LEED Silver rating. These include 12 helical wind turbines on the roof that generate electricity and parking spaces on the upper levels for electric and hybrid cars. The precast concrete also contributed to the rating via its energy efficiency, recycled and locally-manufactured materials, and other factors.

A swimming pool with landscaped gardens will be added on the roof for guests at the adjacent hotel, and double tees on this level were thickened by 20% to provide the necessary support. Spandrel panels facing the hotel on this level were designed to be replaced so a bridge to the hotel could be created at a later date without undue complications in construction.

Lobbies on each level feature tips for sustainable-design concepts that help encourage users to create a greener environment. These tips reinforce the message delivered by the project that functional and attractive designs can also offer sustainable living concepts.

'The owners' goals were to create a durable, high-quality structure that could withstand the beach environment and salt air.'

The Metropolitan

The Metropolitan project in Jacksonville Beach, Florida, was the first large-scale, mixed-use building allowed along the beach, and it has served as a pioneer for additional construction. The project includes retail space on the first floor, parking for 320 cars on floors two through five, 30 office condominiums on levels six and seven, and 26 residential condominiums on levels eight and nine. The multiple functions and beach location required a lengthy design and permitting process before it could proceed.

Helping to speed construction once the nine-story building was approved was a total-precast concrete structure. It features columns, beams and double tees with load-bearing architectural panels for its façade. Gate Precast Co. in Monroeville, Alabama, supplied the architectural precast panels, while the plant in Jacksonville, Florida, supplied the structural precast concrete components.

The project was "cutting edge for condos in this area, especially with the materials we used as well as being mixed-use in a high-rise application," Tom Rensing, principal at KBJ Architects told local newspapers. The owner wanted to develop the property with multiple uses and asked the designer and contractor Elkins Constructors to create a plan that could bring that vision to life. Initially, the building featured a cast-in-place design, but that was value-engineered to precast concrete to speed the construction schedule.

"The owners' goals were to create a durable, high-quality structure that could withstand the beach environment and salt air," Rensing explains. "I've done a lot of precast concrete parking structures, and we saw that we could extend those concepts to work well with these other functions. I like working with concrete. It provided all the benefits we sought as well as some additional ones."

Precast Creates Open Spans

A key advantage came with the 60-foot-wide spans that the double tees could provide. "Each function in the building has different layout requirements, and it can be difficult to stack them. Parking requires long, open spans, while other functions require more walls that add loading. Precast concrete provided the clear spans we needed on those levels while providing support for upper floors. The condominium levels also benefited from being able to be designed with fewer columns. That eased the complexity of the design."

The retail levels were designed as speculative spaces, and they since have been filled, including a restaurant on the corner. "The precast concrete design provided a lot of flexibility in creating the retail spaces, which ensured they were attractive to a wide range of retailers," Rensing says. The precast concrete also provided inherent fire resistance, which saved time and materials and simplified the requirements for meeting building codes for the various functions and separations between them.

Plant-casting the components also provided another benefit, he noted. "The quality control in the plant ensured that we did not have to worry about steel reinforcement ending up too close to the surface. With some projects, that has led to corrosion and spalling due to the salt air penetrating and reaching the steel. That doesn't happen with precast concrete."

Fabricating the components off-site also alleviated congestion on the site, which was constrained on all sides. Contractors had only 2 feet of leeway to the north and south and 20 feet on

The first large-scale, mixed-use building on the beachfront in Jacksonville Beach, Florida, The Metropolitan features retail space, parking, offices, and condominiums. The project features a total-precast concrete structural solution enhanced with architectural panels that used a blend of local aggregates to create a terra-cotta color that didn't require paint or stucco to blend with nearby buildings.

PROJECT SPOTLIGHT

The Metropolitan

Location: *Jacksonville Beach, Fla.*

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

Size: *258,000 square feet*

Designer: *KBJ Architects Inc., Jacksonville, Fla.*

Owner: *Metro Beach Developers, Ponte Vedra Beach, Fla.*

Contractor: *Elkins Construction Inc., Jacksonville, Fla.*

PCI-Certified Structural Precaster: *Gate Precast Co., Jacksonville, Fla.*

PCI-Certified Architectural Precaster: *Gate Precast Co., Monroeville, Ala.*

Precast Specialty Engineer: *Seaboard Services of Va., Richmond, Va.*

Precast Components: *Columns, beams, double tees, and load-bearing architectural panels.*

the east and west sides. "The delivery of materials and erection had to be tightly choreographed, but it went smoothly," Rensing says.

The aesthetic treatment of the panels required them to be large and heavy compared to typical architectural members. The construction team remained in close communication throughout the erection to ensure the beam and column members, which were integrally cast into the load-bearing members, could be handled at the site.

The precast concrete mix used for the façade features a blend of local aggregates, including Florida limestone, high-quality fine white sand and pigments that achieved a peachy, terra-cotta color that didn't require paint or stucco to blend with nearby buildings, Rensing notes. A light sandblast was provided on the panels with an accent achieved with a slightly heavier sandblast. The condominium levels feature exposed ceilings for a semi-loft look and high-performance windows to enhance aesthetics and help maintain the building's energy efficiency.

"This is the only building that's constructed like this in the state," says Austin Calhoun, assistant project manager for Elkins. Rensing agrees.

"It's an elegant building with a lot of versatility."

Hampton Roads Transit Facility

The Bus Maintenance facility for the Hampton Roads Transit company in Norfolk, Virginia, featured a number of significant challenges for developer Concord Eastridge and the construction team led by A/E firm Parsons Brinckerhoff. The facility needed to contain bus parking and maintenance centers as well as office space and employee parking. A tight site and a variety of aesthetic needs, coupled with a fast construction schedule, made precast concrete components the best choice for some of the components.

The complex consists of a three-story, 60,000-square-foot office building featuring a total-precast concrete structural system and a 138,000-square-foot precast concrete parking structure for 320 cars with bus-maintenance operations on the lower level. Two additional buildings were constructed with steel frames and architectural precast concrete panels for cladding. They consist of an 80,000-square-foot administrative-support and bus-parking structure and a 9,000-square-foot wash/refueling facility.

"The precast concrete designs were chosen because of the speed of construction they provided, as well as their ease of maintenance and ability to create a high-quality finish at a relatively inexpensive cost," explains Brian Eichenlaub, a supervising architect with Parsons Brinckerhoff and the final project manager.

Aesthetics was a key driver, he notes. The back sides of the buildings, facing into the complex, were finished with precast concrete panels given a medium or light sandblast, creating a banding pattern, with the addition of reveals to break the scale of the massive structures. The more public sides of the buildings feature thin-set brick embedded into the façades, providing a traditional look that adds detail and texture. Tindall Corp.'s Virginia Division in Petersburg, Virginia, supplied the precast concrete components.

'Using a total-precast system made construction simpler and eliminated some of the trades from the site.'

The Bus Maintenance facility for the Hampton Roads Transit company in Norfolk, Virginia, consists of office, bus-maintenance facilities, refueling and washing space, and office space. The office and parking facilities feature total-precast concrete structural solutions, while the others feature architectural precast concrete panels, most of which include embedded thin brick to provide a masonry façade appearance.

PROJECT SPOTLIGHT

Hampton Roads Transit Facility

Location: *Norfolk, Va.*

Project Type: *Bus-maintenance and storage facility with offices and employee parking*

Size: *287,000 square feet*

Cost: *$62 million*

Designer/Engineer: *Parsons Brinckerhoff, Norfolk, Va.*

Owner: *Concord Eastridge Inc., Arlington, Va.*

Contractor: *W.M. Jordan, Richmond, Va.*

PCI-Certified Precaster: *Tindall Corp.'s Virginia Division, Petersburg, Va.*

Precast Concrete Specialty Engineer: *TRC Worldwide Engineering Inc., Allentown, Pa.*

Precast Components: *Beams, columns, double tees, inverted-L beams, i nsulated architectural concrete panels, load-bearing panels, and stairs.*

The precast concrete parking structure features columns, beams, double tees, inverted L beams, and stairs to complete the package. It connects to the adjoining section of administrative building via a pedestrian ramp consisting of flat slabs at the upper level.

The bus-maintenance portion of the administrative building features wide bay openings that provide access and maneuverability for the buses as they arrive at the depot. Long skylights were installed in this portion of the complex to provide daylight to the building's center. This required the precaster to cast openings into the roof tees and frame around them. A green roof was created over some portions of the structure, which helped the project achieve LEED certification.

The lateral system for the buildings posed a challenge for connecting the beams and columns, as the structure used moment-frame connections to resist lateral forces. As the foundations were designed as pinned and not fixed, this created exceptionally high forces to transfer between the beams and columns. The resulting beam-to-column connections required large welds to secure them to the columns. Similarly, the beams were not prestressed, as the precaster didn't want any shrinkage to the columns from the prestressing to occur once the connections were made.

The total-precast concrete office building features columns, beams, double tees, and architectural panels. "Using a total-precast system made construction simpler and eliminated some of the trades from the site that would have been required during the construction of the shell," says Eichenlaub.

The design also provided open interiors by using long double tees, some of which reached 72 feet long. "We were able to provide a lot of open space for the floor plans," Eichenlaub says. "Steel framing would have required columns every 24 feet on-center." The precast structure also provided the necessary fire-separation between the bus-maintenance area and the Class-B office space. "It was very, very easy for us to achieve the fire-separation standard we needed using the precast concrete structure."

The site was tight, with the buildings near the edge line, fitting the large footprint onto a 9.7-acre triangular site. Power lines within 10 feet of the lot line also had to be watched carefully to ensure nothing disrupted them. As a result, one of the buildings was notched so the other structure could be fitted up against it as construction continued.

The site also dropped $2^1/_2$ feet from one end to the other, requiring taller columns on one side of the parking structure to level the floors. "We maxed out the slenderness ratio for the columns just within the tolerable limits for the column lengths to achieve the height we needed," Eichenlaub says.

The parking structure was completed first, followed by the bus-maintenance facility and the three-story office building last. The work moved smoothly, Eichenlaub says, thanks in part to the close cooperation among the construction team members.

"We approach a project with ideas that will achieve the owners' goals, but in working with the precast on this design, we created better and more efficient ways to provide the strong appearance while minimizing the number of pieces and making construction easier. We talked with Tindall throughout the design phase and worked through the details in the shop drawings to incorporate their ideas for how to make the work efficient."

These designs show a multitude of ways that different functions can be fit together to achieve a variety of needs in a condensed, efficient space. The versatility of precast concrete components ensured these designs will meet the owners' needs today and in the future.

'The total-precast concrete structure was used for both functional and financial reasons.'

St. Charles Plaza Building

An ambitious $100-million project in St. Charles, Illinois, plans to revitalize a 7.2-acre portion of the downtown area by creating a riverfront pedestrian walkway, public plaza and a variety of building functions, including residential, office, commercial space and parking. A key building in the program, one of the first projects completed, contains two-story-tall restaurants and retail on the first level, offices and parking on the floor above plus two additional levels of parking.

The 160,000-square-foot Plaza Building features a total precast concrete structure, consisting of 1,050 components including columns, beams, double tees, spandrels, shear walls, load-bearing wall panels, and hollow-core planks. Spancrete fabricated all of the precast concrete components.

"The total-precast concrete structure was used for both functional and financial reasons," explains Ryan Gusewelle, senior project manager for Power Construction Company, the general contractor on the project. "We needed larger, open bays without columns for both the retail and parking levels, and precast concrete could provide those spans easily."

A cost analysis also was done, which determined that the most cost-effective way to achieve long spans would be to use precast concrete. The owners and designers also knew that costs would be higher if the construction had to extend into the cold winter months, when sitework would be more difficult and expensive to accomplish.

Precast concrete also aided the schedule by speeding erection of the building shell and by helping to create the aesthetically-pleasing design the owners needed to draw attention to the structure as the first signature design in the development. Precast also helps minimize long-term maintenance needs.

Blending Retail, Parking

Combining the retail and office functions with parking facilities required particular attention to moisture prevention between levels (the needed fire separation was inherent in the concrete's composition and required no additional applications). Because the double tees remained exposed on the ceiling side of the lower retail and office levels, they were insulated using fiberglass insulation with a foil vapor barrier. These materials were attached to the precast double-tees with stick pins adhered to the concrete. On the upper side, the pretopped double tees had a waterproofing membrane applied over them.

The exterior features embedded thin brick on architectural panels on the north, south and west walls, which face away from the high-profile street side. On the east facade, field-applied brick was installed onto structural precast concrete wall panels cast with dovetail slots and over gypsum wall structures. "The embedded thin-

An ambitious $100-million project in St. Charles, Illinois, kicked off with the construction of the Plaza Building, which combines retail, restaurants, offices and parking. A total-precast concrete structural solution was used to provide the necessary structural support and open spans that all functions in the building desired. The project was designed so the parking levels could be opened ahead of the rest of the project to provide these services to the community quickly.

PROJECT SPOTLIGHT

Plaza Building

Location: *St. Charles, Ill.*

Project Type: *Mixed use (retail, offices and parking)*

Size: *160,000 square feet*

Designer/Engineer: *Knauer Inc., Deerfield, Ill.*

Owner: *1st Street LLC, St. Charles, Ill.*

Contractor: *Power Construction, Schaumburg, Ill.*

Structural Engineer: *McCluskey Engineering Corp., Naperville, Ill.*

PCI-Certified Precaster: *Spancrete, Arlington Heights, Ill.*

Precast Components: *Beams, columns, double tees, load-bearing architectural panels, and stairs.*

brick precast concrete panels were more cost-effective, but the field-applied brick on the streetside façade was used to match the nearby buildings in the historic downtown area," Gusewelle explains. The southeast corner features load-bearing, architecturally finished curved precast beams to highlight this most prominent corner and pull attention to the building.

A key challenge arose in building over Walnut Street, which runs beneath the building that otherwise covers the full city block. The street was shut down during construction and double tees were used to span the street, resting on load-bearing precast concrete walls on each side. Positioning the crane to build this portion required close communication and attention to logistics.

Speed was essential to bringing the project online early so parking spaces could be used while other construction progressed. The building, with its retail and office levels plus 300 parking spaces, took 14 weeks to erect.

A cast-in-place helix ramp was installed at the back of the building to facilitate access to all five floors and ensure maximum spaces on each level inside the parking levels. The precaster had to work closely with the concrete subcontractor to ensure the interface between the ramp and the precast concrete components worked smoothly. Close tolerances were required to ensure quick construction.

The project is the first of a number planned for the development in the coming years, which will provide as much as 136,500 square feet of retail space, 115,000 square feet of office space, residential apartments and condominiums, nearly 1,000 parking spaces, and a variety of public improvements. A number of these additional structures also are planned to feature structural precast concrete systems and architectural panels, in part owing to the benefits achieved on the first project to be completed.

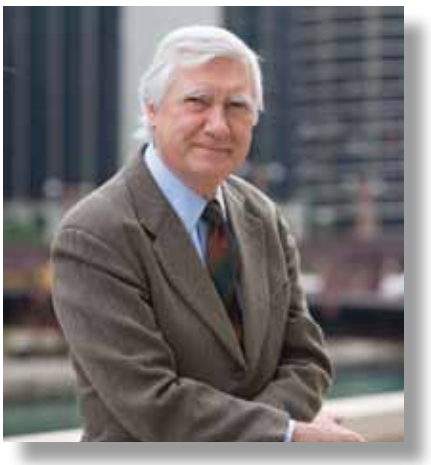
This wide range of projects, incorporating a variety of functions, shows some of the ways that precast concrete structural and architectural systems are helping designers meet the needs of mixed-use buildings. As owners continue to diversify their properties to provide more capabilities to attract a wider variety of tenants and customers, the need for flexible solutions will continue to grow. ■

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

Updating the Past for Today

Lucien Lagrange, who incorporates Chicago's history into his residential designs, is now updating his own history as part of VOA's team

— Craig A. Shutt



Lucien LaGrange

Lucien Lagrange's retirement was a short one. The 71-year-old architect, well known for his work designing elegant, high-end residential projects, announced the closing of his eponymous Chicago firm in 2010. Only one year later, in August 2011, he joined VOA Associates Inc. as lead designer in the firm's luxury residential, hospitality and commercial mixed-use markets. The move brings a new chapter to a storied design career, which has focused on reinventing past architectural success for a new generation.

"I like taking problems that are puzzling for owners and even other architects and creating 'diabolically simple' solutions," he says. "When we can cut through the confusion with a plan that makes the owner say, 'Why, of course!' that's success. When it's a large-scale project where our solution represents both a major spatial statement and a remarkable business solution, the pleasure is even greater."

Lagrange decided to retire after turning 70 in 2010 and seeing few opportunities on the horizon for the commissions on which he has thrived.

Park Tower in Chicago, which combined hotel, condominium and retail functions, was the first high-profile project for Lagrange. The building is one of the tallest in the world to be clad with architectural precast concrete panels, containing 3,152 pieces.

"The market disappeared, and the work I was interested in doing did not look to be available any time soon," he explains. "I decided it was time to readjust my life and cut back the pressure. It can be pretty demanding to run an office with 50 or 60 people when you are the only principal."

VOA provides Lagrange with organizational support, which frees him to focus on design. "It's a very good group of people, no big egos, very easy to work with," he says. "They are doing good work on a low profile, and it makes a good match for us." The opportunity arose when Lagrange ran into colleague Mike Toolis, VOA chairman/CEO, at a local community meeting. Conversations about possibilities became more serious talks, which led to Lagrange coming on board.

Respecting the Past

Lagrange is well known for his appreciation of Chicago's architectural history, especially Louis Sullivan's work and the period of 1900 to 1930, when construction of significant downtown buildings, especially along Michigan Avenue, flourished. He has been inspired by those stone edifices with their intricate detail, updating them to modern styles that represent twenty-first century functions and aesthetics.

"Being in Chicago, I have seen the great architecture that has been done here, and that leads me often to stone rather than steel and glass for my residential designs," he says. "Everyone admires those buildings along Lake Shore Drive and the Gold Coast from the 1920s, and there is good reason for that. It's a comfortable style. When you get there, you are home. That's what I've always been searching for."

Lagrange's affinity for masonry and stone designs comes naturally. The son of a mason, he grew up in Provence in France and studied architecture at McGill University in Montreal. In 1978, he moved to Chicago and joined Skidmore, Owings & Merrill, working on a variety of large-scale projects.

He opened his own firm in 1985 and established his name with the design of the 70-story Park Tower on Michigan Avenue in 2000. Other

key projects include the 26-story 840 Lake Shore Drive condominiums, the 48-story Pinnacle residential/retail building, the 61-story Elysian Hotel & Private Residences, the 35-story 10 East Delaware residential building, the 41-story Lincoln Park 2520 condominium, and the 40-story Ritz Carlton Residences.

'I like creating "diabolically simple" solutions.'

Creating Modern Styles

Deciding on the style for each project creates aesthetic and functional challenges, he notes, but the ultimate designs are driven by the building's need. But make no mistake: he is not designing "historic" buildings. "All are very modern designs, with historic appearances. They have large windows and use modern materials."

At the Ritz Carlton Residences, for instance, owners wanted balconies in each corner. "You don't do a classical building and put balconies in each corner, so we chose a concept that was inspired by an Art Deco style," he explains. "But no matter the look, all of the projects are designed for living. That is the ultimate purpose and their need."

Many of his projects have used precast concrete façades, a modern material that helps invoke the richness of history often incorporated into his projects. "Precast concrete allows us to bring the complexity of detail to these projects that would not be possible in stone," he explains. "It often is the best material to use. It provides a richness of color and texture and creates any detail we want. And it's not too expensive to work with."

The Park Tower project, Lagrange's first high-profile design, is one of the tallest projects in the world (844 feet) to feature architectural precast concrete panels. The goal was to blend the building with the nearby Water Tower, the landmark structure that was one of the few to survive the Great Chicago Fire of 1871. "We discussed the potential of precast concrete for this project in advance for some time and whether it would work," he says. "I visited the plant many times and studied the possibilities and capabilities."

Today, precast concrete's capabilities have grown, he notes. "It's a wonderful material that has become more versatile. It used to be big, flat panels, but today, the level of detail that can be achieved has been increased. There is really nothing better for this type of project."

There are possibilities for more designs using precast concrete in Lagrange's future now that he has aligned himself with VOA. Having just returned from a trip to China to discuss potential projects, he has become involved with two rental-residential projects in Chicago, a suburban synagogue, and others.

Whatever projects are coming, they will invoke the richness of the past in a current vocabulary. "I have been pretty disappointed by the design work I see today that tries to produce modern images," he says. "Compared to the 1900 to 1930 period, today's work is very confusing. I don't really know what is happening with it. I much prefer to go back to the older times and move the designs forward."

That doesn't mean the new designs are old-fashioned, he stresses. "There is a lot to learn from past designers in Chicago especially, and there is a lot of value there. We should not lose that. We need to take the quality of the experience that is available to us and reinterpret it for the twenty-first century. I'm not sure that is happening to the best of its ability right now." ■

The Pinnacle residential tower in Chicago feature architectural precast concrete panels in two finishes to complement the French limestone at the base and blend the building with the nearby Cathedral District.

Architectural precast concrete panels clad the upper floors of the Lincoln Park 2520 in Chicago, one of Lagrange's most recent high-profile projects. The panels were designed to complement the two-story decorated base, which was clad with granite and limestone.

Creating Community

Mixed-use projects are becoming more diverse by adding multiple program functions and providing more amenities to boost synergies

— By Grant C. Uhlir, AIA, NCARB, LEED AP, Gensler

Mixed-use projects, which combine several functional programs into one building, are becoming more common in both urban and suburban locations. These projects are going beyond the most basic concept of combining two functions—such as retail and parking or residential and retail—to add more functions and provide more amenities and benefits. As such, they create more challenges for designers.

In many cases, providing buildings with multiple purposes allows the developmental team to more easily navigate volatile economic conditions and spread the risk of the various market segments' cyclical natures. By combining residences with offices and adding retail, the mix ensures developers have not placed all of their eggs in one basket, which could weaken the project's revenues if that market slows.

Developers also are working to mitigate unknown conditions—which have multiplied in recent years as the Great Recession continues—by creating 3P projects: Private-Public Partnerships. This financing model allows developers to join with public entities, often universities, cities or counties, to spread the funding to other sources or tap into available grants that encourage development under certain conditions. Developers continue to look for creative ways to secure funding, and in some cases these approaches impact the type of functions for which the building is designed.

– Grant C. Uhlir, AIA, NCARB, LEED AP is a principal in the Chicago office of Gensler.

The Center on Halsted in downtown Chicago features a Whole Foods store on the first level and the headquarters for a community center for LGBT persons that required an open, welcoming design. The facility includes retail, offices, classrooms, below-grade parking and a terraced roof garden. Precast concrete architectural panels were used to clad the upper levels of the project, which received a LEED Silver rating, while retaining the existing historic storefront on the first floor. Photo: Gensler

The popularity of private-public partnerships has led recently to an increase in university-led projects, in which the institution develops projects, or a developer creates one with the guidance of the university which then leases the space. These projects combine student lofts with classrooms and bookstores or other retail.

The desire to generate revenues quickly, to produce a more favorable ROI, has led developers to look for design solutions that can phase in functions on a staggered basis. In many cases, these projects construct and open parking levels first while upper, or lower levels with other functions continue construction. Because parking functions require little finishing, they can open quickly once the structure is in place. That allows parking revenues to be generated and locals to become familiar with the building while other levels are finished and opened as they are completed.

Synergies Boost Projects

As indicated by the education projects, the key benefit provided by multi-use projects is the synergies created by combining different functions that work together. Develop-

Including data-center functions within an office project often consigns the design to a drab appearance due to the high-security and protection needs. For an insurance client in Rochelle, Illinois, Gensler used a structural precast concrete wall system for its 52,000-square-foot Tier 3 data center and office, which includes 16,000 square feet of raid-flooring and support galleries. The design divides the facility into three masses that overlap and intertwine, with the data center serving as the anchor and backdrop. The structure can withstand an EF-2 tornado with sustained winds of 135 mph. Photo: Gensler

The popularity of private-public partnerships has led to an increase in university-led projects.

ers of any residential or commercial office property today want to create additional functions that provide amenities for the building's users. Most often, these functions focus on retail or restaurant options, but they can extend to fitness centers, theaters, recreational facilities, and other entertainment options.

Their goal is to extend the hours in which the building is used, including daylight hours for residential properties and evening hours for commercial-office properties. This design provides activity throughout the day and creates a vibrant and active community that allows each function to build on others.

As part of this community building, more projects have focused on providing green space or communal areas that help tenants create connections to others in the building. This approach helps build a neighborhood feeling that is enhanced by having other amenities included in the project.

Combining functions also proves attractive to retailers, who benefit from more activity in the building and can target demographically-appealing segments that fit their own products. These functions often build on each other, as building tenants want amenities to be close to home, which requires retail activity, while retailers are looking for a critical mass of local customers to ensure the store's long-term success. Once a base of activity is established, the rest can build quickly to create an active location.

Rental Driving Projects

Rental residential drives most mixed-use projects being built today, with the economy remaining in the doldrums. This category benefits from the housing bust, which has driven many homeowners to look for more economical housing. Many previous rental units have been converted to condominiums, reducing supply just as demand rises. Over the past 18 to 24 months, the condominium-to-rental 'reverse conversion' trend supports this.

As competition grows, customers are demanding more amenities, such as interior parking, commons facilities, fitness centers, green space, retail, and restaurant options. Developers want to add these benefits, as they help differentiate a new project from other available options. Thus the other functions serve as marketing tools.

A key option inherent in a project's location is the availability of nearby transportation centers. With more people returning to the city and looking for convenient ways to get to work and cut commuting time, locating projects near subways, trains and other transport creates an additional amenity that can create differentiation.

Today, virtually all office projects, and even predominantly located parking structures, are including a retail element. By adding storefronts to the first-floor level, buildings create more activity and visual interest which attracts pedestrian attention. These spaces also help generate revenue that boosts the project's success.

Adding retail takes careful planning to ensure it provides attractive space for a variety of possibilities. Lease spaces can't be too narrow or too deep, as retailers want wide, sometimes column-free, areas to encourage merchandising sight lines and to

avoid a claustrophobic feel. Properly planning spaces for retail activity will ensure they can be marketed and filled quickly.

At the same time, providing the open spaces on lower levels that retailers prefer can create challenges for designing residential or office spaces on upper levels. These floors require smaller, more compartmentalized modules that may add higher structural loads that must be accounted for in providing the support on lower levels.

Careful attention also has to be paid to how much retail space is being added to the overall development mix. Too much retail space can leave stores empty and make the building's main face feel stagnant. At the same time, providing too little can cut into the activity and excitement of the project and eliminate potential revenue generation. Proper balance and flexibility are paramount.

In some cases, developers are creating two-story retail spaces to take full advantage of the potential for generating retail revenues. These spaces create more challenges, as it can be difficult to draw customers in to second-story retail. Adjacent parking facilities that align with, and are accessible to, upper level retailers are also favorable. Above two levels, retail becomes extremely challenging unless the locations are destination sites, such as food courts, restaurants, spas or theaters.

Attracting major retailers and national chains requires additional planning. These retailers will require specific amounts of parking space based on their square footage, which must be included in the parking requirements being built. Typically, the parking space provided for these projects exceeds that which is required by local codes.

Parking Usually Included

Virtually every mixed-use project today and many single-use residential and commercial properties contain parking levels. This amenity has become critical to users of all types, and it serves as either a marketing benefit or a revenue generator for the developer.

Parking provides a versatile aspect to these projects, because it can be located in any position and prove successful. Below-grade parking can become extremely expensive, but it can be a solution for projects in which height becomes an issue or locating parking on higher levels creates other architectural problems. Dealing with ground-water issues, excavation costs and ramping needs can boost per-stall costs and create budget challenges that developers try to avoid.

Grade-level parking offers another option. Typically, storefront retail can be added along key pedestrian traffic ways while maintaining sufficient parking spaces behind these retail spaces within the building's footprint. In some cases, the parking will extend to upper levels as well.

Some projects use the entire first level and even the second for retail, requiring parking levels to be raised higher. Indeed, with two-story retail, even more space is required for parking to supply sufficient spaces for the retail square footage.

The 90,000-square-foot Barneys New York store in Chicago's Gold Coast neighborhood includes a restaurant on the top floor and additional storefront retail at street level. The façade consists of two-story architectural precast concrete panels on all floors above the first, which features limestone. This stacked format allowed speedy erection and overall cost efficiencies. The panels were acid etched, with a mix formulated to simulate natural stone. Joint patterns, reveals and deeply notched recesses at the panel edges allowed the window-opening design detailing to create the desired depth and shadow lines. The panels helped the project achieve a LEED Silver rating. Photo: Gensler

No Green Premium

Mixed-use projects lend themselves well to implementing sustainable-design concepts. At Gensler, green building is not an additive process but a conceptual design philosophy inherent to every project. Although developers are wary of systems that add a premium for green-building benefits, achieving even a Silver LEED rating does not create a premium today.

Projects that combine a variety of functions offer great potential for maximizing the capabilities of sustainable-design techniques. Energy efficiency and water recycling in particular can be used to maximum advantage by capturing gray water from one function for use by another at another time of the day. Likewise, heat recovery from offices and retail establishments during the day can be dissipated or used for water heating for residential units at night. With more cutting-edge technology being devised all the time, more such capabilities will arrive that will enhance the ability of multi-use projects to make efficient use of sustainable options.

Mixed-use projects also create added life safety issues that must be considered, as different functions will require different building-code requirements. Key elements include providing fire-rated separations between various occupancies and proper egress solutions. Other requirements may arise depending on the functions being provided. In most cases, these can be challenging to balance.

Precast Concrete Benefits

Precast concrete designs help meet the challenges produced by mixed-use properties in a number of ways. The capability to create attractive, efficient, and quickly-constructed parking levels with precast concrete components provides a major benefit, especially for developers looking to phase in their projects. In many cases, projects designed with precast concrete easily allow for phased construction and expansion. This can also provide a single-source of materials supply and create a unified appearance.

Particularly in urban areas, precast concrete's capabilities for providing easy constructability make it a good choice. It can be erected quickly, allowing the building's shell to be enclosed rapidly to protect the building from weather while interiors are finished. It also requires minimal on-site staging room, allowing large panels to be erected quickly from flat-bed trucks.

Gensler managed the design and development for The Shops at Kingsbury Square in Chicago's Lincoln Park neighborhood, a mixed-use development that was anchored by a Whole Foods store. The 300,000-square foot building features retail on the ground floor and two levels of parking above, along with green roofs and a river walk to encourage pedestrian traffic. Precast concrete spandrels and architectural panels were used to clad the exterior, which helped the project achieve a LEED rating. Photo: Gensler

Precast concrete's inherent Mass provides the fire-rated separation needed between parking levels and other uses, and it can create long spans that provide the open spaces retailers desire while providing the loading needed to compartmentalize upper floors.

It also offers considerable sustainable-design benefits, including energy conservation through its thermal mass and capabilities for insulation, the use of recycled content through fly ash and other additives, local manufacture due to nearby location of plants, elimination of on-site construction waste, recycled energy and materials in fabrication, and other factors.

At the same time, it can provide the high-quality aesthetic statement that developers require with high-profile multi-use projects. Precast concrete can replicate limestone or granite appearances or make use of embedded thin brick to project a more traditional or classic look. It's a highly plastic material that also can create a contemporary, upscale image if that is desired.

Mixed-use projects have become more prevalent as developers focus on minimizing their risk in a difficult economy and boosting the marketability of their projects. Balancing all of the needs of these projects creates challenges. But the result of good design and construction efforts are vibrant, highly used buildings that can make a statement and boost an entire neighborhood. ■

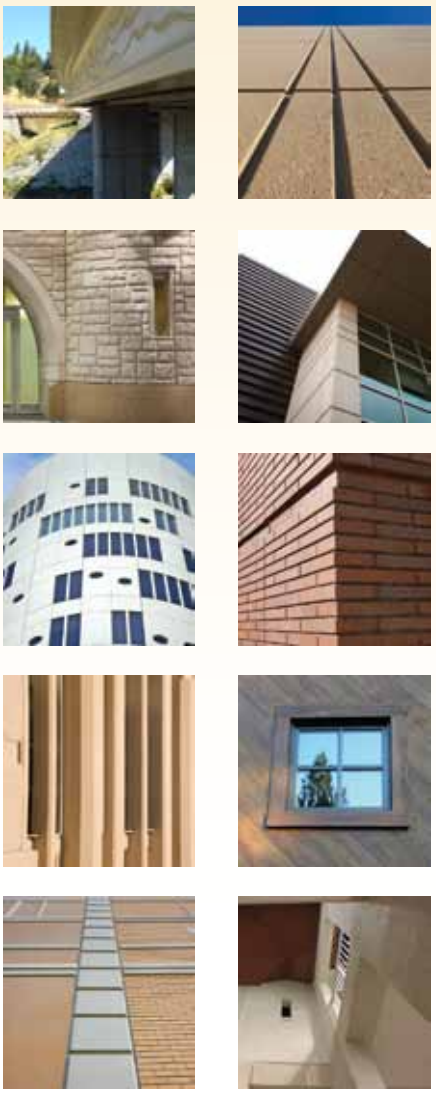
For more information on these or other projects, visit www.pci.org/ascent.

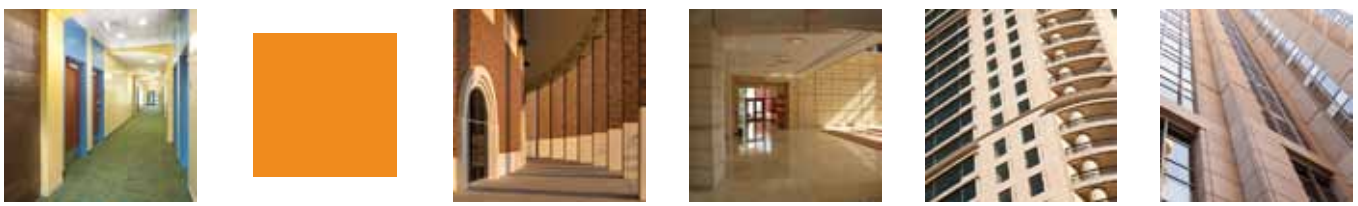
The Aesthetic Versatility of Precast

Precast concrete provides excellent aesthetic versatility. It is available in practically any color, form, and texture. Precast concrete can also be veneered with other traditional building materials such as brick, granite, limestone, terra cotta, tile, and more. This provides the look and feel of these materials while adding all the benefits of precast concrete.

Different finishes can also be combined for one project, even in one panel, without requiring multiple trades and additional detailing for movement and waterproofing. It offers an efficient way to develop a multitude of façade treatments while reducing costs and risk.

Mixed use projects often have challenging aesthetic requirements. Some projects strive to maintain a traditional appearance that blends with other buildings, some inject a contemporary image that draws attention, and yet another might need to provide the illusion of several distinct buildings, when in fact it is actually one project. Whatever the aesthetic goals, precast concrete provides high performance aesthetic versatility to meet them. The next few pages show some of the capabilities of precast concrete's aesthetic versatility on projects throughout the United States.





Norristown Mixed Use Parking Facility

Norristown, Pa.

The $11.2 million facility boasts ornate storefronts and metalwork that greatly revitalizes the aesthetic quality of the town. The exterior façade is highlighted by two different architectural precast colors, as well as variant levels of sandblast finish. In addition, the design has two different color thin bricks integrated into the precast panels. It provides parking for 483 cars on four levels. Vehicles enter on one street and exit on a perpendicular street to decrease traffic congestion. The layout also includes 6,500 square feet of retail space along both streets on which the facility is located. The total building area is 166,500 square feet.

Architect: *Timothy Haahs & Associates, Inc., Blue Bell, Pa.*

Structural Engineer: *Timothy Haahs & Associates, Inc., Blue Bell, Pa.*

Contractor: *Shoemaker Construction Co., W. Conshohocken, Pa.*

Owner: *Redevelopment Authority of the County of Montgomery, Norristown, Pa.*

Precaster: *Newcrete Products, a division of New Enterprise Stone & Lime Co., Inc., Roaring Spring, Pa.*

The Century

Los Angeles, Calif.

Architect: *Robert AM Stern Architects, New York, NY*

Architect: *HKS, Beverly Hills, Calif.*

Structural Engineer: *Magnusson Klemencic & Associates, Seattle, Wash.*

Contractor: *Webcor Builders, Los Angeles, Calif.*

Owner: *The Related Companies, LLP, Century City, Calif.*

Precaster: *Clark Pacific, Fontana, Calif.*

This unique, elliptical shaped 42-story high-rise contains 140 luxury condominium units (including nine penthouses) with a 368-car, subterranean parking garage located on Century City's Avenue of the Stars. The project features high-end exterior finishes (including stone and architectural precast concrete), floor-to-ceiling windows, private elevators, wine storage, and a fitness center with a pool and spa. Other amenities include a restaurant, conference room, catering kitchen, library, screening room, and valet parking service.

The design-build structure includes an exterior comprised of 170,000 sq. ft. of punched window architectural precast concrete and stone cladding – all produced on radiused forms.

The Tower has earned notoriety in the mainstream press for being the future residence of Candy Spelling, widow of late TV producer Aaron Spelling, who is reportedly paying more than $40 million for the top level two-story 16,500 sq. ft. penthouse.

Westin

Lombard, Ill.

The Westin is a 21-story luxury hotel. The project also contains a five-story parking structure, restaurant, and conference center. The lower levels are clad in architectural precast concrete which consists of a lightly tinted, white precast, with a light sandblast finish. Thin brick accents were also used.

Precast concrete structural and envelope systems are used for levels three through 21. These consisted of load bearing precast exterior walls, interior demising walls, and elevator/stair shafts, with hollow core plank. The higher floors use a painted finish over gray concrete, which was applied at the plant and shipped to site, cleaned, and then hoisted into location. Multiple reveal patterns and projections are used for architectural influences.

Architect: *VOA, Chicago, Ill.*

Structural Engineer: *Klein & Hoffman (Consulting Engineer), Chicago, Ill.*

Contractor: *Walsh Construction, Chicago, Ill.*

Owner: *Westin Hotels, Lombard, Ill.*

Precaster: *ATMI Precast, Aurora, Ill.*

Precaster: *ATMI Dynacore, Lockport, Ill.*

Precaster: *Lombard Architectural Precast, Alsip, Ill.*

Precast Specialty Engineer: *PEC, Waukesha, Wis.*

Science Park Parking Garage

New Haven, Conn.

The 427,500 sq. ft. structure was built on a brownfield site. An abandoned five-story industrial building was razed, and a soil remediation plan undertaken to prepare the brownfield site for development. Science Park is at the intersection of a residential community, a commercial/industrial area, and the edge of the Yale University campus in downtown New Haven. Although the need for the parking structure was to accommodate the growing commercial workforce in the area, it takes on a larger responsibility. The structure joins the three diverse neighborhoods and extends the downtown fabric by providing street level retail and restaurant spaces. The finish of the façade panels is varied in texture and color, and also included thin brick as a surface material. The project also includes glass fiber reinforced concrete (GFRC) lintels, sills and watertable elements.

Accommodation of retail spaces within parking structures is not new, but to do it successfully requires the retail storefronts to have a dominant presence rather than receding into the structure. By varying the depths of wall panels shadow lines were created to help articulate the façades. Adding pigment to the wall panels adds warmth and distinguishes them from the structural precast components of the parking structure elements behind and above. Using score lines and varying surface textures creates subtle variations that are reminiscent of streetscapes that evolve with time. The result is a facade that brings the massive scale of the structure to an appropriate level for the local streetscape, and emphasizes the storefronts rather than the parking function.

Architect: *BL Companies, Inc., Meriden, Conn.*

Structural Engineer: *BL Companies, Inc., Meriden, Conn.*

Contractor: *KBE Building Corporation, Farmington, Conn.*

Owner: *Winstanley Enterprises, New Haven, Conn.*

Precaster: *Blakeslee Prestress, Inc., Branford, Conn.*

The Flair Tower

Chicago, Ill.

Replacing a surface parking lot, this new building features 198 luxury apartment rentals, 9,500 sq. ft. of first-floor retail, and a 185-space parking structure concealed within the second through sixth floors.

The building's cut stone masonry appearance is presented in classical proportions on a human scale. White solid load-bearing precast panels finished with a light acid etch form the highly visible west, south, and east sides of the facade, completely concealing the sloped ramps of the garage behind. Reveals built in to the precast forms create the impression of cut stone. The panels are embellished with layers of banding and projections that pushed the limits of the standard 9-$^{1}/_{2}$ in.-thick panel forms. Reveals $^{3}/_{8}$ in. in depth provided the look of block-cut limestone and successfully camouflage the precast panel joints.

To convey a crisp residential feel, dark gray field-applied polished granite cut stone is installed into recesses in the bases of white pilasters, which are topped with details emulating column capitals. The gray granite was also incorporated into the storefront windows, above which pairs of windows are outlined in gray concrete color.

First floor retail space is separated from the building's influential neighbor to the east by a thin brick veneer facade. A blend of brown, red, and burnt orange veneer imported from Germany provides a hand-laid, Old World look to the running bond pattern. The precaster took special care to ensure the precast concrete "grout" color create an age-appropriate backdrop. Brick quoins were added to the corners to pay homage to the historic building next door.

Architect: *Antunovich Associates, Chicago, Ill.*

Structural Engineer: *CS Associates, Inc., Oak Lawn, Ill.*

Contractor: *W.E. O'Neil, Chicago, Ill.*

Owner: *McCaffrey Interests, Inc., Chicago, Ill.*

Precaster: *High Concrete Group LLC, Springboro, Ohio*

Westin Virginia Beach Town Center Residences

Virginia Beach, Va.

Architect: *BBG–BBGM, Washington, D.C.*

Structural Engineer: *Armada Hoffler, Virginia Beach, Va.*

Contractor: *Armada Hoffler, Virginia Beach, Va.*

Owner: *Armada Hoffler, Virginia Beach, Va.*

Precaster: *Smith-Midland Corporation, Midland, Va.*

The Westin's "main-street" style mixed-use structure offers 236 upscale guest rooms, 41,000 sq. ft. of ground-level retail space, a spa, a 25,000 square foot conference center, 119 luxury condominiums, a social room for residents, a restaurant, and five parking levels. Condos range from 800 to 4000 square feet in size. Penthouse condos have sold for up to four million dollars each. The first four floors of the Westin are clad in brick, to match the surrounding architecture. The remainder of the exterior showcases more than 77,000 square feet of a lightweight composite architectural precast cladding system. The 525 exterior panels boast two finishes, a buff architectural precast concrete mix with light acid wash and contrasting dark brown accents, which give additional architectural detailing and interest.

Dealing with Interfaces

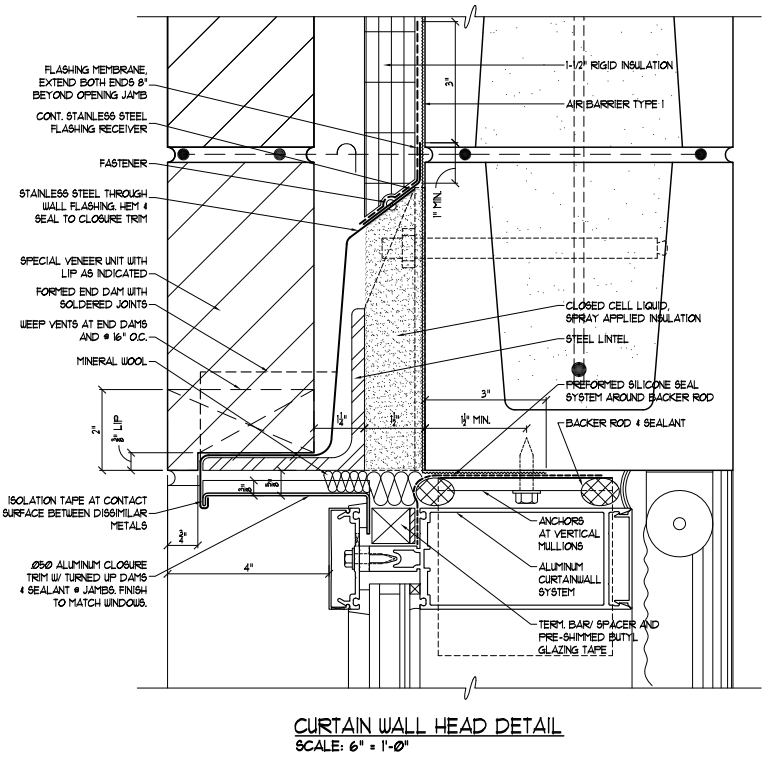
Points where materials come together create great challenges and require close attention to ensure long-term success

— By Steven A. Becica, AIA, LEED AP, Becica Associates LLC

As the complexity of building design increases with growing program requirements, sustainability features, and the expanding array of building materials, the challenges of joining dissimilar materials become greater. This is especially true in the building envelope, where weather resistance, air, moisture, vapor, and thermal barriers must perform in parallel with the design features of the façade. Understanding and clearly detailing these interfacing conditions at the design phase—and following through during the construction phase—is critical to ensure the success of the building's performance.

As an architectural and engineering firm with a focus in building forensics, Becica Associates often consults with clients to sort out design and construction deficiencies related to interface issues between materials. An overlooked detail or a misunderstood material application with in the building envelope can cause air and moisture infiltration affecting the buildings energy performance as well as damage to the structure and interior finishes. These types of problems are usually difficult and costly to repair. A forensic study is often needed to gain a full understanding of the problem and to develop long-term solutions.

– Steven A. Becica, AIA, AP LEED, is principal in Becica Associates LLC in Cherry Hill, N.J.



Curtain-wall applications require close attention to detail to ensure continuity of the drainage plane as well as a complete air and moisture barrier.

In reviewing building failures, team members begin with a review of the construction documents followed by an assessment of the as-constructed conditions. This phase identifies visual deviations. A more in-depth tactile investigation along with further testing may be conducted depending on the issue being addressed. Components of the building are then carefully removed, layer by layer, and examined to determine the cause of the failure.

Building-failure investigation services provide important lessons about detailing the interface of materials, and these lessons have complemented our own design efforts and showed some of the key details that often are overlooked.

Neglected Details

Interface issues often arise because a critical detail was not provided describing a material application or system. Aggressive project schedules are often the underlying cause impacting the time designers allocate to evaluate building systems and materials and to develop design and construction documents. Construction documents must show such detail as necessary to give a comprehensive representation of the construction contemplated. Clearly, not every pos-

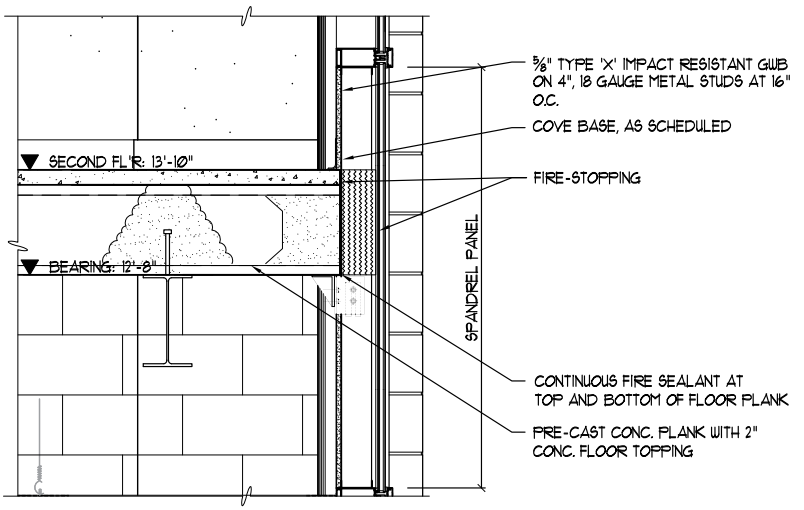
sible condition encountered on a project can be detailed. The challenge is to provide the information that will ensure a successful project. Designers who rely on the drawings to generally describe materials and the specifications for the specific application are simply delaying the detailing to a later time, usually during construction when decisions need to be made in a timely fashion to avoid delays. This scenario places an additional burden on the architect during the construction phase of the project.

Relying on the contractor to issue a request for information (RFI) is not a failsafe solution. The importance of a particular detail may not be recognized by the contractor. Problems occur when a critical detail is overlooked or if the contractor attempts to resolve the condition in the field. In the absence of a specific question, the contractor may proceed with the work as he understands it based on the construction documents. While standard details and manufacturers' recommendations often provide necessary guidance, they may not address every field condition or geometry of a material interface.

If the interface condition is covered with other materials, a potential problem may go unnoticed until a failure occurs.

In the Seventh Edition of the *PCI Design Handbook*, section 13.5.3, key questions are suggested that can apply to any interface that can help when considering the level of detailing needed for a specific project. These include:

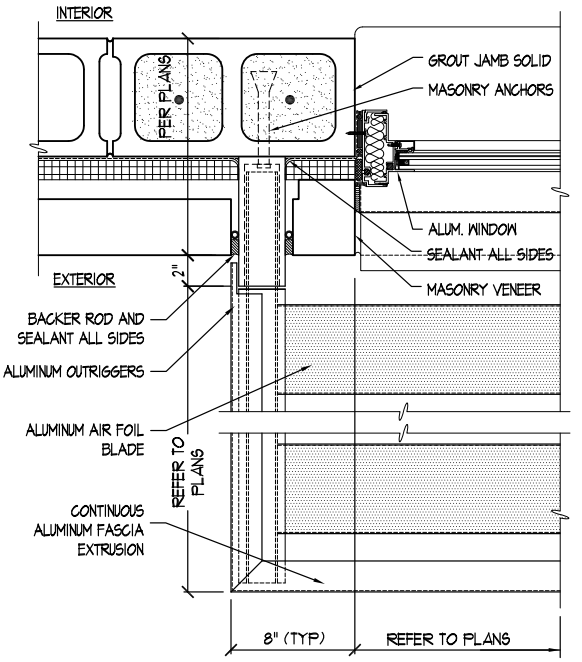
1. What specifically is to be interfaced?
2. How does the interface function?
3. Is there provision for adjustment upon installation?
4. How much adjustment can occur without rework?
5. What are the consequences of an interface tolerance mismatch (i.e., what rework requirements in labor and materials will be needed and what rejection point is there)?
6. What are the highest material cost elements of the interface?
7. What are the highest labor cost elements of the interface?
8. What are the normal tolerances associated with the system to be interfaced?



PRE-CAST @ CURTAIN WALL INTERFACE
SCALE: 3/4" = 1'-0"

Connecting two dissimilar materials, such as curtain wall and precast concrete planks, require detailing to ensure the joints don't allow energy loss or moisture penetration.

An overlooked detail or a misunderstood material application can affect the performance of the building envelope.



SUNSHADE PLAN DETAIL
SCALE: 1-1/2" = 1'-0"

As accessories such as sun shades and light shelves are added to building exteriors, detailing must be provided to show their connection methods.

Precast wall panels provided a one-component barrier-wall or face-sealed design solution at the Mitchell H. Cohen Court House in Camden, N.J.

9. Are the system-interface tolerances simple planar tolerances or are they more complex and three-dimensional?
10. Do all of the products of this type have the same interface-tolerance requirements?

Connection Details

Connections or anchors for components onto the building exterior are a key area where interfaces often are not delineated. The importance of these details increases as designers introduce new materials and sustainable features into buildings such as sun shades and light shelves.

Anchorage and interfacing these elements as part of the building façade has added yet another challenge for the designer. Drawings must define how these structures will be connected to the building structure, penetrations through the building facade and interface with water proofing elements. Embeds or other advance preparations may make these structures easier to attach and create a longer-lasting and serviceable connection.

Expansion and contraction joints must also be properly detailed. The properties of each material and the direction of the anticipated movement must be understood to ensure that a sufficiently sized and configured joint is provided. It is also important to use high-quality, long-lasting sealants to help reduce any potential for long-term problems. Sealants must be compatible with the adjoining materials. Adhesion testing and certifications are always good ideas and should be made part of the submittal and mock up requirement for the project.

Rain-Screen Designs

The use of lightweight rain-screen wall systems as exterior cladding has further expanded the level of detail needed in construction documents. Rain screens require several components such as the exterior skin, clip brackets and trim pieces, drainage and venting, sub framing, and anchorage system.

The rain-screen principal is to equalize and reduce the effect that wind and air pressure have on the façade by allowing air and moisture to enter behind the cladding and using gravity to carry the moisture out of the system. Waterproofing and controlling the amount of air that gets in are critical. Compartmentalizing areas behind the cladding balances the pressure and helps to ensure moisture is not forced in through the façade and into the building interior.

Rain-screen design presents numerous challenges. The primary issue is to ensure that continuity of the air/moisture barrier, or the vapor barrier depending on the thermal design of the wall, is maintained at all penetrations, from the moisture/vapor barrier at the roof to a point where water drainage can exit the wall system. Fortunately, air, moisture and vapor barriers are becoming more commonly used and better understood as their importance has been recognized.

In some cases, vapor retarders take the form of thin sheets or coatings applied to the structural assembly. One recent approach has been to apply emulsified or solvent-based moisture barriers in the back-up plane of the drainage cavity or to use new types of spray foam on the interior side of the rain screen panel, allowing it to serve as the vapor retarder as well as adding some insulation value.

Face-sealed systems, such as precast concrete, help to reduce many of these concerns. The concept is to prevent air and moisture from breeching the outermost surface of the wall system. For example, in most applications, precast concrete serves as an air and moisture barrier without requiring additional treatments.

Thermal Protection

As requirements for insulation continue to grow, providing the necessary insulation for a building can create significant interfacing challenges. A wide range of insulation options are available, but ensuring complete, continuous insulation requires close attention to detail in both design and construction. No gaps or bridging can occur through the insulation or the desired energy performance characteristics of the project may not be achieved.

A key problem arises with connectors and framing elements, which provide conduction points that allow heat loss. Minimizing these or disrupting this conductive property is critical to ensuring high energy efficiency.

In this regard, precast concrete sandwich wall panels offer a significant benefit by creating panels with several inches of insulation sandwiched between two wythes of concrete. Most precast concrete systems today run this insulation to the edges of the panel. The insulated panel can provide finished exterior and interior faces, creating quick installation and ensuring high energy efficiency without worries about interfaces between the insulation and the structural exterior wall.

Additional components can be installed in the precast concrete pieces at the precaster's plant.

Precast Concrete Benefits

Precast concrete also offers benefits in providing a monolithic material that can combine a variety of design elements. Using several textures, colors and/or finishes of precast within the same architectural panel can avoid creating joints or interfaces between materials. This helps to eliminate the long-term maintenance requirements due to the expansion and contraction effect of different materials. Lintels, for instance can be created in the panel and colored as an accent piece rather than having to be attached at a later time, eliminating joints and cracks around these key openings.

Similarly, using embedded thin brick cast directly into the precast panel face alleviates concerns about long-term durability of mortar joints that can cause moisture penetration if not maintained.

The Mitchell H. Cohen Court House in Camden, N.J., included an elevated pedestrian walkway to the adjacent parking structure, creating interfacing challenges for the precast concrete façade.

There is no cookie-cutter approach.

Additional components also can be installed in the precast concrete pieces at the precaster's plant. These include windows, conduit, interior finishes, and more. Discuss these issues with local precasters to see what materials can be provided in advance to alleviate interface problems at the site and speed construction once materials arrive.

Mechanical interfaces with precast concrete components are critical to design in advance of construction. Because of the variety of mechanical and electrical penetrations that are needed, utility pathways for duct work, piping and electrical conduits must be located in advance so the penetrations can be provided by the precaster during the casting phase. Targeting these areas on the construction documents and having the contractor confirm them during the shop drawing phase as a coordination effort is critical to ensuring no problems arise on the site at these interfaces.

Precast concrete floor plank often interfaces with reinforced concrete masonry bearing walls, creating a mix of materials that must be addressed, either in design or in the field.

Modeling Opens Opportunities

Building Information Modeling (BIM) opens the opportunity to ensure interface details are not lost in the shuffle and to enhance coordination efforts. BIM techniques are gaining ground rapidly as a design and construction tool that can be utilized by designers and contractors to develop more detailed building information early on to avoid clashes in the field and work out solutions to key challenges before construction begins.

An argument can be made that BIM simply reassigns design time, theoretically reducing the amount of time spent during the construction phase responding to questions and RFI's and coordination issues. Thereby increasing the time available during the design phase to address details and develop a comprehensive set of construction documents ultimately for the benefit the overall project.

New technologies are introducing design techniques and materials that can help create dramatic, efficient, and aesthetically pleasing projects. But these new technologies do not lessen the need to pay attention to the details of how building materials and systems interact and join together at their interfaces.

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

Building Vertically

Publix Supermarkets fits GreenWise shopping concept into tight urban historic space using total precast concrete system

— Craig A. Shutt

The new GreenWise organic supermarket by Publix Supermarket in Tampa, Fla., combines grocery, retail, offices and parking space in a total precast concrete structural solution that offers the functional needs for each use as well as an attractive façade that fit into the historic neighborhood.

With the population growth in urban centers and the scarcity of commercially available land to meet the new needs, developers are looking to revitalize existing locations and fit more services into tighter spaces. A total precast concrete structure helped Publix Supermarkets achieve those goals when it constructed a building in the historic and trendy south section of Tampa, Florida known as SOHO that contains a 40,000-square-foot grocery and retail center on the first floor and two levels of parking above.

The facility represented a new approach to supermarket layout for Publix as well as an extension of its new shopping concept, explains Randy Simmons, chairman of R.R. Simmons Construction Co., the design-build firm on the project. "Publix has recognized that many people today are looking for more natural and organic choices, and this store approach achieves that by avoiding foods produced with pesticides and chemicals, hormones and antibiotics," he says. "The goal was to create a multi-use facility as a one-stop shopping destination for organic, all-natural and earth-friendly products."

Fitting that store concept into downtown Tampa's "trendy, highly urban and historic area" proved challenging. The Tampa GreenWise Hyde Park store, the second constructed in Florida, houses an upscale grocery as well as a café, a full kitchen offering prepared foods for curbside service, and a mezzanine with seating and a Wi-Fi network. Above this two-story-tall area are two levels of structured parking with space for 200 cars. They are reached via oversized elevators, escalators and cart conveyors that carry shopping carts to the second floor.

Prior to creating the design, the architects held review meetings with the public to learn their concerns and explain the concept. Their prime focus, Simmons says, was to ensure the project fit into the streetscape of the historic area and that there was sufficient parking to prevent congestion and allow easy access to the stores.

Deciding to create this multi-purpose structure using precast concrete was an easy one, Simmons notes. "We've done many parking structures for a variety of clients, and we're pre-

cast concrete advocates," he says. "Precast concrete is our first love for every project. It's the most cost-effective and flexible design option, and it provides excellent aesthetics. You can make it do pretty much whatever you want it to do. It was a natural choice for the high-density, stacked construction we needed here."

'The goal was to create a multi-use facility as a one-stop shopping destination.'

Design-Build Aids Process

What was not natural was revamping the store layout to fit the available space and the need for escalators. Supermarket officials chose R.R. Simmons to create a design-build concept for the first time due to the logistics of the tight site and need to adapt to fit.

"Parking with the grocery functions in its base rather than below or beside the retail space was a new concept for them," Simmons says. "The building had to serve two masters—it had to park cars efficiently, but it also had to house a sophisticated retail grocery operation. It worked well to have both design and construction functions in-house so they could play off each other to solve problems as they arose. It really made the process go much faster, but the design-build process enhanced the creativity issues as well as constructability. And there were difficult challenges, no doubt about it."

Towers along the main pedestrian way add interest and break up the large scale of the building's façade. The architects held review meetings with the public to explain the concept and listen to their feedback. One of their key concerns was that the building fit into the historic look of the area.

One of the first centered on Publix's need to adjust its paradigm. "Typically, they would adjust the grocery store to fit their layout needs," Simmons explains. "However, to truly optimize the project, Publix had to adapt the grocery layout to fit the bay spacing for the parking structure. We worked with them to reinvent the concept so it met their needs and didn't create problems for the upper parking levels."

In particular, the prepared-food section required a fully functional kitchen, but the venting could not go out through the roof (i.e. into the parking level) as more typical grocery locations could do. "We had to create different openings and camouflage them so they weren't obvious from the street," he says. That also required planning the penetrations early in the design process so they could be incorporated into the fabrication of the precast concrete components and interface with equipment smoothly on site.

The precast concrete structural solution allowed long double tees to eliminate columns on the retail level that would have interfered with merchandising and traffic flow while

The tight site required the structure to be built from the inside out, positioning the crane inside the footprint and working across the building before backing up to erect the next set of bays. When the crane finished the final portion, the speed ramp to the parking levels was built as the final piece.

PROJECT SPOTLIGHT

GreenWise Supermarket

Location: *Tampa, Fla.*

Project Type: *Grocery store and parking*

Size: *199,100 square feet*

Cost: *$12.5 million*

Designer/Contractor: *R.R. Simmons Construction Co. Tampa, Fla.*

Owner: *Publix Supermarkets Inc., Lakeland, Fla.*

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

Precast Specialty Engineer: *LEAP & Associates International, Tampa, Fla.*

Precast Components: *Columns, beams, double tees, spandrels, stairs with landings, load-bearing wall panels and flat slabs.*

The speed ramp along the back of the building quickly pulls customers up to the parking levels, alleviating congestion on the street. Vent ducts at the top of the parking levels were needed due to the working kitchen and other facilities inside the supermarket on the first floor.

A variety of paint colors and finishes created the appearance of smaller shops along the supermarket and parking facades.

providing the loading needed for the parking levels above.

Mezzanine Adds Space

A 1,000-square-foot mezzanine level was created in the retail level using precast concrete flat slabs bearing on the exterior walls and on columns and beams placed along the perimeter. Precast concrete stairs lead up to this level. The level provides space for mechanical equipment and operational offices while allowing management personnel to overlook the grocery floor. "We wanted to take advantage of the tall space in areas where it wasn't needed for the grocery level," Simmons explains.

On the parking levels, careful column spacing was required to optimize traffic flow as well as to meet the retailer's requirement for the number of spaces available to customers. Bays were designed at a spacing of 36 by 60 feet. The floor was leveled due to the number of shopping carts accessing the floors, with independent ramping used to facilitate that approach. Measures also were taken to improve the pedestrian flow, including well-lit signage, glass lobbies and the elimination of parking curbs to reduce trip hazards.

Modifications to adjust to the tight geometrics were made, including integrating the ramp design with the storm-water vault and hidden truck court on the ground floor. The structure also required a vibro-floatation foundation due to the poor soil conditions, which were highly saturated with moisture. The process pushes water into the excavation to remove loose soil and stabilize it, then backfill is vibrated to compact it into the base and connect with adjoining soil. The foundation posed no challenges to interfacing with the precast concrete structural components.

Fitting the parking levels to the retail facility below required careful attention to moisture penetration.

Moisture a Key Concern

Providing parking levels over the retail facility below required careful attention to protecting against moisture penetration due to Tampa's wet climate. Although the precaster typically supplies pretopped double tees for parking levels, the second level's double- tees were not topped, allowing a weatherproofing membrane to be applied prior to the topping.

The roof membrane was carefully integrated into the waterproofing system over the precast concrete double tees, eliminating the need for a secondary drop ceiling above the retail areas. All exposed double-tee joints were sealed, allowing for a simple paint finish for the store's ceiling. Recesses were cast into the double tees' stems to accept threaded rods and other types of supports for signage and other interior needs.

In addition, an envelope consultant was hired to provide suggestions during the design phase and to regularly monitor placement of insulation during construction. Stainless-steel coping and flashing also were used, and the base of the exterior walls was coated with a brick finish and an integrally-colored EIFS coat rather than just paint.

The precast concrete design helped meet the public's concern for safety on the parking levels by providing open, clear spans. Vertical visual obstructions were minimized by pushing the ramps to the outer edges of the structure, while the number and locations of columns were tightly controlled to maintain unobstructed lines of sight. A speed ramp was provided to enable customers to quickly access the parking levels and alleviate congestion on the street and in the parking structure.

Details Enhance Aesthetics

The structure is located on a dense urban site in close proximity to adjacent buildings, which feature decorative and historic storefronts, as well as pre-existing underground utilities. To ensure the precast concrete structure fit into the neighborhood, a variety of techniques were used to break up the large scale of the façade. The precast concrete panels were cast with embedded thin brick, cast-in tile mosaics and rustications, with a number of paint colors used, including some to enhance false windows cast into the panels. These variations were embellished with accessories, including iron canopies, decorative grilles, balconies, Bahama shutters, EIFS shapes and awnings.

"We created a number of appearance changes to break up the scale and add interest in this urban area," Simmons says. "We knew we couldn't create a vanilla garage-like look and satisfy the community. We wanted to have a busy exterior to match the fabric of the neighborhood and to avoid a monolithic look." The building was topped with colored metal standing-seam roofing to enhance its unique appearance.

The precast concrete panels were cast with embedded thin brick, cast-in tile mosaics and rustications, with a number of paint colors used. Some were used to create false windows cast into the panels (lower row). These variations were embellished with accessories such as decorative grilles and awnings.

'We created a number of appearance changes to break up the scale and add interest in this urban area.'

Publix officials had to adjust the supermarket layouts to effectively make use of the parking-bay design on the overhead floors, but the result was a dramatic addition to the area streetscape that added function and style to the trendy SOHO section of the city.

Due to the tight site, the structure was built from the inside out, positioning the crane inside the footprint to erect the northwest corner first, and then working across to the southwest corner. The load-bearing wall panels and columns were placed, followed by the beams and double tees. The crane then was backed out to the east by one bay and the process repeated, moving north to south. For the final bay width on the east side, the crane was backed out onto the street and the speed ramp was constructed in its place.

"It's not uncommon for us to work this way," Simmons says. "We've done a number of hospital projects on medical campuses that have to be completed in the same way. Using precast concrete helped with the construction, because all of the components could be staged at the plant and delivered on a just-in-time basis. That allowed us to keep the site clear and a lot of the construction work away from the residential neighborhood."

The result of the revamping to adapt the grocery paradigm to its new location is a brightly colored and ornate multistory building that was the buzz of the tightly-knit community, Simmons says. Once the doors opened, crowds were eager to get a taste of the new concept.

"The store became a hot topic in town," he says. "They kind of shook up this historic neighborhood, and there were some concerns about whether it would fit in. But it works very well. This is truly one of the most unique retail developments in all of west central Florida. It's a very different concept, both for Tampa and for Publix, but it ended up meshing well and provides a fun environment that's not your average suburban grocery. And we couldn't have done it with anything except a precast concrete solution." ■

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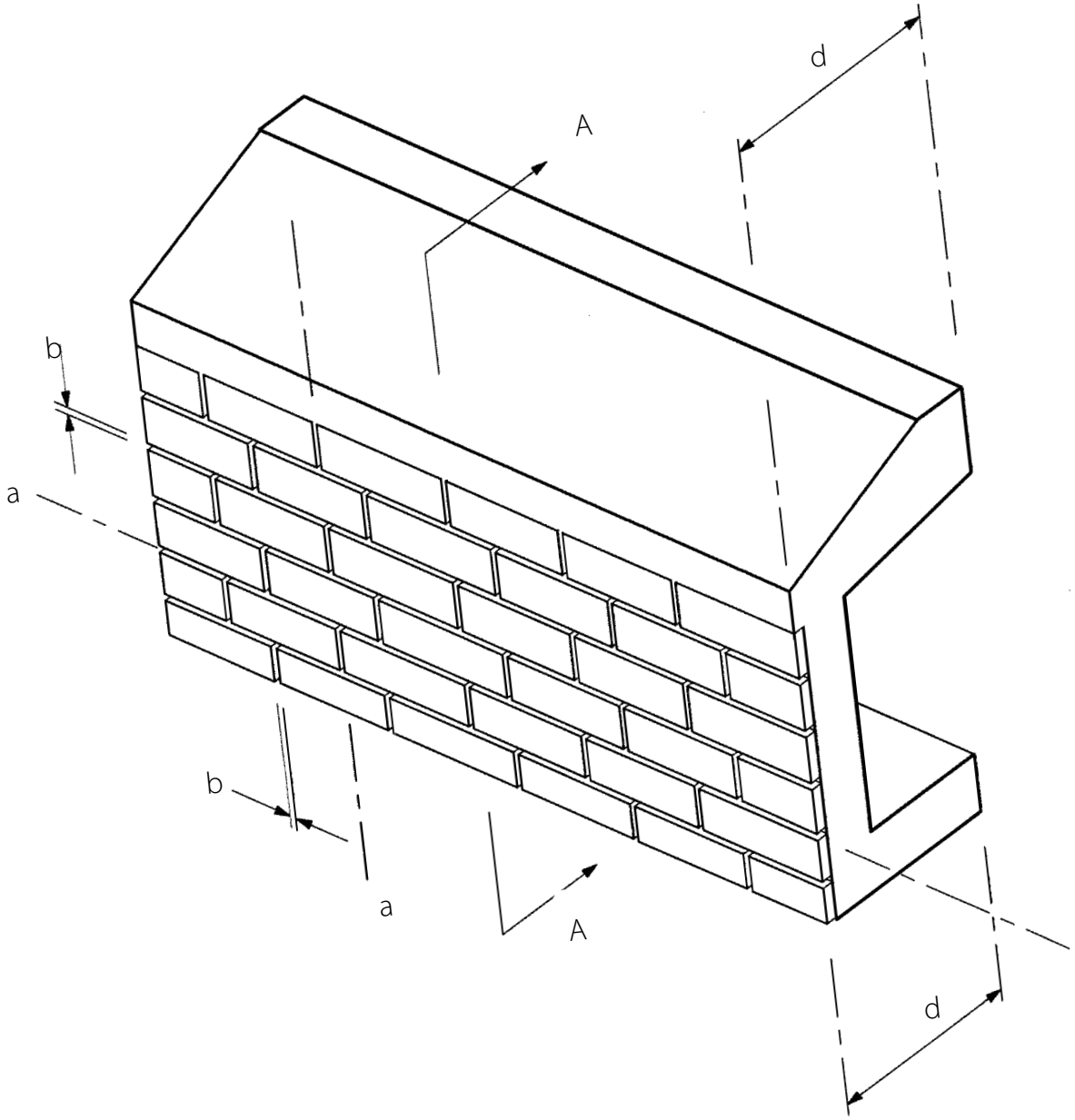
ENVELOPE TOLERANCES FOR ARCHITECTURAL PRECAST



designer's**notebook**

ENVELOPE TOLERANCES FOR ARCHITECTURAL PRECAST

Designers must recognize that manufacturing and erection tolerances apply to precast concrete just as they do to other building materials. Tolerance is defined as a permissible variation from a specified dimension. A tolerance can be expressed as an additive (+) or subtractive (-) variation from a specified dimension or relation or as an absolute deviation from a specified relation. Tolerances define realistic limits for size and shape within which the precast concrete units must lie, and must satisfy the designer's intent while ensuring the constructability and economy of the building system.

Three groups of tolerances should be established as part of the precast concrete design: product tolerances, erection tolerances, and interfacing tolerances.

Tolerances are established for the following reasons:

1. Structural—To ensure that structural design accounts for variations in production and installation dimensional control. Examples include eccentric loading conditions, bearing locations, hardware anchorage locations, and locations of reinforcing or prestressing steel.
2. Feasibility—To ensure acceptable performance of joints and interfacing materials, such as glazing between panels, and to ensure that designs and details are dimensionally feasible.
3. Visual—To ensure that the variations will result in an aesthetically acceptable structure.
4. Economic—To ensure ease and speed of production and erection with a known degree of accuracy in the dimensions of the precast concrete product.
5. Contractual—To establish a known acceptability range and to establish responsibility for developing, achieving, and maintaining mutually agreed tolerances.
6. Legal—To avoid encroaching on property lines and to establish tolerance standards against which the work can be compared in the event of a dispute.

Tolerances and interface conditions are best handled by the design team, general contractor, or other entity having the contractual authority necessary to specify, coordinate, and control interfacing requirements of other trades that adjoin the precast concrete construction.

While the responsibility for specifying and maintaining tolerances of the various elements may vary among projects, it is important that this responsibility be clearly assigned and communicated to all members of the project team. The tolerances must be reasonable, realistic, and within generally accepted limits. Some manufacturing and erection costs are directly proportional to the tolerance requirements. It is more economical to design connection and interface details with maximum flexibility and to keep tolerance requirements as realistic as possible.

ACI has adopted the PCI Tolerances as a consensus standard in ACI ITG-7, ***"Specification for Tolerances for Precast Concrete"*** which is referenced by ACI 301 ***"Specifications for Structural Concrete."***

It should be understood by those involved in the design and construction process that the tolerances listed in this publication must be considered as guidelines for an acceptability range and not limits for rejection. If specified tolerances are met, the members should be accepted. If these tolerances are exceeded, the member may still be acceptable if it meets any of the following criteria:

1. Exceeding the tolerances does not affect the structural integrity, architectural performance of the member, or other trades.
2. The member can be brought within tolerance by structurally and architecturally satisfactory means.
3. The total erected assembly can be modified reasonably to meet all structural and architectural requirements.

The enforcement of tolerances should be based on the technical judgment of the designer. This design professional is able to decide whether a deviation from the allowable tolerances affects safety or appearance. In building construction, very little out of tolerance work, whether it is concrete, masonry, cast-in-place concrete, steel, or precast concrete, has been rejected and removed solely because it was "out-of tolerance."

Product Tolerances - Product tolerances relate to the dimensions and dimensional relationships of the individual precast concrete units. They are a measure of the dimensional accuracy required on individual members to ensure, prior to delivery, that the members will fit the structure without requiring tolerance related rework. Product tolerances are applied to physical dimensions of units such as thickness, length, width, squareness, and location and size of openings. They are determined by economical and practical production considerations, and functional and appearance requirements. Product tolerances also control the locations of the member features as they relate to the overall member dimensions.

Tolerances for manufacturing are standardized throughout the industry and should not be specified to be more stringent, and therefore more costly, unless absolutely necessary. Areas that might require more exacting tolerances could include special finish or appearance requirements, glazing details, and certain critical dimensions on open shaped units such as C or U shaped panels, and spandrels interspersed with windows.

When a project involves particular features sensitive to the cumulative effect of generally accepted tolerances on individual portions, the design team should anticipate and provide for this effect by setting a cumulative tolerance or by providing clearances where accumulated tolerances or production tolerances can be absorbed. The consequences of each materials tolerances permitted on a particular project should be investigated to determine whether a change is necessary in the design or in the tolerances applicable to the project or individual components. For example, there should be no possibility of minus tolerances accumulating so that the bearing length of members is reduced below the required design minimum. These bearing dimensions and their tolerances should be shown on the erection drawings.

The published allowable variation for one element of the structure should not be applicable when it will permit another element of the structure to exceed its allowable variations.

Restrictive tolerances should be reviewed to ascertain that they are compatible and that the restrictions can be met. For example, a requirement that states, "no bowing, warpage, or movement is permitted," is not practical or possible to achieve.

The product tolerances for architectural precast concrete panels have the following significance:

1. Length or width dimensions and straightness of the precast concrete will affect the joint dimensions, opening dimensions between panels, and possibly the overall length of the structure. Tolerances must relate to unit size and increase as unit dimensions increase.
2. Panels out-of-square can cause tapered joints and make adjustment of adjacent panels difficult.
3. Thickness variation of the precast concrete unit becomes critical when interior surfaces are exposed to view. A non-uniform thickness of adjacent panels will cause offsets of the front or the rear faces of the panels.

Industry product tolerances for architectural precast concrete panels are defined as follows:

Warping is generally the twisting of a member, resulting in an overall out-of-plane curvature in which the corners of the panel do not all fall within the same plane. Warping tolerances are stated in terms of the magnitude of the corner variation, usually the allowable variation per 1 ft (0.3 m) of distance from the nearest adjacent corner with a not-to-exceed maximum value of corner warping.

Bowing is an overall out-of-plane curvature, which differs from warping in that while the corners of the panel may fall in the same plane, the portion of the panel between two parallel edges is out of plane. Differential temperature effects, differential moisture absorption between the inside and outside faces of a panel, the effects of prestress eccentricity, and differential shrinkage between wythes in an insulated panel should be considered in design to minimize bowing and warping.

Bowing and warping tolerances are of interest primarily at the time the panel is erected. They have an important effect on the edge match-up during erection and on the visual appearance of the erected panels, both individually and when viewed together. The requirements for bowing and warping of panels may be overridden by erection tolerances for panels as installed with reference to joint widths and jog in alignment.

Table 1 shows the relationship between overall flat panel dimensions and thickness. Panels with thicknesses less than those shown in Table 1 should not be automatically subjected to the standard tolerances for bowing and warping. Note that the thickness values in this table should not be considered as limiting values, but rather as an indication that more detailed consideration of the possible magnitude of warping and bowing is warranted. The major criteria for maintaining or relaxing bowing and warping tolerances will be the appearance requirements, the required type of connections (as well as the number and location of tieback connection points), and the advice of the local precaster regarding overall economic and construction feasibility.

Note: Care must be taken to prevent possible cracking resulting from overstressing the panel in pushing and pulling a bowed panel into tolerance using intermediate tiebacks.

Table 1. Guidelines for Panel Thickness for Overall Panel Stiffness Consistent with Suggested Normal Panel Bowing and Warping Tolerances.[1]

Panel Dimmensions[1]	8 ft	10 ft	12 ft	16 ft	20 ft	24 ft	28 ft	32 ft
4 ft	4 in.	4 in.	4 in.	5 in.	5 in.	6 in.	6 in.	7 in.
6 ft	4 in.	4 in.	4 in.	5 in.	6 in.	6 in.	6 in.	7 in.
8 ft	4 in.	5 in.	5 in.	6 in.	6 in.	7 in.	7 in.	8 in.
10 ft	5 in.	5 in.	6 in.	6 in.	7 in.	7 in.	8 in.	8 in.

[1]This table represents a relationship between overall flat panel dimensions and thickness below which suggested bowing and warping tolerances should be reviewed with precaster and possibly increased. For ribbed panels, the equivalent thickness should be the overall thickness of such ribs if continuous from one end of the panel to the other. Flat panel thickness governs if ribs are not continuous.

Note: 1 ft = 0.3048 m; 1 in. = 25.4 mm

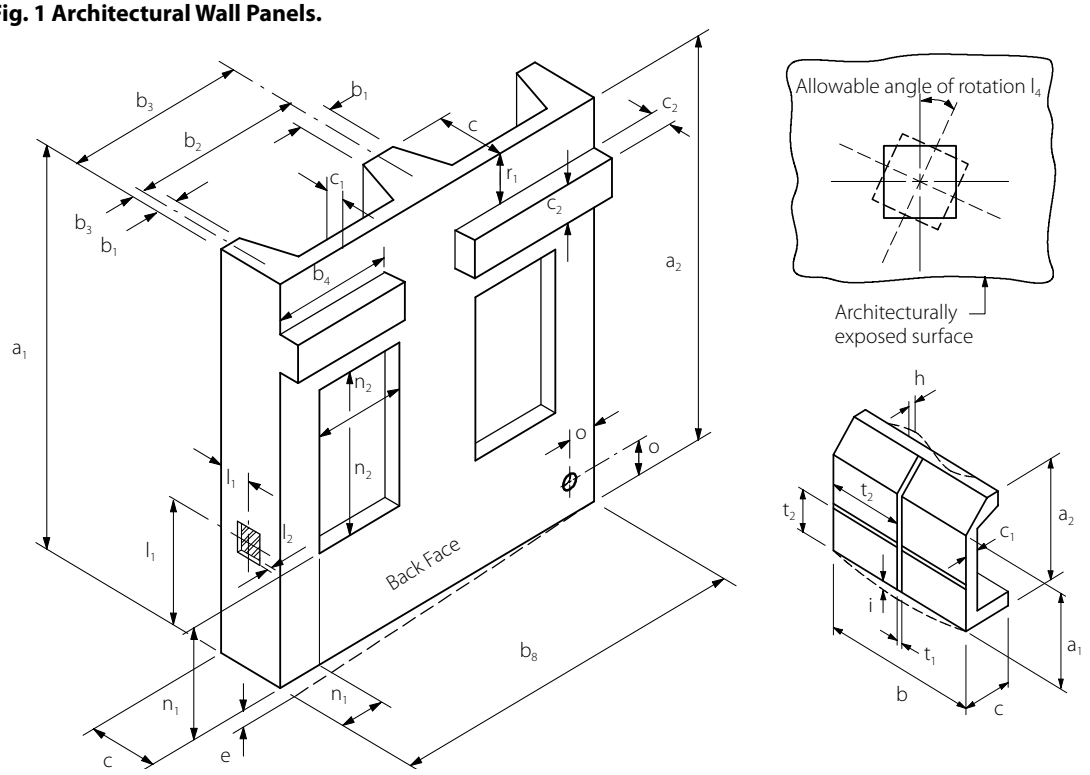
To reduce the possibility of panel warpage or bowing, consideration should be given to the panel length, shape, and connection locations. The longer the panel, the more difficult it is to control planeness of the panel.

Panels that are manufactured using large-aggregate concrete (above $^3/_4$ in. [19 mm] aggregate) or units that are fabricated from nonhomogeneous materials (such as two significantly different concrete mixtures, natural stone or clay product veneers, insulating mediums, and the like) also require more careful consideration of all aspects of fabrication, storage, and handling with regard to bowing and warping.

Surface out-of-planeness is defined as a local smoothness variation rather than a bowing of the entire panel shape. The tolerance for this type of variation is usually expressed in fractions of 1 in. per 10 ft (25mm per 3 m).

Dimensional tolerance requirements for architectural precast concrete elements are given in Figs. 1 and 2. It must be emphasized that these are guidelines only and that each project must be considered individually to

Fig. 1 Architectural Wall Panels.



a_1 = Overall height of unit measured at the face exposed to view:
- Up to 10 ft [3 m] ..... ± 1/8 in. [± 3 mm]
- 10 to 20 ft [3 to 6 m] ..... + 1/8 in., –3/16 in. [+ 3 mm, –5 mm]
- 20 to 40 ft [6 to 12 m] ..... ± 1/4 in. [± 6 mm]
- Greater than 40 ft [12 m] ..... ± 1/16 in. per 10 ft [± 1.5 mm, per 3 m]

a_2 = Overall height of unit measured at the face not exposed to view:†
- Up to 10 ft [3 m] ..... ± 1/4 in. [± 6 mm]
- 10 to 20 ft [3 to 6 m] ..... + 1/4 in., –3/8 in. [+ 6 mm, –10 mm]
- 20 to 40 ft [6 to 12 m] ..... ± 3/8 in. [± 10 mm]
- Greater than 40 ft [12 m] ..... ± 1/8 in. per 10 ft [± 3 mm, per 3 m]

b = Overall width of unit measured at the face exposed to view:
- Up to 10 ft [3 m] ..... ± 1/8 in. [± 3 mm]
- 10 to 20 ft [3 to 6 m] ..... + 1/8 in., –3/16 in. [+ 3 mm, –5 mm]
- 20 to 40 ft [6 to 12 m] ..... ± 1/4 in. [± 6 mm]
- Greater than 40 ft [12 m] ..... ± 1/16 in. per 10 ft [± 1.5 mm per 3 m]

b_1 = Rib width ..... ± 1/8 in. [± 3 mm]

b_2 = Distance between ribs ..... ± 1/8 in. [± 3 mm]

b_3 = Rib to edge of flange ..... ± 1/8 in. [± 3 mm]

b_8 = Overall width of unit measured at the face not exposed to view:
- Up to 10 ft [3 m] ..... ± 1/4 in. [± 6 mm]
- 10 to 20 ft [3 to 6 m] ..... + 1/4 in., –3/8 in. [+ 6 mm, –10 mm]
- 20 to 40 ft [6 to 12 m] ..... ± 3/8 in. [± 10 mm]
- Greater than 40 ft [12 m] ..... ± 1/8 in. per 10 ft [± 3 mm per 3 m]

c = Total thickness ..... + 1/4 in., –1/8 in. [+ 6 mm, –3 mm]

c_1 = Flange thickness ..... + 1/4 in., –1/8 in. [+ 6 mm, –3 mm]

c_2 = Dimensions of haunches ..... ± 1/4 in. [± 6 mm]

Fig. 1 Architectural Wall Panels. (cont.)

e = Variation‡ from square or designated skew ..... ± 1/8 in. per 6 ft, ± 1/2 in. max. [± 3 mm per 2 m, ± 13 mm max.]

h = Location smoothness, unconcealed surfaces ..... ± 1/4 in. per 10 ft, [± 6 mm per 3 m]

i = Bowing ..... ± Length/360, to maximum of 1 in. [25 mm]

j = Warp (from adjacent corner) ..... 1/16 in. per ft [1.5 m per 300 mm]

l_1 = Location of weld plates ..... ± 1 in. [± 25 mm]

l_2 = Tipping and flushness of plates ..... ± 1/4 in. [± 6 mm]

l_4 = Allowable rotation of plate, channel insert, electrical box ..... 2 degrees
1/4 in. [6 mm] maximum measured at perimeter of insert

m_2 = Haunch bearing surface tipping and flushness of bearing plates ..... ± 1/8 in. [± 3 mm]

m_3 = Difference in relative position of adjacent haunch bearing surfaces from specified relative position ..... ± 1/4 in. [± 6 mm]

n_1 = Location of opening within panel ..... ± 1/4 in. [± 6 mm]

n_2 = Length and width of blockouts and openings within one unit ..... ± 1/4 in. [± 6 mm]

n_3 = Location and dimensions of blockouts hidden from view and used for HVAC and utility penetrations ..... ± 3/4 in. [± 19 mm]

o = Position of sleeve ..... ± 1/2 in. [± 13 mm]

p = Position of insert ..... ± 1/2 in. [± 13 mm]

q = Position of handling devices ..... ± 3 in. [± 75 mm]

r_1 = Location of bearing surface from end of member ..... ± 1/4 in. [± 6 mm]

s_1 = Reinforcing steel and welded wire reinforcement:
Where position has structural implications or affects concrete cover ..... ± 1/4 in. [± 6 mm]
Otherwise ..... ± 1/2 in. [± 13 mm]

s_3 = Reinforcing steel extending out of member ..... ± 1/2 in. [± 13 mm]

s_4 = Location of strand:
Perpendicular to panel ..... ± 1/4 in. [± 6 mm]
Parallel to panel ..... ± 1 in. [± 25 mm]

t_1 = Dimensions of architectural features and rustications ..... ± 1/8 in. [± 3 mm]

t_2 = Location of rustication joints ..... ± 1/8 in. [± 3 mm]

w_1 = Location of flashing reglets ..... ± 1/4 in. [± 6 mm]

w_2 = Location of flashing reglets at edge of panel ..... ± 1/8 in. [± 3 mm]

w_3 = Size of reglets for glazing gaskets ..... ± 1/8 in. [± 3 mm]

z = Electrical outlets, hose bibs, etc. ..... ± 1/2 in. [± 13 mm]

Tolerances below are for smooth-finished stone veneer-faced precast concrete panels.

1. Variations in cross-sectional dimensions: For thickness of walls from dimensions indicated ..... 1/4 in. (6 mm).

2. Variation in joint width: 1/8 in. in 36 in. (3 mm in 900 mm) or a quarter of nominal joint width, whichever is less.

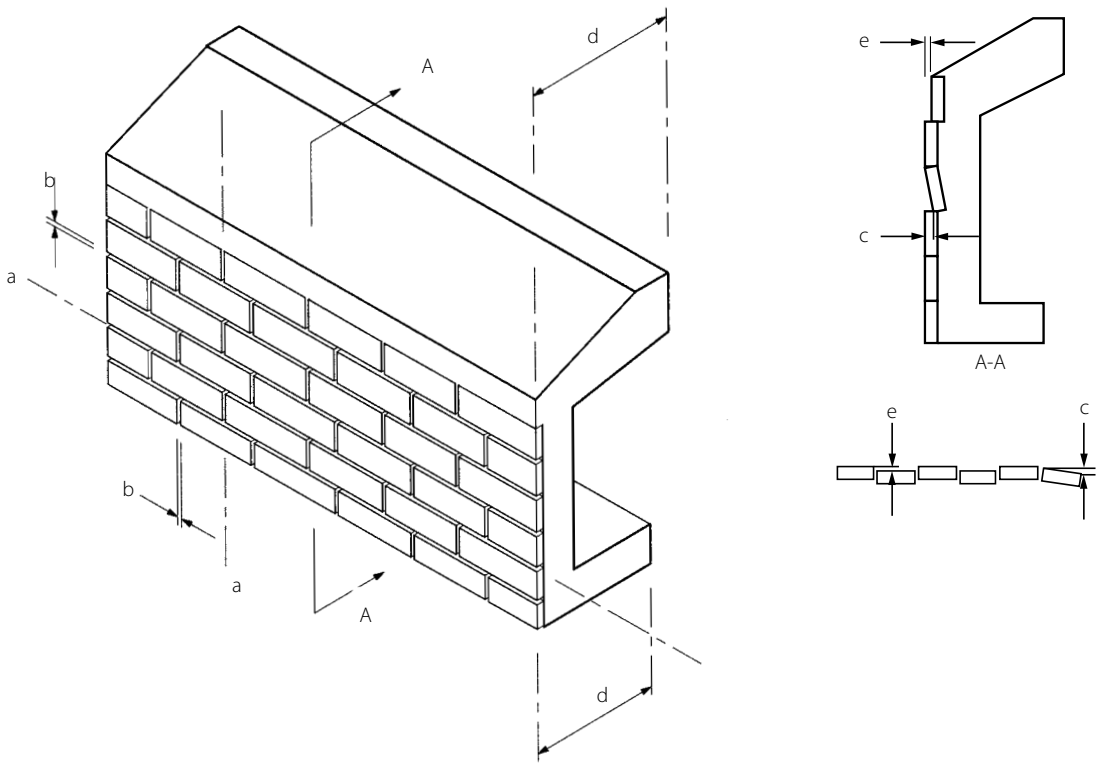
3. Variation in plane between adjacent stone units (lipping): 1/16 in. (1.5 mm) difference between planes of adjacent units.

*Units shall be manufactured so that the face of each unit which is exposed to view after erection complies with the following dimensional requirements.

†Unless joint width and fit-up requirements demand more stringent tolerance.

‡Applies to both panel and to major openings in panel. Tolerances apply to the difference of the two diagonal measurements.

Fig. 2 Brick faced architectural elements.



a = Alignment of mortar joints:
Jog in alignment ..... 1/8 in. [± 3 mm]
Alignment with panel centerline ..... ± 1/8 in. [± 3 mm]

b = Variation in width of exposed mortar joints ..... ± 1/8 in. [± 9 mm]

c = Tipping of individual bricks from the panel plane of exposed brick surface −1/4 in. [–6 mm]
≤ depth of form liner joint

d = Exposed brick surface parallel to primary control surface of panel ..... + 1/4 in., −1/8 [+ 6 mm, −3 mm]

e = Individual brick step in face from the panel plane of exposed brick surface ..... −1/4 in. [–6 mm]
≤ depth of form liner joint

Note: The number of bricks that could exhibit these misalignments should be limited to 2% of the bricks on the panel. See other panel tolerances in Fig. 1

ensure that the stated tolerances are applicable.

Groups of inserts or cast-in items that must be located in close tolerance to each other should not be separated into two different panels by a joint.

Erection Tolerances - Erection tolerances control the position of the individual precast concrete members as they are located and placed in the assembled structure. They normally involve the general contractor and various subcontractors, such as the precast concrete erector.

Erection tolerances are provided to help achieve uniform joint widths, level floor elevations, and planar wall conditions. Erection tolerances should be determined on the basis of individual unit design, shape, thickness, composition of materials, and overall scale of the unit in relation to the building. The specified erection tolerances may affect the work of several different building trades and must be consistent with the tolerances specified for those trades. If the final erection tolerances are different from those given in this publication, the tolerances should be stated in contract documents and noted on the project precast erection drawings.

The erector is responsible for erecting the members within the specified tolerances and completing the connections in the manner detailed. Appropriate surveying and layout procedures should be followed to ensure accurate application of tolerances. When a unit cannot be erected within the specified tolerances, the erector should notify the precaster and GC/CM to check the structural adequacy of the installation and determine if the connection design should be modified. No unit should be left in an unsafe condition. Any adjustments affecting structural performance, other than adjustments within the prescribed tolerances, should be made only after documented approval by the precast concrete design engineer and engineer of record (if required).

The primary control surfaces or features on the precast concrete members are erected to be in conformance with the established erection and interfacing tolerances (Fig. 3). A primary controls surface is a surface on a precast element, the dimensional location of which is specifically set and controlled in the erection process. Clearances are generally allowed to vary so that the primary control surface can be set within tolerance. It is important to recognize product tolerances are not additive to the primary surface erection tolerances.

Secondary control surfaces that are positioned from the primary control surfaces by the product tolerances are usually not directly positioned during the erection process, but are controlled by the product tolerances. Thus, if the primary control surfaces are within erection and interfacing tolerances, and the secondary surfaces are within product tolerances, the member should be considered erected within tolerance. The result is that the tolerance limit for secondary surfaces may be the sum of the product and erection tolerances. Product tolerances, in general, must not exceed erection tolerances.

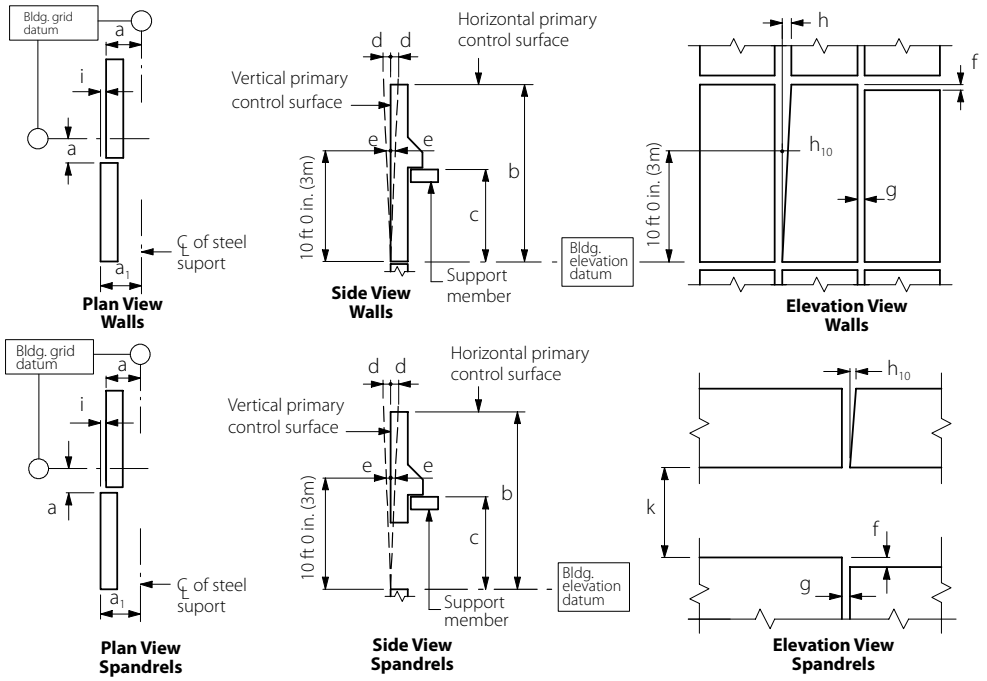
Because erection and product tolerances for some secondary control surfaces of a precast concrete member may be directly additive, the erection drawings should clearly define the primary erection control surfaces. If both primary and secondary control surfaces are critical, provisions for adjustment should be included. The accumulated tolerance limits may be required to be accommodated in the interface clearance. This may occur with window openings between two spandrels when the critical elevation, top or bottom and as indicated on the erection drawings, must be maintained. If more than one critical line is indicated, the erector should balance any deviations between the two edges. Surface and feature control requirements should be clearly outlined in the plans and specifications.

During panel installation, priority is generally given to aligning the exterior face of the units to meet aesthetic requirements. This may result in the interior face of units being out-of-plane.

Erection tolerances are largely determined by the actual alignment and dimensional accuracy of the building foundation and frame in those circumstances where the building frame is constructed from some material other than precast concrete. The general contractor is responsible for the plumbness, levelness, and alignment of the foundation and non-precast concrete structural frame, including the location of all bearing surfaces and anchorage points for precast concrete products.

The architect/engineer should clearly define in the specifications the maximum tolerances permitted in the

Fig. 3 Architectural walls/spandrels erection tolerances.



The primary control surfaces are usually as shown, although this needs to be confirmed on a job-by-job basis.

a = Plan location from building grid datum* ..... ± 1/2 in. [± 13 mm]

a_1 = Plan location from centerline of steel support† ..... ± 1/2 in. [± 13 mm]

b = Top elevation from nominal top elevation:
Exposed individual panel ..... ± 1/4 in. [± 6 mm]
Nonexposed individual panel ..... ± 1/2 in. [± 13 mm]

c = Support haunch elevation from nominal elevation:
Maximum low ..... 1/2 in. [13 mm]
Maximum high ..... 1/4 in. [6 mm]

d = Maximum plumb variation over height of structure or 100 ft [30 m] whichever is less* ..... 1 in. [25 mm]

e = Plumb in any 10 ft [3 m] of element height ..... 1/4 in. [6 mm]

f = Maximum jog in alignment of matching edges:
Exposed relative to adjacent panel ..... 1/4 in. [6 mm]
Nonexposed relative to adjacent panel ..... 1/2 in. [13 mm]

g = Joint width (governs over joint taper) ..... ± 1/4 in. [± 6 mm]

h = Joint taper maximum ..... 3/8 in. [10 mm]

h_{10} = Joint taper over 10 ft [3 m] length ..... 1/4 in. [6 mm]

i = Maximum jog in alignment of matching faces ..... 1/4 in. [6 mm]

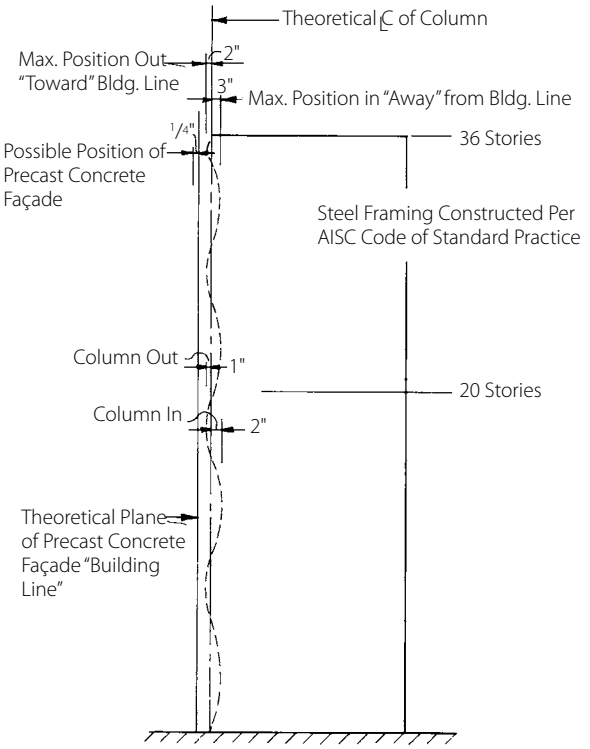
j = Differential bowing or camber as erected between adjacent members of the same design ..... 1/4 in. [6 mm]

k = Opening height between spandrels ..... ± 1/4 in. [± 6 mm]

*For precast concrete buldings in excess of 100 ft [30 m] tall, tolerances "a" and "d" can increase at the rate of 1/8 in. [3 mm] per story to a maximum of 2 in. [50 mm].

†For precast concrete elements erected on a steel frame, this tolerance takes precedence over tolerances on dimension "a".

Fig. 4 Clearance example.



Note: 1 in. = 25.4 mm.

foundation and building frame alignment, then should specify that the general contractor check frequently to verify these tolerances are being held. In addition, the architect/engineer should ensure that the details in the contract documents allow for the specified tolerances. To accommodate any misalignment of the building frame, connections should provide for vertical, in-plane lateral and out-of-plane lateral adjustments of at least 1 in. (25 mm).

If the precast concrete units are to be installed reasonably "plumb, level, square, and true," the actual location of all surfaces affecting their alignment, including the levels of floor slabs and beams, the vertical alignment of floor slab edges, and the plumbness of columns or walls, must be known before erection begins. The general contractor is expected to, and should be required to, establish (and maintain at convenient locations) control points, benchmarks, and lines in areas that remain undisturbed until the completion and acceptance of the project.

Tolerances for the building frame must be adequate to prevent interferences that may cause difficulty with panel installation. Beam elevations and column locations should be controlled within the applicable material tolerances with the appropriate clearance between the precast concrete and support elements.

The location of hardware items cast into or fastened to the structure by the general contractor, steel fabricator, or other trades, should be located ±1 in. (±25 mm) in all directions (vertical and horizontal) from the specified location, plus a slope deviation of no more than ±1/4 in. (±6 mm) in 12 in. (300 mm) for critical bearing surfaces.

In the determination of erection tolerances, attention should also be given to possible deflection and/ or rotation of structural members supporting precast concrete. This is particularly important when bearing on flexible or cantilevered structural members. Consideration by the engineer of record should be given to both initial and to long-term deflection caused by camber and creep of the supporting structural members.

Structural steel framing tolerances should be specified to conform with the American Institute of Steel Construction (AISC) Code of Standard Practice for Steel Buildings and Bridges, 2010, (see section16.3). Particular attention is directed to the "Commentary" included in this code, which provides a detailed explanation of the specified erection tolerances. Mill, fabrication, and erection tolerances combined result in the final dimensional accuracy of the structural steel frame.

Precast concrete tolerances should follow those for the steel frame, because the allowable tolerances for steel frame structures make it impractical to maintain precast concrete panels in a true vertical plane in tall structures. Based on the allowable steel frame tolerances, it would be necessary to provide for a 3 in. (75 mm) adjustment in connections up to the 20th story plus a 2 in. (50 mm) clearance between the back of the precast concrete member and steel frame, Fig. 4. Above the 20th story, the façade may be maintained within $^{1}/_{16}$ in. (1.6 mm) per

story with a maximum total deviation of 1 in. (25 mm) from a true vertical plane, if connections that provide for 3 in. (75 mm) of adjustment are used. Connections that permit adjustments of +2 in. (+50 mm) to -3 in. (-75 mm) (5 in. [125 mm] total) will be necessary in cases where it is desired to construct the façade to a true vertical plane above the 20th story. These adjustments in connections are not economically feasible.

A solution that has proven both practical and economical is to specify the more stringent AISC elevator-column erection tolerances for steel columns in the building façade that will receive the precast concrete panels. This type of solution should be agreed to as part of the design and specification process, or at least prior to finalization of the fabrication erection process.

Cast-in-place concrete frame tolerances are given in ACI 117, *Specification for Tolerances for Concrete Construction and Materials*, unless otherwise stated in the contract documents. ACI tolerances are ± 1 in. up to 83 ft. and linearly varies to ±6 in. at 500 ft. Clearance to cast-in-place frame of 1-$^1/_2$ to 2 in. (38 to 50 mm) must also be considered. These tolerances can make precast connections uneconomical. Also, greater variations in height between floors are more prevalent in cast-in-place concrete structures than in other structural frames. This may affect the location or mating of the inserts in the precast concrete units with the cast-in connection devices. Tolerances for cast-in-place concrete structures may have to be increased further to reflect the complexity of the structure. As a result, it is recommended that precast concrete walls should follow concrete frames in the same manner as for steel frames, if the details allow it and appearance is not affected.

The following anchor bolt tolerances, in addition to ACI 117 and AISC requirements, should be specified for cast-in-place concrete to which precast concrete units are to be connected:

a. Anchor bolt projection: - $^1/_4$ in., + $^1/_2$ in. (-6 mm, + 13 mm).

b. Plumbness of anchor bolt projection: ± $^1/_{16}$ in./ft (± 1.6 mm/0.3 m)

To properly mate steel embeds to anchor bolt connections, AISC requirements can be followed. Position tolerances and required hole diameters for various anchor rod sizes are summarized in Table 2.

Table 2. Anchor rod hole diameter and position tolerance.

Anchor Rod Diameter, in. (mm)	Hole Diameter, in. (mm)	Position Tolerance, in. (mm)
$^3/_4$ (19)	$1^5/_{16}$ (33)	±$^1/_4$ (±6)
$^7/_8$ (22)	$1^9/_{16}$ (40)	±$^1/_4$ (±6)
1 (25)	$1^{13}/_{16}$ (46)	±$^3/_8$ (±10)
$1^1/_4$ (32)	$2^1/_{16}$ (52)	±$^3/_8$ (±10)
$1^1/_2$ (38)	$2^5/_{16}$ (59)	±$^3/_8$ (±10)
$1^3/_4$ (44)	$2^3/_4$ (70)	±$^1/_2$ (±13)
2 (50)	$3^1/_4$ (82)	±$^1/_2$ (±13)
$2^1/_2$ (63)	$3^3/_4$ (95)	±$^1/_2$ (±13)

It should be recognized that ACI 117 applies primarily to reinforced concrete buildings, and the AISC Code of Standard Practice applies only to steel building frames. Neither of these standards apply to buildings of composite construction (that is, concrete floor slabs supported by steel columns or concrete-encased structural steel members, fireproofed frames, or steel frames with precast concrete cladding). Obviously, the location of the fireproofing face on the steel, as well as that of the steel member itself, are both critical. Because the alignment of composite members, fireproofing, and masonry work are not controlled by referencing these standards, the architect/engineer should require that the location of all such materials contiguous to the precast concrete units be controlled within tolerances that are no less stringent than those specified in ACI 117. Should there be some doubt as to what these tolerances should be, the precast concrete manufacturer or erector should be consulted for advice.

There is less potential for erection tolerance controversy in structures consisting entirely of precast concrete units than for structures that are combinations of precast and cast-in-place concrete or steel. A total precast concrete structure is erected by one entity with single source responsibility eliminating interfacing with other structural systems. Where precast concrete units connect to site work, such as at footings or foundation walls, larger erection tolerances are particularly necessary but the elevation of haunches or corbels needs to be controlled to obtain level floors.

The erection tolerances of architectural precast concrete are given in Fig. 3. After precast concrete erection and before other trades interface any materials with the precast concrete members, it should be verified that the precast concrete elements are erected within the specified tolerances.

Because a panel base connection often allows some positioning flexibility, it is often more important to control dimensions from haunch to haunch in walls or multistory columns rather than to maintain tight control of actual haunch location dimensions from the end of the member.

If reasonable tolerances and adjustments have been designed into the construction details, more precise installation and general improvement in appearance are achieved, and the erector should be able to:

1. Avoid joint irregularities, such as tapered joints (panel edges not parallel), jogs at intersections, and non-uniform joint widths.
2. Maintain proper opening dimensions.
3. Properly execute all fastening connections.
4. Align the vertical faces of the units to avoid out-of-plane offsets.
5. Adjust for the accumulation of tolerances.

The precast concrete erector should perform a survey of the building as constructed and lay out joint centerlines spaced along an elevation prior to actual product installations and center the units between them. This will keep the differential variation in joint width to a minimum, as well as identifying problems caused by building frame columns or beams being out of dimension or alignment. Horizontal and vertical joints should be aligned and uniform joint widths should be maintained as erection progresses.

Variations from true length or width dimensions of the overall structure are normally accommodated in the joints or, where this is not feasible or desirable, at the corner panels, in expansion joints, or in joints adjacent to other wall materials. A liberal joint width should be allowed if variations in overall building dimensions are to be absorbed in the joints. This may be coupled with a closer tolerance for variations from one joint to the next for uniformity of appearance purposes. The individual joint width tolerance should relate to the number of joints over a given building dimension. For example, to accommodate reasonable variations in actual site dimensions, a $^{3}/_{4}$ in. (19 mm) joint may be specified with a tolerance of $\pm\ ^{1}/_{4}$ in. (±6 mm) but with only a $^{3}/_{16}$ in. (5 mm) differential variation allowed between joint widths on any one floor or between adjacent floors.

In a situation where a joint must match an architectural feature (such as a false joint), a large variation from the theoretical joint width may not be acceptable and tolerance for building lengths may need to be accommodated at the corner panels. A similar condition often occurs where precast concrete is interspersed with glass or curtain wall elements, as in precast concrete mullion projects.

Clearance - Clearance is the space provided between the structure and the back surface of precast concrete members. It is one of the most important factors to consider in erection because of its impact on the final appearance of the structure. The clearance space should provide a buffer area where frame, erection, and product tolerance variations can be absorbed. Clearances should be reviewed during the design stages of the project to ensure they are appropriate from both erection and aesthetic points of view.

With reasonable tolerances for the building frame established, it is equally important that the designer provide adequate clearances, for example, between the theoretical face of the structure and the back face of a precast

concrete panel in detailing the panel and its relationship to the building structure. If clearances are realistically assessed, they will enable the erector to complete the final assembly without field-altering the physical dimensions of the precast concrete units. Adjacent materials may include products such as glass or subframes that are installed after the precast concrete panels are in place. If sufficient space is not provided, alignment of the wall as specified will likely necessitate delays and extra costs and alignment may be impossible.

Designing clearances should consider not only the dimensional tolerance of the precast concrete members, but also the dimensional accuracy of the support system (building frame).

The type of member is partially accounted for when product tolerances are considered. There are additional factors that should also be considered. An exposed to-view member requiring small erection tolerances requires more clearance for adjustment than a non-exposed member with a more liberal erection tolerance. Similarly, a corner member should have a large enough clearance so it can be adjusted to line up with both of the adjacent panels.

The size and weight of the member are other considerations in determining erection clearances. Large members are more difficult to handle than smaller ones; a large member being erected by a crane requires more clearance than small member that can be hand-erected or adjusted.

Clearance design should consider member deflection, rotation, and movements caused by temperature expansion and contraction, creep, and shrinkage. Clearance between a vertical member and a horizontal member should allow for some movement in the horizontal member to prevent the vertical member from being pushed or pulled out of its original alignment.

Consideration should be given to the limits of adjustment permitted by the connection details. All connections should provide maximum adjustability in all directions that is structurally or architecturally feasible. When a 1 in. (25 mm) clearance is needed but a 2 in. (50 mm) clearance creates no structural or architectural difficulty, the 2 in. (50 mm) clearance should be selected. Closer tolerances are required for bolted connections than for most grouted connections. To accommodate any misalignment of the building frame, connections should provide for vertical, in-plane lateral, and out-of-plane lateral adjustments of at least 1-$^1/_2$ in. (38 mm). If a connection is attached to a spandrel beam or column that is fireproofed, more clearance will be needed to install fastenings than when the anchors are located on the top surface of beams and the sides of columns. Also, space should be provided to make the connection (sufficient room for welding or adequate space to place a wrench to tighten a bolt).

Nominal clearance dimensions shown on the erection drawings should be equal to the actual clearance required plus the outward tolerance permitted for the adjacent construction, and should be determined based on the assumption that the construction will be as far out of position in the wrong direction as is allowed. Special attention should be given to complex geometric interfaces. Connections should be designed to accommodate the clearance plus tolerance.

If the clearance provided is too tight, erection may be slow and costly because of fit-up problems and the possibility of rework. A good rule of thumb is that at least $^3/_4$ in. (19 mm) clearance should be required between precast concrete members, with 1 in. (25 mm) preferred; 1-$^1/_2$ in. (38 mm) is the minimum clearance between precast concrete members and cast-in-place concrete, with 2 in. (50 mm) preferred. For steel structures, 1-$^1/_2$in. (38 mm) is the minimum clearance between the back of the precast concrete member and the surface of the fireproofing, with 2 in. preferred. If there is no fireproofing required on the steel, then 1-$^1/_2$ in. (38 mm) minimum clearance should be maintained. At least a 1-$^1/_2$ to 2 in. (38 to 50 mm) clearance should be specified in tall structures, regardless of the structural framing materials. The minimum clearance between column covers and columns should be 1-$^1/_2$ in. (38 mm); 3 in. (75 mm) is preferred because of the possibility of columns being out of plumb or a column dimension causing interference with completion of the connection. If clearances are realistically assessed, they will solve many installation problems.

Interfacing Tolerances - Interfacing tolerances and clearances are required for the joining of different building materials in contact with or in close proximity to precast concrete, and to accommodate the relative move-

ments expected between such materials during the life of the building. Typical examples include tolerances for window and door openings; joints, flashing, and reglets; mechanical and electrical equipment; elevators and interior finishes; and walls and partitions.

Fabrication and erection tolerances of other building materials must also be considered in design of the precast concrete units and coordinated to accommodate the other functional elements comprising the total structure. Evaluation of interfacing tolerances should be done during design coordination meetings, preconstruction meetings, and presubmittal coordination. Unusual requirements or allowances for interfacing should be stated in the contract documents.

When the matching of different building elements is dependent on work executed at the construction site, interface tolerances should be related to erection tolerances. When the execution is independent of site work, tolerances should closely match the normal manufacturing tolerances for the materials to be joined plus an appropriate allowance (clearance) for differential volume changes between materials. For example, window elements have installation details that require certain tolerances on window openings in a precast concrete panel. If the opening is completely contained within one panel, can the required tolerances on the window opening be economically met? If not, is it less expensive to procure special windows or to incur the added cost associated with making the tolerances on the window opening more stringent? Also, openings for aluminum windows should allow clearance for some thermal expansion of the frame.

The following installation tolerances developed by the window wall, and window installers and/or associations along with louver tolerances need to be considered to properly interface with precast concrete panels:

Aluminum curtain walls (prefabricated)

Position of components from location shown on the drawings….. ± 1/8 in. (3mm)

Offset alignment between two identical members end to end…..1/16 in. (1.5 mm) max.

Variation from plane…..1/8 in. per 12 ft. (3mm per 3600 mm, or 1/2 in. (12 mm) max. in any length

Variation in diagonal lengths within any rectangular opening in a curtain wall unit….. 1/8 in. (3mm) max.

Variation of mullions from plumb or horizontal in any single run….. ± 1/8 in. in 12 ft (3 mm in 3660 mm) or ± 1/4 in. (6 mm) max.

Out-of-plane offset of horizontal and vertical glazing legs in the same plane …..1/32 in. (0.8mm) max.

Storefront systems, window wall, and entrances in multi-story buildings

Difference in length of diagonals of any rectangular opening……1/8 in. (3mm) max.

Variation in plumb or level……± 1/8 in. in 12 ft (3 mm in 3660 mm), or ± 1/4 in. (6mm) max. in any single run

Aluminum windows

Overall height and width, dimensions 72 in. (1830 mm) and under…..±1/16 in. (1.5 mm)

Overall height and width, dimensions between 72 in. (1830 mm) and 144 in (3660 mm) …..±1/8 in. (3 mm)

Overall height and width, dimensions over 144 in. (3660 mm)…..±3/16 in. (4.5 mm)

Steel windows

Overall height and width of window unit…..±1/16 in. (1.6 mm)

Hollow metal glazed openings

Overall height and width of frame opening…..+1/16 in. (1.6 mm), -1/32 in. (0.8 mm)

Frame depth: ……±1/16 in. (1.6 mm)

Frame face width: …..±1/32 in. (0.8 mm)

Louvers

Opening size $^{1}/_{2}$ in. (13 mm) larger than louver assembly, $^{1}/_{4}$ in. (6 mm) at each side.

It is important to note that interfacing tolerances may be system dependent. For example, windows of one type may have a different interface tolerance than windows of another type. If material or component substitutions are made after the initial design is complete, the responsibility for ensuring that the interface tolerances are compatible with adjacent building materials passes to the party initiating the substitutions.

Adequate interface/erection tolerances are required for window openings, doors, or louvers common to two or more panels. The cost of erecting the panels to achieve required window interface tolerances must also be considered. A similar condition often occurs where precast concrete is interspersed with glass or metal curtain wall elements, as in many precast concrete spandrel or mullion projects.

Product tolerances, erection tolerances, and interface tolerances together determine the dimensions of the completed structure. Which tolerance takes precedence is a question of economics, which should be addressed by considering fabrication, erection, and interfacing cost implications.

Special tolerances or construction procedures require early decisions based on overall project economics. Once these decisions have been made, they should be reflected in the project plans and specifications. All special tolerance requirements or allowances for interface, special details, and special procedures should be clearly spelled out in the specifications. The plans and specifications then define the established tolerance priority for the project.

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Review the learning objectives below.

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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:

understand the three groups of tolerances established for architectural precast concrete;

recognize the architectural precast product tolerances which are standardized within the precast concrete industry;

describe the erection tolerance issues for architectural precast concrete on various framing systems; and

understand interfacing and compatibility issues between architectural precast concrete and other construction materials.

Ascent 2012 – Envelope Tolerances For Architectural Precast

Name (please print): _____

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1. Tolerance, in this article, is defined as
   a. the ability to resist heat and cold without extreme deformation.
   b. a permissible variation from a specified dimension.
   c. a permissible variation from a mix design.
   d. the ability to understand one's in-laws.

2. The primary groups of tolerances discussed in this article are:
   a. product and manufacturing
   b. manufacturing and erection
   c. precast, cast-in-place and steel
   d. product, erection, and interfacing

3. Which of the following is NOT a reason to establish tolerances:
   a. Feasibility
   b. Legal
   c. Visual
   d. All of the above
   e. None of the above

4. Tolerances from a contractual standpoint are developed to establish a known acceptability range and to establish responsibility for developing, achieving, and maintaining mutually agreed tolerances.
   a. True
   b. False

5. Tolerances listed in PCI MNL 135, Tolerance Manual for Precast and Prestressed Concrete Construction, are considered guidelines for an acceptability range and NOT limits for rejection.
   a. True
   b. False

6. At what minimum thickness should a 12' x 10' wall panel's suggested bowing and warping tolerances be reviewed and possibly increased or a mid-point tieback used?
   a. 4 inches
   b. 5 inches
   c. 6 inches
   d. 7 inches

7. Which of the following statements are true?
   a. Product tolerances are not additive to the primary erection tolerances.
   b. Product tolerances, in general, must not exceed erection tolerances
   c. During panel installation, priority is generally given to aligning the exterior face of the panels, to meet aesthetic requirements.
   d. a and c only
   e. all of the above

8. According to Figure 3, what is the tolerance for the joint width?
   a. ±3/8 inch
   b. ±1/4 inch
   c. ±1/8 inch
   d. none of the above

9. There is less potential for erection tolerance controversy in structures utilizing both a precast concrete structural and envelope systems.
   a. True
   b. False

10. When specifying interfacing tolerances between different building elements, which of the following should be taken into account?
   a. Relative movements between the materials
   b. Product tolerances
   c. Erection tolerances
   d. a and c only
   e. All of the above

11. When can interfacing tolerances closely match normal manufacturing tolerances for materials?
   a. When the installation is independent of site work
   b. When the installation is dependent on site work
   c. When the materials have the same coefficient of thermal expansion
   d. When the manufacturer is certified

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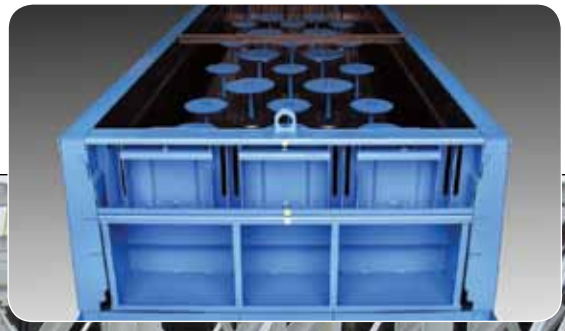
11 CASE STUDY

HAMILTON FORM DELIVERS



The Project:

Unistress Corporation of Pittsfield, MA needed to cast precast slabs for an unusual floor design. The slabs have multiple, variable size holes for ventilation pipes and wire chases for the floor of a 210,000 square foot “clean room” in the new Global Foundries semi-conductor plant in upstate New York. This unusual design called for custom formwork. Unistress called on Hamilton Form.

The Solution:

Hamilton Form designed formwork that was extremely efficient for set-up and stripping. Steel alignment plates are used to precisely form the holes, the end block was designed to accommodate protruding rebar loops and the sideforms pivot back for stripping the slabs that weigh as much as 24 tons each.

The Result:

Innovative formwork simplified what would have been a complex set-up and casting process.

Precast is a highly adaptable, high performance material that allows for a great deal of flexibility in design. The next time your vision requires custom formwork, make sure your precaster calls on Hamilton Form to transform vision into reality.

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Manager, Sustainability Programs

PCI has an opening for manager, sustainability programs, to report to the director of quality and sustainability programs at PCI headquarters in Chicago, Ill. This position will be generally responsible for strategic and tactical management of PCI activities relating to sustainable development for the precast concrete structures industry.

Manager, Codes and Standards

PCI has an opening for manager, codes and standards, to report to the managing director of technical activities at PCI headquarters in Chicago, Ill. This position will be generally responsible for strategic and tactical management of PCI activities relating to the development and improvement of codes and standards that affect the precast concrete structures industry.

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PCI Precast/Prestressed Concrete Institute

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PCI has teamed with **SmartBrief** e-news service to provide a free e-newsletter for architects and other A/E/C professionals. **PCI Buildings Industry SmartBrief** will provide a weekly overview of key information and news in the buildings industry, and provide summaries and direct links to articles that target the needs of buildings industry professionals.

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- Designing with the 7th Edition *PCI Design Handbook*: An Introduction (1 PDH)
- Life Cycle Assessment and How it Can Contribute to Sustainable Design (1 GBCI CE/1 PDH/1 LU)
- Parking Structures: Best Practice to Design, Build, and Maintain (1 PDH/1 LU)
- Quality Assurance - Your Lifeline to a Better Project (1 PDH/1 LU)
- Precast Concrete - Providing Aesthetic Versatility in Color, Form, and Texture (1 PDH/1 LU)
- Designing Building Envelopes to Meet Sustainable and Aesthetic Goals - Part I (1 PDH/1 LU)
- Designing Building Envelopes to Meet Sustainable and Aesthetic Goals - Part II (1 PDH/1 LU)

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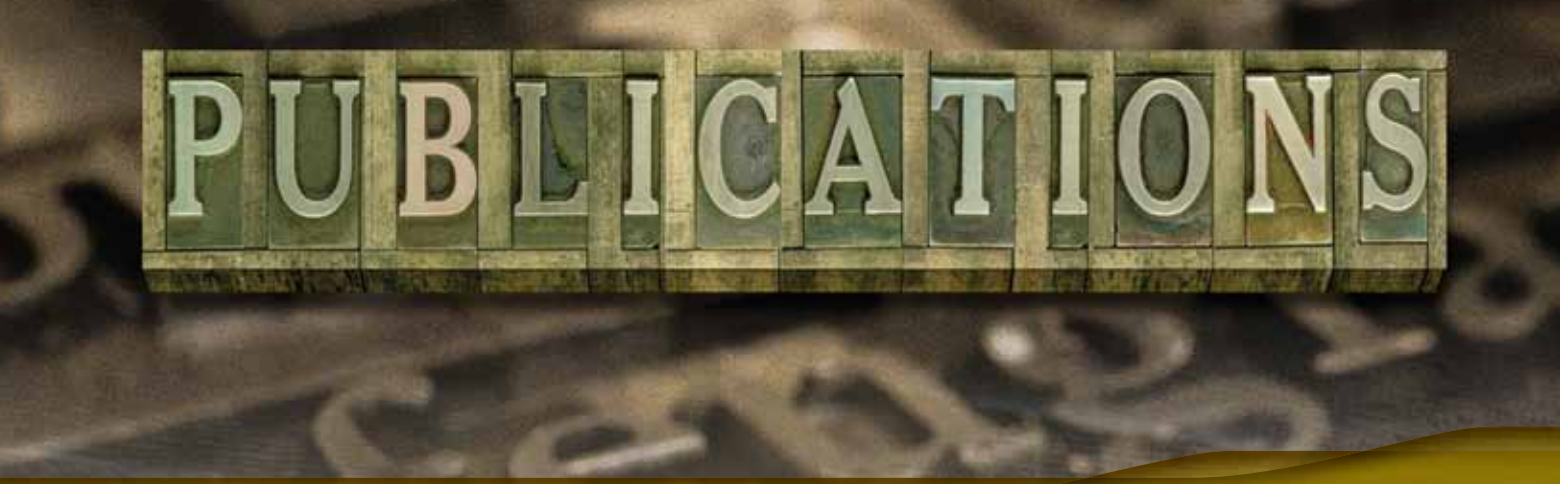


New Publications from PCI

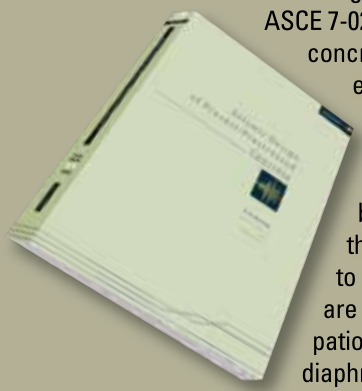
More Sustainable Than Ever: *Architectural Precast Concrete*, 3rd edition

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*, Seventh Edition**. The standard for the design, manufacture, and use of structural precast/prestressed concrete and architectural precast concrete.
MNL-120-10. ISBN: 0978-0-937040-87-4
$390 / PCI Members $195

***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.
MNL-137-06. ISBN: 0-937040-75-4 / 978-0-937040-75-9
$50 / PCI Members $25

***Recommended Practice for Glass Fiber–Reinforced Concrete Panels*, Fourth Edition**. Includes information on planning, preparing specifications, design, manufacture, and installation.
MNL-128-01. ISBN: 0-937040-67-3 / 978-0-937040-67-4
$30 / PCI Members $15

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Upcoming Webinars:

- **Functional Resilience – A Critical Component of Sustainability**
  February 21 and 23, 2012

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

Upcoming Seminars:

- **Quality Control School**
  Level I/II
  May 7-9, 2012, Nashville, Tenn.
  Level III
  May 9-12, 2012, Nashville, Tenn.
  CFA/IES
  May 7-9, 2012, Nashville, Tenn.
  CCA
  May 10, 2012, Nashville, Tenn.

Lunch-and-Learns

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

PCI-Certified Plants

(as of December 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.

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

ALABAMA

Gate Precast Company, Monroeville (251) 575-2803 ..... **A1, C3A**
Hanson Pipe and Precast Southeast, Pelham (205) 663-4681 ..... **B4, C4**
Standard Concrete Products, Theodore (251) 443-1113 ..... **B4, C2**

ARIZONA

Coreslab Structures (ARIZ) Inc., Phoenix (602) 237-3875 ..... **A1, 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**
CTU Precast, Olivehurst (530) 749-6501 ..... **C3**
Hanson Structural Precast, Irwindale (626) 962-8751 ..... **C4**
KIE-CON Inc., Antioch (925) 754-9494 ..... **B4, C3**
Mid-State Precast, L.P., Corcoran (559) 992-8180 ..... **A1, C3A**
StructureCast, Bakersfield (661) 833-4490 ..... **A1, B3, C3A**
Universal Precast Concrete, Inc., Redding (530) 243-6477 ..... **A1**
US Concrete Precast Group /dba Pomeroy, Perris (951) 657-6093 ..... **B4, C2A**
Walters & Wolf Precast, Fremont (510) 226-5162 ..... **A1, G**
Willis Construction Co., Inc., San Juan Bautista (831) 623-2900 ..... **A1, C1, G**

COLORADO

EnCon Colorado, Denver (303) 287-4312 ..... **B4, C2**
Plum Creek Structures, Littleton (303) 471-1569 ..... **B4, C3A**
Rocky Mountain Prestress LLC, Denver (303) 480-1111 ..... **B4, C4**
Rocky Mountain Prestress LLC, Denver (303) 480-1111 ..... **A1, AT, C3A**
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., Quincy (850) 875-4651 ..... **B4, C2**
Cement Industries, Inc., Fort Myers (239) 332-1440 ..... **B3, C3,**
Colonial Construction, Concrete, Precast, LLC, Placida (941) 698-4180 ..... **C2**
Coreslab Structures (MIAMI) Inc., Medley (305) 823-8950 ..... **A1, C4A**
Coreslab Structures (ORLANDO) Inc., Orlando (407) 855-3191 ..... **C2**
Coreslab Structures (TAMPA) Inc., Tampa (813) 626-1141 ..... **A1, B3, C3A**
Dura-Stress, Inc., Leesburg (800) 342-9239 ..... **A1, B4A, C4A**
Finfrock Industries, Inc., Orlando (407) 293-4000 ..... **A1, 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, C3**
Gate Precast Company, Kissimmee (407) 847-5285 ..... **A1**
Metromont Corporation, Bartow (863) 440-5400 ..... **A1, C3**
Oldcastle Precast, Jacksonville (904) 768-7081 ..... **C1**
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, Corrections Div., Conley (800) 849-6383 ..... **C2A**
Tindall Corporation, Prestress Div., 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 ..... **A1, B3, B3-IL, C3A**
Prestress Engineering Corporation, Blackstone (815) 586-4239 **B4, B4-IL, C4**
Spancrete of Illinois, Inc., Crystal Lake (815) 459-5580 ..... **C2**
St. Louis Prestress, Inc., Glen Carbon (618) 656-8934 ..... **B3, B3-IL, C3**
Utility Concrete Products, LLC, Morris (815) 416-1000 ..... **B1A, C1A**

INDIANA

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

IOWA

Advanced Precast Co., Farley (563) 744-3909 ..... **C1A**
Andrews Prestressed Concrete, Inc., Clear Lake (641) 357-5217 ..... **B4, C4**
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**
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**

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

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MASSACHUSETTS

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

MICHIGAN

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, B3, 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

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

MISSISSIPPI

F-S Prestress, LLC, Hattiesburg (601) 268-2006 .....**B4, C4**
Gulf Coast Pre-Stress, Inc., Pass Christian (228) 452-9486 .....**B4, C4**
J.J. Ferguson Prestress-Precast Company, Inc., Greenwood (662) 453-5451 ..**B4**
Jackson Precast, Inc., Jackson (601) 321-8787.....**A1, C2A**
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, C4A**
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**
Montana Prestressed Concrete - MT City Plant, Montana City (406) 442-503 .....**B4**

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, C2A**
Stonco, Inc., Omaha (402) 556-5544.....**A1**

NEW HAMPSHIRE

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

NEW JERSEY

Boccella Precast LLC, Berlin (856) 767-3861.....**C2,**
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., Selkirk (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 .....**B4, C3**

NORTH CAROLINA

Gate Precast Company, Oxford (919) 603-1633 .....**A1, C2**
Metromont Corporation, Charlotte (704) 372-1080.....**A1, C3A**
Prestress of the Carolinas, Charlotte (704) 587-4273 .....**B4, C4**
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.....**C3**
Prestress Services Industries LLC, Grove City (614) 871-2900 .....**B4, C1**
Prestress Services Industries of Ohio, LLC, I-Beam
Mt. Vernon (800) 366-8740 .....**B4, C3**
Prestress Services Industries of Ohio, LLC, Box Beam,
Mt. Vernon (740) 393-1121 .....**B3, C1**
Sidley Precast, Thompson (440) 298-3232.....**A1, C4A**

OKLAHOMA

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

OREGON

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

PENNSYLVANIA

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**
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**
Parker Marine Contracting Corporation, Charleston (843) 723-2727.....**B2**
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**

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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, C3**
East Texas Precast Co., LTD., Hempstead (936) 857-5077 ..... **C4A**
Enterprise Concrete Products, LLC, Dallas (214) 631-7006 ..... **B3, C3**
Gate Precast Company, Hillsboro (254) 582-7200 ..... **A1**
Gate Precast Company, Pearland (281) 485-3273 ..... **C2**
GFRC Cladding Systems, LLC, Garland (972) 494-9000 ..... **G**
Heldenfels Enterprises, Inc., San Marcos (512) 396-2376 ..... **B4, C4**
Lowe Precast, Inc., Waco (254) 776-9690 ..... **A1, C3A**
Manco Structures, Ltd., Schertz (210) 690-1705 ..... **B4, C4A**
North American Precast Company, San Antonio (210) 509-9100 ..... **A1, C4A**
Rocla Concrete Tie, Inc., Amarillo (806) 383-7071 ..... **C2**
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 ..... **B2, C1**
Owell Precast LLC, Bluffdale (801) 571-5041 ..... **B3A, C3**
The Shockey Precast Group, LLC, Harriman (540) 667-7700 ..... **C3**

VERMONT

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

VIRGINIA

Atlantic Metrocast, Inc., Portsmouth (757) 397-2317 ..... **B4, C4**
Bayshore Concrete Products Corporation,
Cape Charles (757) 331-2300 ..... **B4, C4**
Bayshore Concrete Products/Chesapeake, Inc.,
Chesapeake (757) 549-1630 ..... **B4, C3**
Coastal Precast Systems, LLC, Chesapeake (757) 545-5215 ..... **A1, B4, C3**
Metromont Corporation, Richmond (804) 222-8111 ..... **A1, C3A**
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., Precast Div., Spokane (509) 921-8716 ..... **B1**
CXT, Inc., Rail Div., 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, 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**
Wausau Tile Inc., Rothschild (715) 359-3121 ..... **AT**

WYOMING

VAE Nortrak North America, Inc., Cheyenne (509) 220-6837 ..... **C2**

CANADA

ALBERTA

Armtec Limited Partnership, Calgary (403) 248-3171 ..... **A1, B4, C4**

BRITISH COLUMBIA

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

MANITOBA

Armtec Limited Partnership, Winnipeg (204) 338-9311 ..... **B4, C3A**

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

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) 52-665-655-2222º ..... **A1, C1, G**

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PCI-Qualified & PCI-Certified Erectors

(as of December 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

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

CONNECTICUT

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

FLORIDA

Concrete Erectors, Inc., Altamonte Springs (407) 862-7100 ..... **S2, A**
Finfrock Industries, Inc., Orlando (407) 293-4000 ..... **S2, A**
Florida Builders Group, Inc., Miami (305) 278-0098 ..... **S2**
Florida Precast Industries, Sebring (863) 655-1515 ..... **S1**
Gate Precast Erection Co., Jacksonville (904) 757-0860 ..... **A**
Gate Precast Erection Co., Kissimmee (407) 847-5285 ..... **A**
Jacob Erecting & Construction LLC, Jupiter (561) 741-1818 ..... **S2, A**
James Toffoli Construction Company, Inc., Fort Myers (239) 479-5100 ..... **S2, A**
Pre-Con Construction of Tampa Inc., Tampa (813) 626-2545 ..... **S2, A**
Solar Erectors U. S. Inc., Medley (305) 825-2514 ..... **S2, A**
Specialty Concrete Services, Inc., Altoona (352) 669-8888 ..... **S2, A**
Structural Prestressed Industries, Inc., Medley (305) 556-6699 ..... **S2**
Summit Erectors, Inc., Jacksonville (904) 783-6002 ..... **S2, A**

GEORGIA

Big Red Erectors Inc., Covington (770) 385-2928 ..... **S2, A**
ConArt Precast, LLC, Cobb (229) 853-5000 ..... **S2, A**
Jack Stevens Welding LLP, Murrayville (770) 534-3809 ..... **S2**
Precision Stone Setting Co., Inc., Hiram (770) 439-1068 ..... **S2, A**
Rutledge & Son's, Woodstock (770) 592-0380 ..... **S2**

IDAHO

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

ILLINOIS

Area Erectors, Inc., Rockford (815) 562-4000 ..... **S2, A**
Creative Erectors, LLC, Rockford (815) 229-8303 ..... **S2, A**
Mid-States Concrete Industries, South Beloit (800) 236-1072 ..... **S2**
Spancrete of Illinois, Inc., Crystal Lake (815) 459-5580 ..... **S2**

IOWA

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

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KANSAS

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

LOUISIANA

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

MAINE

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

MARYLAND

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

MASSACHUSETTS

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

MICHIGAN

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

MINNESOTA

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

MISSISSIPPI

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

MISSOURI

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

NEBRASKA

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, A**

NEW HAMPSHIRE

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

NEW JERSEY

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

NEW MEXICO

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

NEVADA

Cedco Commerical, LLC, Las Vegas (702) 361-6550 ..... **A**

NEW YORK

Arben Group LLC, Pleasantville (914) 741-5459 ..... **S2**
Empire Constructors LLC, Pittsford (585) 586-1510 ..... **A**
J.C. Steel Corp., Bohemia (631) 563-3545 ..... **A**
Koehler Masonry, Farmingdale (631) 694-4720 ..... **S1**
Oldcastle Building Systems Div. / Project Services,
Manchester (518) 767-2116 ..... **S2, A**
Oldcastle Building Systems Div. / Project Services,
Selkirk (518) 767-2116 ..... **S2, A**

NORTH CAROLINA

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

NORTH DAKOTA

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

OHIO

Ben Hur Constructionn Company, Fairfield (513) 874-9228 ..... **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**
Bennett 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**
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High Concrete Group, Denver (717) 336-9300 ..... **S2, A**
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Nitterhouse Concrete Products, Inc., Chambersburg (717) 267-4505 ..... **S2**
Patterson Construction Company, Inc., Monongahela (724) 258-4450 ..... **S1**

SOUTH CAROLINA

Davis Erecting & Finishing, Inc., Greenville (864) 220-0490 ..... **S2, A**
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Tindall Corporation, Fairforest (864) 576-3230 ..... **S2**

TENNESSEE

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TEXAS

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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

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

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Spancrete, Valders (920) 775-4121 ..... **S2, A**
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