JVI

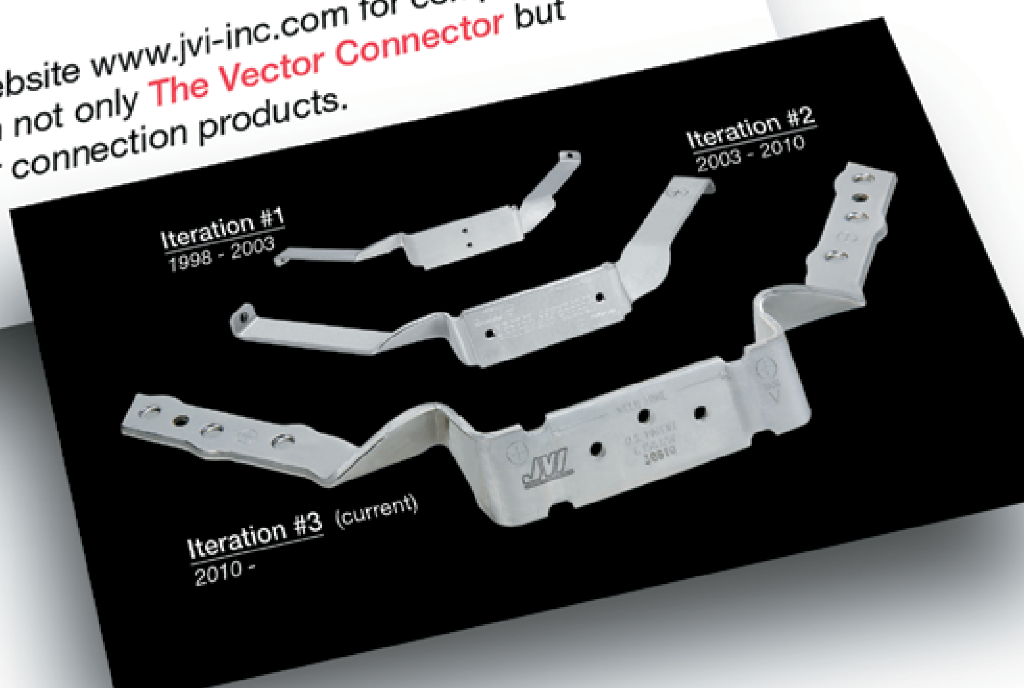
To: Precasters, Design Firms, All interested parties
From: JVI, Inc.
Re: Nomenclature clarification

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.

These two products serve most shear/alignment connection requirements for precast double tees, wall panels, and slabs. Together, they continue the tradition of being the state-of-the-art of connection technology.

Consult our website www.jvi-inc.com for complete information on not only The Vector Connector but also our other connection products.



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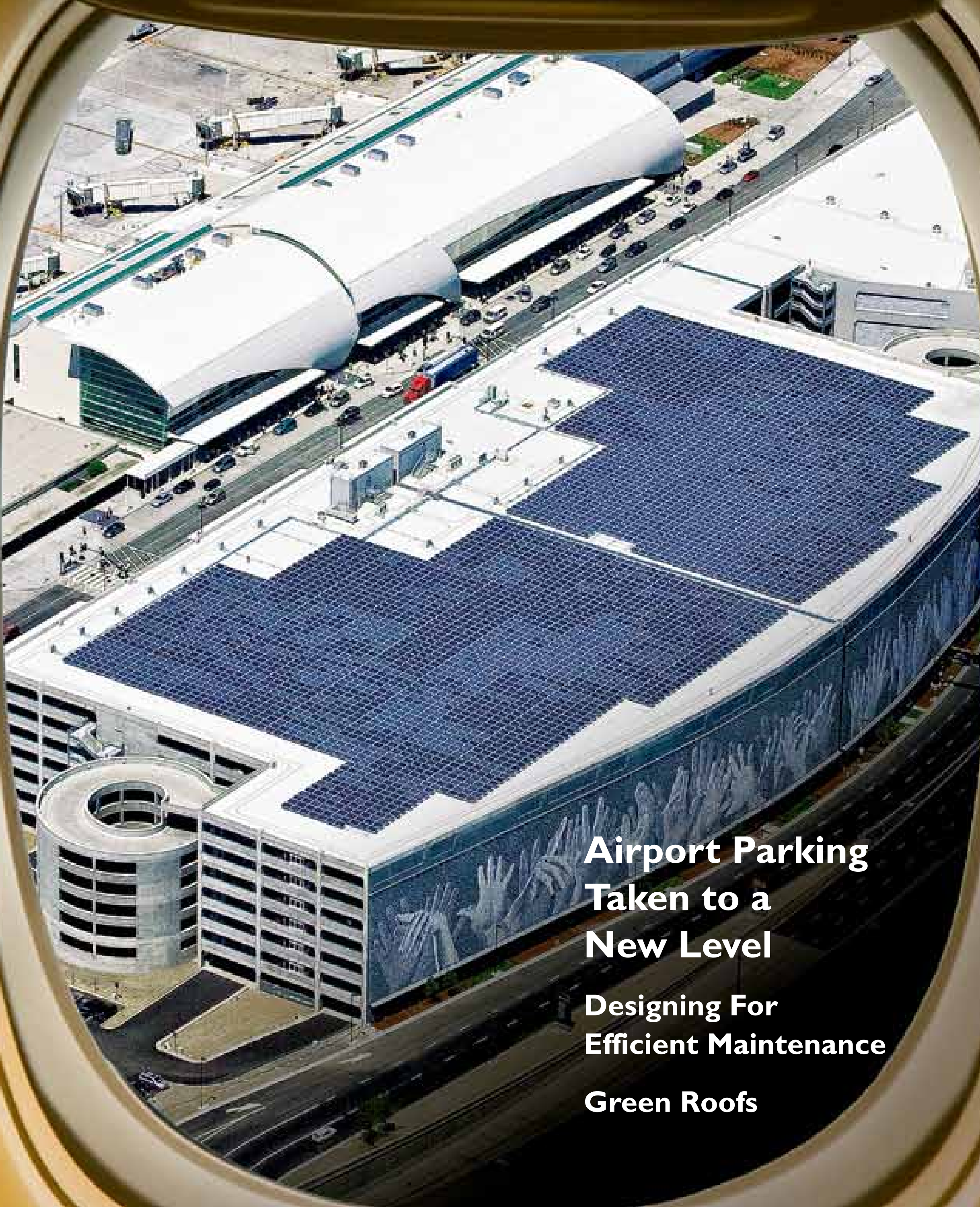

Airport Parking Taken to a New Level

Designing For Efficient Maintenance

Green Roofs

CONTINUING EDUCATION AIA

AIA Education Program Inside
page 49

WWW.PCI.ORG

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In 2008, the National Renewable Energy Laboratory (NREL) set out to create a Zero Energy office building so efficient that the facility and its 800 occupants would consume only the amount of energy generated by renewable power on and near the building.

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Our System NC insulation products were selected for the precast concrete sandwich panels to create a durable, energy efficient envelope that uses thermal mass to moderate the building's internal temperature.

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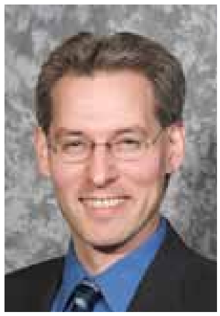
Innovation in Design, and in Learning



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

Since its introduction, America has had a love affair with the automobile, and that love will not abate—as recent high gas prices have shown. This relationship, which continues to grow, greatly impacts our infrastructure and built environment. For example, we need places to park the increasing number of automobiles as people drive to work, school, shops, movies, their condos, etc. A key concern today has become how we accomplish this in a sustainable way.

Sustainably-designed parking structures can reduce expansive land use for surface parking, minimize heat island effects, and reduce negative impact to the environment. This issue of *Ascent* offers a series of articles to help designers meet sustainable design requirements and achieve LEED Certification, provide greenery, and reduce life-cycle costs. There are also some fantastic project photos in our new photo book section, "The Aesthetic Versatility of Precast," on pages 34-37.

However, parking structures are only one building category requiring new ideas to meet owners' demands. These demands help drive the need for ongoing continuing education. PCI offers a variety of continuing education programs, including an article in each issue of *Ascent*. Simply read the article, take the test at the end, and submit it to PCI for C.E. credit. This issue's article is on *Acceptability of Appearance*, starting on page 49.

Expanding on that need, PCI has introduced the **PCI eLearning Center**. This online system provides free, continuing-education courses 24 hours a day, 7 days a week that can be used from the comfort of your own office, home, or beach chair, if you are so lucky.

Courses are registered with the American Institute of Architects for Learning Units. Additionally, courses qualify for Professional Development Hours (PDHs) in all 50 states and you can print your certificate when you have completed a test. Some courses also qualify for USGBC credit, which is now required for maintaining your LEED AP credentials.

Already there are seven great courses posted, with new courses being added often. There is even a course on parking structure design. To learn more and set up your personal account visit www.pci.org/elearning.

PCI also offers free, monthly webinars on a variety of topics. May's webinar is on the History of the Parking Structure and June's is on Sustainable Design of Parking Structures. To register, and for more information, visit www.pci.org/webinars.

These programs can help ensure that you remain on the cutting edge of new technologies and design ideas that will aid in meeting owners' goals.

PCI
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Precast/Prestressed Concrete Institute

ASCENT On the cover: San Jose International Airport (see page 42)

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PCI Launches eLearning Center

CHICAGO, ILLINOIS

The **Precast/Prestressed Concrete Institute (PCI)** has launched the PCI eLearning Center, a free 24-hour online education resource providing architects and engineers an opportunity to earn continuing education credits on demand.

The PCI eLearning Center is the first education management system dedicated to the precast concrete structures industry. Visitors can create a personal profile and gain access to a growing number of online courses. Each course includes a webinar presentation, pertinent reference materials and a quiz. All courses offer continuing education credit in all 50 states and are registered with organizations that include AIA, NCEES and USGBC.

"PCI is proud to offer this outstanding new program to design professionals," said PCI President James G. Toscas, P.E. "They can easily log on, view a one-hour webinar course at any time, and then complete a quiz for continuing education credit."

Seven courses are available, with new courses added frequently. Several current courses focus on precast concrete's role in sustainability. Current course offerings comprise:

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

Check out the PCI eLearning Center at www.pci.org/elearning.

Dorms To Use Horizontal Load-bearing Enclosure Panel

DENVER, PENNSYLVANIA

Montclair State University dorms will be clad with load-bearing, thermally efficient CarbonCast walls provided by **High Concrete Group LLC** of Denver, Pa. The wall system encapsulates three inches of rigid foam insulation between concrete wythes secured with carbon-fiber shear truss to deliver a uniform R value of 15. The interior wythes of these architecturally detailed horizontal panels are thickened to 6" for to accommodate their unique structural load-bearing condition.

The design architect on the project is **Design Collective Inc.** of Baltimore, Md. while **PS&S** of Warren, N.J., is the architect of record. Terminal Construction Co. of Wood-Ridge, N.J., serves as general contractor.

EnCon Utah Awarded Correctional Project

TOOELE, UTAH

EnCon Utah has begun erection of precast concrete components for the Tooele County Correctional Facility project. The design-build team on the project also includes construction-services company Sahara Inc. in Bountiful, Utah, as well as **GSBS Architects** and DUNN & Associates Engineers, both in Salt Lake City, Utah, and EnCon Design LLC in Denver.

EnCon Utah is serving as a member of the design team, participating in budget decisions and working with the design-build team to maintain budget and schedule parameters. The project comprises 273 precast pieces (57,000 square feet) of wall panels, consisting of interior solid precast wall panels and exterior CarbonCast insulated load-bearing structural shear wall panels — the first to be used in Utah. The panels will provide an R-19 steady-state panel with no thermal bridges.

Oldcastle Adds Two Correctional Projects

TELFORD, PENNSYLVANIA

Oldcastle Precast Modular is providing modular precast concrete prison cells and building components for two projects underway. They are the $71 million, 330,000-square-foot expansion of the Chatham County Detention Center in Georgia and the new State Correctional Institution Graterford East and West project in Pennsylvania. The $365 million prison will be one of the largest correctional projects in progress in the United States.

The Chatham County project is being directed by Hunt/Mills, a joint venture (Hunt Construction Group and WG Mills). The center was designed by Pennsylvania-based L. Robert Kimball & Associates. The expansion will add 852 inmate beds in two- and four-level housing pods to the center, which currently has 1,224 beds. The added facilities are needed to eliminate temporary housing units used for an overflow population of inmates.

Oldcastle Precast Modular is supplying fully outfitted rear-chase precast cells, which will include electrical fixtures, detention furniture; plumbing fixtures and interior wall paint. Each of the 280 two-bunk precast cells is designed with a rear chase so maintenance personnel can access mechanical systems without disrupting daily routines. Oldcastle will also supply the unique 144 rear-chase, four-bed dorm rooms, 80 multi-purpose rooms and 88 plenum modules.

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

Walsh Construction and Heery International (Walsh/Heery Joint Venture) are the principal builders on the project, while the project architects are **Astorino, Heery Design Group** and **KZF Design**. The project is part of a state-wide initiative to add 9,000 beds to the state prison system. The prison, designed to be the state's first to be LEED-certified, is tentatively planned to open in 2014.

Finfrock Builds Parking for Virginia Development

ORLANDO, FLORIDA

Finfrock Construction Inc. has been commissioned by Edens & Avant to deliver a parking garage for Mosaic, a 31-acre mixed-use development designed to revitalize the Merrifield area of Fairfax County, Va. Mosaic will contain more than 400,000 square feet of retail, 1,000 residential units, 65,000 square feet of office, two parks, two boutique hotels and an eight-screen arthouse cinema.

Finfrock is providing complete design-build services for the $12 million, seven-level garage. Construction began in March and will be completed in November.

Tindall Receives Certification For Wind-Tower Base

SPARTANBURG, SOUTH CAROLINA

Tindall Corp. has received certification from Germanischer Lloyd for the Atlas CTB Concrete Tower Base. The certification allows the wind industry to extend hub heights above 100 meters to generate more power using the precast concrete tower base.

The Atlas CTB met guidelines for erection of a prototype based on a plausibility check of the design documentation. "The Atlas CTB will enable our customers to take advantage of stronger, steadier winds that generate more renewable power," says Chairman William Lowndes III.

High Concrete Group Selected For Dulles Metrorail

DENVER, PA

High Concrete Group LLC is producing architectural-cladding enclosures for the new Dulles Corridor Metrorail Project. Planned for completion in 2013, the 325,000-square-foot transit project includes thermally efficient precast enclosures for five new metro-station buildings, six entrance pavilions and two ventilation structures. Erection started this spring.

The cladding will feature a utility-size brick-veneer finish in two colors. About one third of the panels consist of CarbonCast insulated-sandwich designs that provide continuous insulation for thermal efficiency. High Concrete Group was awarded the $20-million contract by **Dulles Transit Partners**, LLC of Vienna, Va., which is the project designer, engineer and general contractor.

Stresscon Building Museum & Discovery Science Center

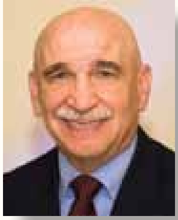
DENVER, COLORADO

Stresscon Corp., an Encon Company firm, erected the precast concrete walls for the new Fort Collins Museum & Discovery Science Center. Hensel Phelps, the general contractor for the project, is constructing the building for the city of Fort Collins and using the EnCon Companies' 7-inch-thick Structural Plus Walls (cinnamon color) for the shell.

The walls, manufactured at the Stresscon plant in Dacono, Colo., consist of 97 individual precast concrete sections, the largest of which is 42 feet tall. Construction on the walls was completed six days ahead of schedule in January. The unique building is laid out like a piano, creating complex angles for serpentine walls, but the wall panels avoided any field issues.

Metromont Acquires Royal Concrete Concepts

GREENVILLE, SOUTH CAROLINA



– *Wally Sanger*

Metromont Corp. has acquired a majority interest in **Royal Concrete Concepts** (RCC) in West Palm Beach, Fla. The transaction will leverage each firm's market-leading technologies to create broader solutions for a growing customer base in the eastern United States and overseas.

Royal Concrete Concepts was founded in 1989 by Wally Sanger and manufactures custom precast concrete modular building systems for residential, educational, commercial and military projects. It also provides turn-key construction services for both domestic and international markets.

Waffle-Crete Portable System Aids Haiti Reconstruction

HAYS, KANSAS

Construction Demathieu & Bard (CDB) has selected the Waffle-Crete portable precast concrete building system produced by **Waffle-Crete International Inc.** as one of the core elements of its strategy for Haiti's reconstruction effort. The island was struck by deadly earthquake in January 2010, followed by widespread flooding in November.

The system has passed rigorous testing for extreme wind and seismic loads, a prerequisite for its selection. A key benefit is that Waffle-Crete wall and roof panels can be cast directly on the job site one day and erected the next. Due to these benefits, the company focuses its marketing efforts exclusively on disaster-resistant construction.

A.L. Patterson Forms Precast Division

FAIRLESS HILLS, PENNSYLVANIA

A.L. Patterson, Inc. has created the **ALP Precast Division** and named Skip Francies as its president. Francies, a 40-year veteran of the precast concrete industry and the holder of 14 patents, will be responsible for sales, marketing, product development and services throughout North America.

Gate Concrete Creates Uniform Name

JACKSONVILLE, FLORIDA

Gate Construction Materials Group has announced that all eight of its manufacturing facilities will operate under the name of **Gate Precast Co**. The company's two structural-precast concrete plants in Jacksonville, Fla., and Pearland, Texas, had used a different name since 1980. The name change will lead to a more cohesive marketing and sales approach for the group, a spokesman said.

Wells Concrete Names New CEO

WELLS, MINNESOTA

Dan Juntunen has been named president/CEO of Wells Companies, including **Wells Concrete**, effective immediately. He joined the company as Chief Financial Officer in March 2007. The financial/accounting role Dan vacated will be filled at a later date as he completes his transition.

High Concrete Group Installs Water Delivery Equipment

DENVER, PENNSYLVANIA

High Concrete Group LLC, an affiliate of High Industries Inc., has invested $275,000 in high-efficiency water heating, chilling and recovery equipment for its Denver, Pa., headquarters' manufacturing operations.

The system delivers water to the company's concrete batching operations to achieve ideal concrete-casting temperature throughout the year. In cold weather, it also supplies process water for heat-curing of the company's precast double tees for parking garages.

"This new system conserves precious water and energy, allowing us to hit our emissions reduction targets while setting the stage for growth says Rick Scheetz, company president. High Concrete Group has set a target of reducing emissions at its Denver facility by more than 18% compared to its 2007 emissions.

Metromont Names New Vice President

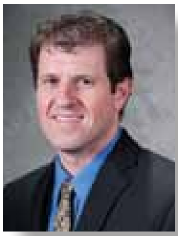
GREENVILLE, SOUTH CAROLINA

– *Chris Pastorius*

Metromont Corp. had named Chris Pastorius as its vice president of sales and estimating. Prior to joining Metromont, Pastorius spent 20 years with Oldcastle Precast, holding several senior management positions. He also serves as a Board member for the Prestressed/Precast Concrete Institute and is the immediate past-chairman of AltusGroup.

Enterprise Precast Concrete Hires Regional Director

KANSAS CITY, MISSOURI



– *Dirk McClure*

Enterprise Precast Concrete Inc. has opened a sales office in Kansas City and hired Dirk McClure, LEED AP, Assoc. AIA, CSI, to manage the sales territory of Missouri, Kansas, and Oklahoma. McClure will work with John Arehart, Enterprise's vice president and general manager, to develop sales and client relationships.

Nitterhouse Adds To Sales Staff

CHAMBERSBURG, PENNSYLVANIA

– *Justin J. Lyons*

Justin J. Lyons will be developing sales for **Nitterhouse Concrete Products** in the New Jersey and New York City areas, replacing Daryl S. Wenger, who has retired. Lyons has been with Nitterhouse for five years and formerly worked as a union contractor specializing in precast concrete erection.

ASCC Elects Officers and Directors

ST. LOUIS, MISSOURI

Clay Fischer, president of Woodland Construction Co. in Jupiter, Florida, has been elected president of the American Society of Concrete Contractors for 2011-2012.

Elected vice presidents were Scott Anderson of Houston, Texas; Chris Plue of San Mateo, California; Mike Poppoff of Moxie, Washington and Thomas Zinchiak of Woodbine, Marylamnd.Harry Moats of Marietta, Georgia, was re-elected secretary/treasurer. Newly elected directors comprise William Bramschreiber of Pasadena, California; Chris Forster of Santa Monica, California; and Rocky Geans of Mishawaka, Indiana.

The Decorative Concrete Council, a specialty council of the ASCC, re-elected Frank Lewis, regional manager of The Coatings Group in Arlington, Texas, as council director. Paul Schneider of Cincinnati, Ohio, was re-elected secretary/treasurer.

The ASCC Safety & Risk Management Council elected Steve Pereira of Professional Safety Associates in Denham Springs, Louisiana, as council director and Scott Winkler of Ceco Concrete Construction in Hamilton, Ohio as secretary/treasurer.

For more information visit www.ascconline.org.

Metromont Supplies Wall Panels for Advance Education HQ

ALPHARETTA, GEORGIA

Advance Education (AdvancED), an educational accreditation organization, is using Carboncast high-performance insulated wall panels from **Metromont Corp.** in the construction of its $10.5 million, 60,000-square-foot corporate headquarters. The precaster will supply 15,100 square feet of wall panels to contribute to energy and cost savings while enhancing aesthetics.

Each exterior precast panel is comprised of inner and outer concrete wythes connected by epoxy-coated fiber grid for shear transfer. The wall panels incorporate 4 inches of EPS insulation for an R-12 value to meet ASHRAE-90.1 requirements for a mass wall with continuous insulation.

The façade incorporates both a retarded and sandblasted finish. For dramatic entryways, polished granite veneer was cast into the wall panel and attached with stainless steel pins. Casting the granite into the wall at the plant sped the schedule and reduced the number of workers on site. The panels were fabricated at Metromont's Hiram, Ga., plant.

The design firm is **Warren Epstein & Associates Architects Inc.** in Atlanta, while R. J. Griffin in Atlanta is serving as general contractor.

Spancrete Adds Two To Sales Force

WAUKESHA, WISCONSIN

– Augustine Chung

– Clinton Krell

Spancrete has added Augustine "Auggy" Chung and promoted Clinton Krell to fill out its sales team in Wisconsin and Illinois. Chung, LEED AP, will serve as a sales manager for the Chicagoland area. Krell, who joined Spancrete 11 years ago, was named sales representative covering southwest Wisconsin. Most recently he served as the director of precast project development and education.

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

WHO **ATTENDS?**

Attendees are decision-makers representing all segments of the parking and transportation industry including:

- building owners
- hospital and medical center parking personnel
- municipal officials
- college and university parking personnel
- procurement officers
- commercial operators
- airport parking officers
- all others charged with the daily management of their parking operations

TRACK **EDUCATION**

- Best Practices (1 & 2)
- Sustainability/Transportation
- Technology
- Metrics

JUSTIFICATION **TOOLKIT**

You probably recognize the value of attending the IPI Conference & Expo, so we'd like to offer you some tools to help convince your supervisor and organization to approve the cost.

- How to calculate ROI
- Tips on presenting value to your organization
- Justification letter for your supervisor
- Cost comparison & real value of the expo

WHAT'S **NEW?**

Pre-Conference Workshops

NEW to the 2011 IPI Conference & Expo, our pre-conference workshops will allow parking professionals of all levels of expertise to expand their knowledge in hands-on, interactive and concentrated session. The Frontline Bootcamp will present an Overview of Parking and focus on Customer Service and Enforcement. The Senior Level Symposium will discuss industry trends and feature breakout problem-solving group discussions.

Bring a Friend & Save $100

For groups of three or more, take $100 off the third-tenth full attendee registration from your organization!

Business Connection Portal

Online tool providing ease of networking between vendors and attendees who are looking for product matchmaking, assistance in setting up appointments or just to reconnect with colleagues in the onsite connection lounge!

Expanded Facility Tours

Now offering four great jam packed facility operation tours over two days – included with your full registration!

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BLOCKS AVAILABLE - ROOM RATE: $189!

REGISTER INSTANTLY

www.parking.org/conference

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SCHEDULE **AT-A-GLANCE**

Saturday, May 21

8:00 am – 5:00 pm	CAPP Course
12:00 pm – 5:30 pm	Annual CAPP Classic Golf Tournament

Sunday, May 22

8:00 am – 5:00 pm	CAPP Course
9:00 am – 12:30 pm	Senior Level Symposium
12:30 pm – 4:00 pm	Frontline Bootcamp
1:00 pm – 2:30 pm	Shoptalks (4)
2:45 pm – 3:45 pm	Educational Sessions (5)
4:00 pm – 5:30 pm	Welcome Keynote & Professional Recognition Program Awards
5:30 pm – 6:00 pm	New Member/First Timer Orientation
5:30 pm – 7:30 pm	"Meet & Mingle" Reception **Expo Hall Open**

Monday, May 23

8:00 am – 10:00 am	Breakfast Keynote & Award of Excellence Recognition
8:00 am – 6:00 pm	CAPP Course
10:00 am – 1:30 pm	**Expo Hall Open**
1:45 pm – 4:00 pm	Educational Sessions (10)
6:00 pm – onward	Open Night for Vendors to Entertain Clients

Tuesday, May 24

8:00 am – 9:30 am	General Session & 2011 CAPP Graduation
8:00 am – 11:00 am	Facility Tours (off property)
9:00 am – 6:00 pm	CAPP Course
9:00 am – 12:00 pm	Educational Sessions (10)
12:00 pm – 3:30 pm	**Expo Hall Open**
3:45 pm – 4:45 pm	Educational Sessions (5)
5:45 pm – 10:00 pm	Industry Event: "Take Me Out to the Ballgame!"

Wednesday, May 25

8:00 am – 5:00 pm	CAPP Course
8:00 am – 9:30 am	General Session
8:00 am – 11:00 am	Facility Tours (off property)
9:45 am – 12:00 pm	Educational Sessions (10)
12:00 pm – 3:00 pm	**Expo Hall Open**
3:15 pm – 4:45 pm	Shoptalks (4)
3:15 pm – 4:45 pm	Sustainability Workshop

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Sustainable Opportunities for Parking Structures

Green building techniques can greatly enhance projects' sustainable strategies and contribute to achieving LEED points

— By Kathy Buck, LEED-AP BD+C, Neumann/Smith Architecture

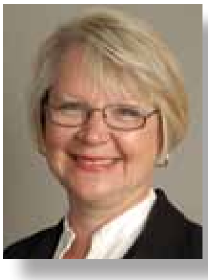
Precast concrete construction, including parking structures, can contribute in a variety of ways toward good sustainable design and LEED certification. A key way for parking structures to raise their contributions to sustainable design and LEED certification can come from an area often overlooked, creating a significant missed opportunity: creating a green roof and otherwise taking advantage of the upper deck or roof of the structure to provide added renewable-energy resources.

Incorporating a green roof onto a parking structure contributes significantly to the project's ability to meet its sustainable goals. Providing a roof over lower parking levels extends the deck's serviceable life by eliminating the need to remove snow with mechanical means or the use of chemicals and salts, minimizing the deleterious and corrosive nature of those materials on the deck structure.

Providing a green roof over parking can create useable space for occupants, such as contemplative spaces, eating/picnic areas and other activity uses.

Vegetated roofs can provide an urban habitat for birds and insects that are essential to a bio-diverse environment as well as provide a more attractive vista when viewed from taller buildings.

The Blue Cross Blue Shield of Michigan parking structure features a 1/10th mile walking track, the use of which has been incorporated into a corporate-sponsored health and fitness program offered to its employees.



– Kathy Buck, LEED-AP BD+C, is a senior project manager and associate at Neumann/Smith Architecture in Southfield, Mich. She served as project manager on the BCBS parking structure.

Certified Parking Project

An example of what can be accomplished is the Blue Cross Blue Shield of Michigan (BCBSM) parking structure in Detroit. On October 23, 2007, that total-precast concrete structure was awarded LEED certification under LEED's v2.1 Rating System. It achieved 27 points out of 69 possible required under that version of the rating system, which qualified it as Certified. (See the accompanying LEED scorecard and sidebar on current LEED requirements.)

BCBSM officials were aggressive in incorporating sustainable-design ideas into the structure. The company is committed to making "green" and sustainable design an integral part of how they do business every day. BCBSM elected to incorporate a 1/10th mile walking track, the use of which has been incorporated into corporate-sponsored health and fitness programs offered to employees.

Showers and locker/changing rooms are provided at the ground level of the deck. The selection of other materials on the roof, such as the track materials, include the use of recycled rubber products, which can further decrease the use of virgin materials.

Planting Choices

Green roof systems are classified as being either "extensive" (those with relatively shallow soil profiles of less than 6 inches) or "intensive" (those with soil profiles of 6 inches and above). Each system is capable of hosting a vast assortment of plant materials although intensive systems offer an opportunity for a much broader use of

The BCBSM parking structure features eight varieties of low-growing sedum in 2 to 3 inches of growing medium over drainage layers. The saturated weight of the system is approximately 15 psf.

grasses, flowers and even shrubs and trees. However, extensive systems also afford a wide selection of lower growing grasses and sedum, which are more drought-tolerant selections.

The 52,307-square-foot green roof on the nine-story BCBSM parking structure was the second largest green roof in Michigan (following the Ford Motor Co. Rouge Plant roof). It features an extensive system of eight varieties of low-growing sedum in 2 to 3 inches of growing medium over drainage layers. The saturated weight of the system is approximately 15 psf, although this can vary widely between projects depending on the overall composition of the system and materials selected.

At BCBSM, the large sections of vegetated sedum matts were installed much like conventional sod over a drainage fabric. It allows for the collection of water above an Ethylene Propylene Diene Monomer (EPDM) membrane that was fully adhered to the precast concrete roof's double-tee structure.

When planning for green roofs, consideration must be given to the use of the space below. Factors include conditioning requirements (if it's an occupied space in a multi-use project), accessibility issues (for access to repairs from below the roof structure, if required) and longevity

Sustainable Suggestions

Additional ways that designers can incorporate sustainable strategies into precast concrete or cast-in-place concrete parking structures include:

- Give strong preference to regional materials.
- Consider concrete mix designs that incorporate materials such as fly ash, slag cement and recycled aggregates that in total will reduce the use of raw/new materials and also reduce the amount of materials disposed of in landfills.
- Work with the contractor to encourage construction-waste programs that will emphasize recycling and reduce the use of materials being sent to landfills.
- Include carbon-dioxide monitoring for regularly occupied spaces of the deck/ building.
- Include battery-charging stations within the deck for electric cars.
- Designate preferred parking spaces for carpools, vanpools, fleet cars and for low-emission vehicles (LEVs).
- Design the parking structure to be a code-defined Open Deck structure that does not require mechanical ventilation for the parking areas, reducing overall energy consumption.
- Incorporate smart lighting systems including sensors, controls and ties to building automation systems and security to maximize use of natural daylight.
- Consider finish materials, paints, adhesives and sealants that are low in volatile organic compounds (VOCs) that can be detrimental to workers and building occupants.
- Encourage the creation of dense and sustainable parking structures to minimize the amount of inefficient surface parking.

Sustainable opportunities are not limited to how they interact with the concrete structures. Thoughtful location of projects in urban environments where there is previously developed land with existing infrastructure vastly reduces the use of new resources and the demand put onto utility systems.

The use of remediated Brownfield sites allows redevelopment of underutilized land. Locating projects near public transportation and community services lessens the emphasis on automobiles while strengthening the local economy. Offering employees opportunities to ride bikes and safely store their bicycle equipment securely on site also reduces the impact of autos while promoting health and fitness.

These concepts can make a contribution toward LEED credits and subsequently encourage the reduction of energy use.

LEED for New Construction v2.0/2.1

BCBS of Michigan
Project # 10002520
Certification Level: Certified
10/23/2007

27	**Points Achieved**		Possible Points: **69**
	Certified 26 to 32 points	Silver 33 to 38 points	Gold 39 to 51 points / Platinum 52 or more points

10 Sustainable Sites — Possible Points: 14

Y			
Y	Prereq 1	**Erosion & Sedimentation Control**	
1	Credit 1	**Site Selection**	1
1	Credit 2	**Development Density**	1
1	Credit 3	**Brownfield Redevelopment**	1
1	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
	Credit 4.4	**Alternative Transportation**, Parking Capacity & Carpooling	1
	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
1	Credit 6.1	**Stormwater Management**, Rate & Quantity	1
1	Credit 6.2	**Stormwater Management**, Treatment	1
1	Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
1	Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
	Credit 8	**Light Pollution Reduction**	1

2 Water Efficiency — Possible Points: 5

Y			
1	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
	Credit 2	**Innovative Wastewater Technologies**	1
	Credit 3.1	**Water Use Reduction**, 20% Reduction	1
	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Energy & Atmosphere — Possible Points: 17

Y			
Y	Prereq 1	**Fundamental Building Systems Commissioning**	
Y	Prereq 2	**Minimum Energy Performance**	
Y	Prereq 3	**CFC Reduction in HVAC&R Equipment**	
	Credit 1.1	**Optimize Energy Performance**, 15% New / 5% Existing	1
	Credit 1.2	**Optimize Energy Performance**, 20% New / 10% Existing	1
	Credit 1.3	**Optimize Energy Performance**, 25% New / 15% Existing	1
	Credit 1.4	**Optimize Energy Performance**, 30% New / 20% Existing	1
	Credit 1.5	**Optimize Energy Performance**, 35% New / 25% Existing	1
	Credit 1.6	**Optimize Energy Performance**, 40% New / 30% Existing	1
	Credit 1.7	**Optimize Energy Performance**, 45% New / 35% Existing	1
	Credit 1.8	**Optimize Energy Performance**, 50% New / 40% Existing	1
	Credit 1.9	**Optimize Energy Performance**, 55% New / 45% Existing	1
	Credit 1.10	**Optimize Energy Performance**, 60% New / 50% Existing	1
	Credit 2.1	**Renewable Energy**, 5%	1
	Credit 2.2	**Renewable Energy**, 10%	1
	Credit 2.3	**Renewable Energy**, 15%	1
	Credit 3	**Additional Commissioning**	1
	Credit 4	**Ozone Depletion**	1
	Credit 5	**Measurement & Verification**	1
	Credit 6	**Green Power**	1

6 Materials & Resources — Possible Points: 13

Y			
Y	Prereq 1	**Storage & Collection of Recyclables**	
	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
	Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1
	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
1	Credit 2.1	**Construction Waste Management**, Divert 50%	1
1	Credit 2.2	**Construction Waste Management**, Divert 75%	1
	Credit 3.1	**Resource Reuse**, Specify 5%	1
	Credit 3.2	**Resource Reuse**, Specify 10%	1
1	Credit 4.1	**Recycled Content**, Specify 5%	1
1	Credit 4.2	**Recycled Content**, Specify 10%	1
1	Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
1	Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
	Credit 6	**Rapidly Renewable Materials**	1
	Credit 7	**Certified Wood**	1

5 Indoor Environmental Quality — Possible Points: 15

Y			
Y	Prereq 1	**Minimum IAQ Performance**	
Y	Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	
1	Credit 1	**Carbon Dioxide Monitoring**	1
	Credit 2	**Ventilation Effectiveness**	1
	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1	Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1	Credit 4.2	**Low-Emitting Materials**, Paints	1
1	Credit 4.3	**Low-Emitting Materials**, Carpet	1
1	Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	1
	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
	Credit 6.1	**Controllability of Systems**, Perimeter	1
	Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
	Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
	Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

4 Innovation & Design Process — Possible Points: 5

Y			
1	Credit 1.1	**Innovation in Design**: Exemplary Performance for SSc7.1	1
1	Credit 1.2	**Innovation in Design**: Exemplary Performance for MRc2	1
1	Credit 1.3	**Innovation in Design**: Green Housekeeping	1
	Credit 1.4	**Innovation in Design**	1
1	Credit 2	**LEED® Accredited Professional**	1

This LEED scoring chart shows how the Blue Cross Blue Shield of Michigan parking structure in Detroit achieved its Certified rating. LEED's scoring has changed since that time, with certification now requiring 40 out of a possible 110 points.

expectations by the owner. The green roof extends the life of the underlying roofing membrane by shielding it from sunlight and degradation from ultraviolet rays and direct contact with weather.

Loading and Other Code Considerations

It is imperative to consider the loading requirements: 100 psf live load is required if the roof level will function as a roof garden/assembly space. This must be considered by the structural engineer in the design of the overall roof system. Code-wise, making the roof level a more accessible space can result in increased need for roof egress, wider egress and elevator access. These must be coordinated with local building codes and building authorities.

At BCBSM, the roof became a popular location for special functions, such as viewing Independence Day celebrations in downtown Detroit over the Detroit River. It is also important to be aware that additional fall-protection measures need to be considered, based on the extent of use of the green roof by occupants. At BCBSM, the use of black vinyl-coated fencing woven over stainless-steel cable strands provided code-required guard protection while minimizing any visual barrier to the vast views of the city and river.

Providing a roof over the structured parking levels may result in 100% covered parking, which for those projects seeking LEED certification can qualify for exemplary performance associated with Heat Island Effect, non-roof (SSc7.1) as an Innovation & Design credit. Heat-island effect refers to the absorption of heat by hardscapes, such as dark, nonreflective pavement and buildings, and its radiation to surrounding areas.

Providing light-colored roofs or including vegetated green roofs minimizes this impact on the environment. Green roofs reduce the heat-island effect of structures (SSc 7.2). The decision to place parking under cover (including in parking structures) minimizes the non-roof heat island effect by decreasing the amount of site parking-lot area (SSc 7.1).

Green roofs also offer the opportunity for increased stormwater control on site by delaying the flow rate of water into stormwater-catchment systems and the utility infrastructure. They also offer the opportunity to collect and store water in precast concrete cisterns, which can then be used for landscape irrigation and other gray water use (if allowed by the local municipality).

At BCBSM, the water from the green roof was combined with water collected from elsewhere on site and collected in an underground concrete stormwater catchment system 164 feet long and 10 feet in diameter. This water is used for site irrigation, including to establish the green roof vegetation, which vastly reduces demand for domestic water use.

Other Energy Options

A parking structure's top level or roof can provide a great opportunity for the inclusion of other site-located renewable energy resources. Onsite renewable energy can be used as captured energy for use in the structure or to sell back to the utility.

An example is a solar-array project to be installed on the roof of a recently renovated cast-in-place concrete

Showers and locker rooms/changing rooms were provided at the ground level of the parking structure, enhancing its use by employees. The structure's roof has become a popular location for corporate activities, such as watching fireworks on July 4th.

New LEED Considerations

The current rating system for new construction under LEED standards is the 2009 LEED BD+C (Building Design and Construction) as part of the overall LEED v3 (version 3). It requires a minimum of 40 out of a possible 110 points for certification of a project.

Formalized with LEED 2009 are Minimum Program Requirements (MPRs) that determine if a project is eligible for certification. Of particular relevance to parking structures is MPR #5: Must Comply with Minimum Occupancy Rates.

It is important to note that for those structures seeking LEED certification under the new LEED v3 rating system for new construction, the project must serve one or more Full Time Equivalent (FTE) occupant(s), calculated as an annual average, to use LEED in its entirety. If the project serves less than one annualized FTE, optional credits from the Indoor Environmental Quality category may not be earned. All prerequisites must still be earned in order to qualify for LEED certification.

Often, parking structures don't include spaces considered to be regularly occupied that can satisfy this condition. Security, parking-attendant or maintenance areas, if designed to qualify for consideration as a conditioned/habitable space, may satisfy this requirement.

This was how the requirement was addressed on the BCBSM parking structure project, which also incorporated other conditioned spaces including meeting rooms, a fitness facility and shower/locker rooms. Other parking structure projects may have to include non-deck related mixed-uses in order to comply with this requirement.

Of course, structured parking can be used to help primary occupied spaces achieve LEED certification as part of a larger project, as well.

Neumann/Smith Architecture created a plan to remove several levels of a parking structure in Detroit. A 200-kW pv array will be installed on the roof and will generate power equivalent to the annual needs of 40 homes.

parking deck originally constructed in 1970 in downtown Detroit for BCBSM. This structure's upper levels had surpassed their serviceable life due to harsh exposure to the elements for more than 30 years.

Neumann/Smith Architecture developed a plan to remove the south half of the deck and two of the upper levels on the north half. The design team elected to leave an elevated level to function as protection for the lower deck levels and to eliminate the need for snow removal from the upper deck level. The exterior of the deck was then clad with a skin of masonry to visually relate to the remainder of the downtown Bricktown District.

The vacant roof space was considered and planned for a potential future green roof, but most recently it presented the perfect opportunity for the installation of a solar array that will cover 31,000 square feet of the 42,000-square-foot roof. Detroit Edison (DTE) and BCBSM have signed a 20-year agreement for a 200-kW photovoltaic system that will be installed on the roof and began operation this spring.

This $1-million solar array will provide BCBSM and the customers of DTE with renewable energy generated from the sun. The PV system is expected to generate an equivalent amount of power that would be consumed by approximately 40 homes in a year. BCBSM expects the array will produce about 20 percent of the base power for its downtown Lafayette campus in Detroit.

Onsite renewable energy can also be used to make use of captured energy for use in the deck, for other project use or to sell back to the utility. The installation is part of Detroit Edison's pilot SolarCurrents program that calls for photovoltaic systems to be installed on customer rooftops or property over the next five years to generate 15 megawatts (MW) of electricity through southeast Michigan.

Thoughtful methods of dealing with and addressing parking in the urban environment can lessen the impact of the automobile on the environment while creating enhanced opportunities for the creation of open space, landscape features and other sustainable benefits, including onsite renewable energy. Design professionals should advise clients of available sustainable strategies to minimize the impact of autos and the built environment and reduce the use of fossil fuels. ■

For More Information

LEED certified projects can be viewed at http://www.usgbc.org/LEED/Project/CertifiedProjectList.aspx.

For LEED minimum program requirements, visit: www.usgbc.org/ShowFile.aspx?DocumentID=6715

For more on the BCBSM parking structure project see the Winter 2008 issue of *Ascent* in the Publications/Ascent/Archives menu at www.pci.org

Precast Provides for Versatility and Innovation in Parking Structures

Owner demands for revenue, sustainable design and other features drive unique designs using total-precast concrete parking systems

— Craig A. Shutt

The tight economy encourages developers to create more efficient buildings, and parking structures are not immune to those demands. A desire to generate more income and a growing interest in using sustainable-design guidelines are adding challenges for designers. Fortunately, total-precast concrete parking structures can help meet those needs while handling site, speed, aesthetic and budget requirements.

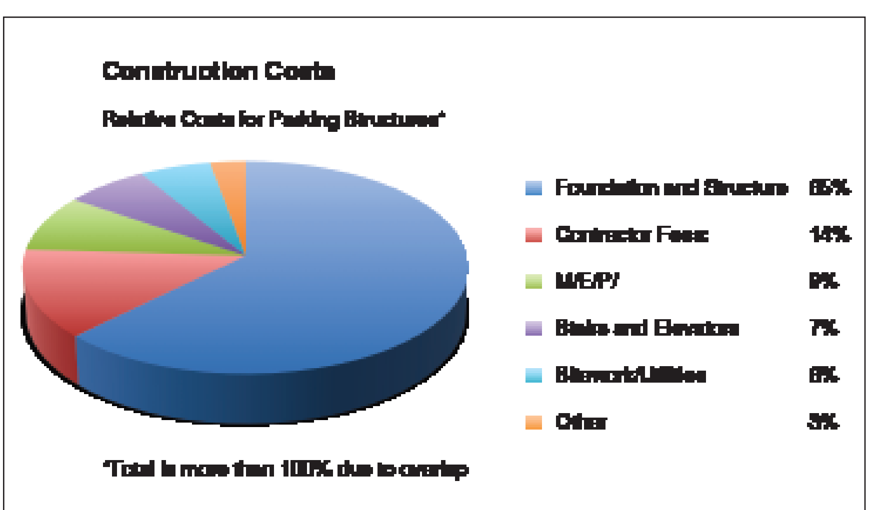
Evaluation of structural materials is a key factor in both the initial and long-term costs for parking projects. The foundation and structure account for 65% of all construction costs for a parking structure, according to a 2009 presentation by Carl Walker Parking in Kalamazoo. This is significantly higher than for other types of structures, in which a large portion of the budget goes to interior partitioning, finishes and other functional and aesthetic requirements (see the diagram).

Multi-use projects are growing in demand, as owners want to raise revenue from their facilities as well as draw more users to them. These needs create a variety of parking impacts. (For more on these trends, see the Parking Trends feature on page 30.)

Meanwhile, the growing green-building movement and use of the Leadership in Energy & Environmental Design (LEED) standards are making owners consider how they can include these elements in their projects.

"We're seeing a lot more interest in using LEED standards with parking structures," says Jim Duller, an architect with Clark Nexson Inc. in Charlotte, N.C., who has designed several such projects. "As the green movement grows, it's becoming more popular, especially in any of our government work, where it's already mandated. We expect more cities and other building owners to follow their lead."

While balancing these concerns, owners also are mandating that parking structures blend with surroundings, becoming an addition to the neighborhood rather than a necessary evil. Precast concrete's capabilities to match many types of stone and other materials can aid with this, providing the versatility to meet any aesthetic challenge.



Foundation and structure accounts for the dominant portion of a parking structure's construction cost, much more than for other types of buildings.

UNCW Blends In

An example can be seen in the 1,000-car, 305,000-square-foot parking structure designed by Clark Nexson on the campus of the University of North Carolina at Wilmington. The four-story parking structure, the first on the university's campus, serves the new 13-acre Seahawk Crossing Privatized Student Housing Complex. Both as the first such campus facility and to complement the new center, the project had to blend with its surroundings rather than announce its presence.

Fact Sheet

Project: *University of North Carolina at Wilmington East Parking Deck*

Location: *Wilmington, N.C.*

Project Type: *Parking structure*

Size: *305,000 square feet*

Cost: *$12.8 million*

Designer: *Clark Nexsen, Charlotte, N.C.*

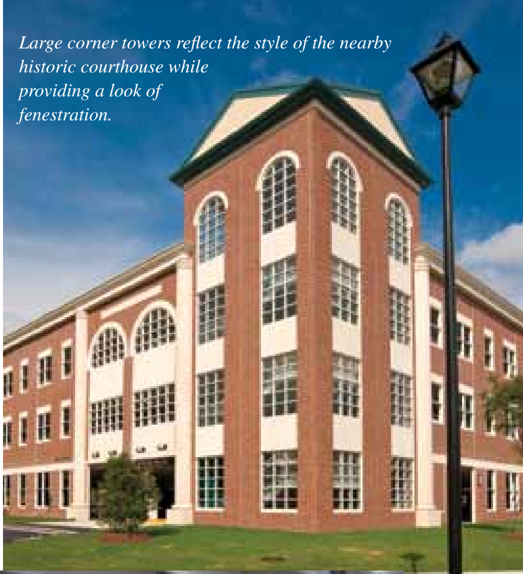
Owner: *University of North Carolina, Wilmington, N.C.*

Contractor: *Donley's, Raleigh, N.C.*

PCI-Certified Precaster: *Metromont Corp., Greenville, S.C.*

Precast Specialty Engineer: *Reigstad & Associates Inc., St. Paul, Minn.*

Precast Components: *651 components, comprising shear walls, columns, double tees, factory-topped inverted tee beams, wall panels, flat slabs, spandrels, stairs, U-shaped molds and cornice molds.*



Large corner towers reflect the style of the nearby historic courthouse while providing a look of fenestration.

The three-story parking structure at the University of North Carolina at Wilmington, the first on campus, features a total-precast concrete structure with an exterior façade designed to resemble traditional Neo-Georgian architecture.

The open plan of the precast concrete design allowed electrical service to be run easily, providing power for electrical vehicles, generating a LEED point for the structure.

The appearance of windows along the façade led city officials to question whether the building met requirements for an open-air parking structure. (It does.)

'We're seeing a lot more interest in using LEED standards with parking structures.'

To achieve this, Clark Nexson's design features a Neo-Georgian style with classical trim and detailing. A total-precast concrete structural system was used, consisting of shear walls, columns, double tees, inverted tee beams, wall panels, flat slabs, spandrels, stairs, U-shaped molds and cornice molds. The design helped the complex achieve LEED Silver certification.

"The university is in a coastal city that's flat, and officials didn't want the parking structure to stand out and detract from other buildings," Duller explains. "The design had to incorporate brick and columns like all buildings on campus."

The total precast concrete system features perimeter panels incorporating embedded thin brick to match the adjacent student housing. A limestone-colored mix was chosen for the base concrete, to contrast the brick-clad portions and the trim and cornice details. Metromont Corp. in Greenville, S.C., provided the precast components and helped with the brick selections.

"We worked closely with the precaster to find a brick style and color that would match others on campus," Duller explains. The designers visited the precaster's plant to review options and selected four mixed palettes. They used those to create sample boards that they took back to campus to compare with existing brick buildings.

To achieve the ideal match, the designers mixed several tones of brick to create the exact color desired even though no one shade matched perfectly. "The base concrete color was slightly lighter than the mortar used between the bricks on the other buildings," he explains. "So we used a slightly darker brick to achieve the contrast and mixed those in with other slightly different colors. The overall impression was the same and provided the match we needed."

Windows and arches were highlighted by exposing the base concrete

The alley through the center of the site at the Herald Court parking structure was turned into a feature by creating retail spaces along both first-floor sides and transforming the alley into a pedestrian walkway.

One of the biggest challenges was creating the embedded thin-brick precast concrete columns. The top side, which could not be cast in the form, features hand-laid brick pressed into the concrete to form mortar joints.

The alley was finished with cobblestones, period lighting and other touches to complement the precast concrete façade. The parking levels above connect via access ramps on each floor, seen at back.

The total-precast concrete design features a variety of finishes, including embedded thin-brick that was used on all four sides of ground-floor columns.

Fact Sheet

Project: *Herald Court Centre*

Location: *Punta Gorda, Fla.*

Project Type: *Parking structure*

Size: *161,887 square feet (including 17,000 retail)*

Cost: *$5.26 million*

Designer: *Fawley Bryant, Sarasota, Fla.*

Owner: *City of Punta Gorda, Florida*

Contractor: *Owen Ames Kimball, Punta Gorda, Fla.*

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

Precast Components: *851 pieces, including double tees, columns, beams, litewalls, shear walls, spandrels, moment frames, stairs, flat slabs, wall panels and balconies.*

'The ability of the precast concrete to span large distances lends itself well to automobile traffic.'

and adding reveals around the openings. Smooth-finished concrete was also used to create the cornice and engaged columns that project from the brick plane, adding depth and breaking up the scale of the façade.

The locations of the precast concrete joints were carefully considered and placed to integrate into the design, Duller notes. Major vertical joints were placed behind the large false colonnades, which matched similar columns on other buildings.

Using precast concrete also helped keep interior space open. "The flexibility of the precast concrete allowed the design to incorporate the aesthetic aspects while still retaining the large, clear floor spaces and open-air ventilation necessary," he says. "The ability of the precast concrete to span large distances lends itself well to automobile traffic. The open floor space created by the long precast concrete spans allowed needed clearances and turning radii."

Precast Helped Complete The Project One Month Ahead of Schedule and Under Budget.

Speed of construction was another important factor in choosing a precast concrete design. "As an integral part of the larger student-housing project, the parking structure provides the majority of required parking for the development," he explains. "Construction needed to be completed before the adjacent wood-frame housing buildings. So we were racing against stick-built construction to match their schedule."

To ensure the deadline was met, the architect selected the precaster during the design-development phase and worked closely with its engineers to design an efficient precast concrete package to meet the tight schedule. In the end, the project was completed one month ahead of schedule and under budget.

Ironically, the team had to do extra calculations because they had done their job so well. As they had disguised the structure's openings behind false mullions and frames, city officials contested whether the design constituted an open-air parking structure. If it were deemed a closed structure, significant time and expense would have been needed to add mechanical and electrical measures.

The designers provided the city with additional calculations to show the design met the percentage requirements necessary to qualify as an open-air structure. "It's really a compliment to the project that they contested its open-air function," he points out.

First LEED Certification

The project was the first building on campus to receive LEED certification. "The natural environment is a leading focus of several major academic programs at the university, and promoting sustainability is a core value," Duller explains. "The parking deck played a key role in achieving a Silver rating. Several LEED points were attained as a direct result of the advantages that precast concrete construction provided."

Precast concrete can aid with a number of LEED points, including through its recyclable attributes and nearby manufacture, as well as for construction-waste management, rainwater diversion, and energy-efficient construction, which all were used in this project. (For more on those aspects, see the Sustainability article on page 16). In this case, the precast concrete design helped with some unique design aspects as well.

Designers allocated one structural bay to bicycle storage to achieve SS 4.2: Alternative Transportation: Bicycle Storage. The design's openness also provided easy access for electrical-conduit runs that allowed efficient installation of 30 alternative-fuel vehicle-refueling stations. That qualified the structure for the point under SS 4.3: Alternative Transportation: Low-Emitting & Fuel Efficient Vehicles.

"Since the parking deck opened, it has become a welcome addition to the campus," he says. "The deck provides much-needed additional parking capacity, created the first LEED Certified project for the university, and has blended fluidly with its surroundings." Since the parking structure was completed, two other decks have been built in the city, following the lead of this first successful design.

Herald Court Square

The four-story, 162,000-square-foot Herald Court Square parking structure in Punta Gorda, Fla., also had high aesthetic standards to meet. The designers used the total-precast concrete design to help convert site obstructions from problems into features. That resulted in the creation of a well-regarded pedestrian way that features retail space along the ground level.

'We had to determine how to make the most efficient use of the footprint.'

The location had an alley running through its middle, explains Richard Fawley president and principal architect on the project at Fawley/Bryant Inc. in Sarasota, Fla. "When we began talks with city officials about specific goals, we realized that they hadn't really thought through how the site obstacles would impact the plan," he says. "We had to determine how to make the most efficient use of the footprint."

The designers took their cue from an alley to the north, which had been turned into a gentrified pedestrian way with coffee shops and other upscale boutiques. "We took that spirit and continued it so the downtown area would have a long pedestrian way that opened to points south." That meant adding retail space to the facility to serve as additional revenue-generating sources. The designers convinced city officials of the benefits, emphasizing that it maximized efficiency of the site. But it also created new challenges.

"It wasn't one big square, so the biggest challenge was working with the precast concrete design to ensure the floor levels connected across the alley to provide vehicular access," he explains. The structure consists essentially of two rectangles that connect via ramps on each floor at one end, providing access to the alley at both ends and drawing light down into the parking levels.

A key challenge was creating a layout using few shear walls, as the city wanted no distractions from the upscale appearance and no obstacles that could restrict flexibility for first-floor retail uses. The precast concrete spandrels connected with wall columns to create a frame system that resists lateral loads, eliminating the need for shear walls.

"The precast concrete structural system was selected because it represented the best choice given cost, site constraints, timing, and aesthetics sought," Fawley says. "Time is money, and the precast concrete system considerably reduced the number of days needed for construction." The precast components arrived onsite as needed and could be erected immediately, he notes. "This eliminated the extra time typically required for storing, hoisting, placing, and tying reinforcing steel that is associated with cast-in-place concrete frames."

Façade Complements Neighborhood

The structure's façade was designed to be sensitive to its neighbors, which include the historic county courthouse and a variety of restaurants. Dominant, Spanish-style towers were positioned at each corner, with thin brick embedded in precast concrete spandrels and column covers to provide accents for the two tones of concrete used over the bulk of the façade. Coreslab Structures (TAMPA) Inc. in Tampa, Fla., provided the precast concrete components.

Canvas awnings, Bahama shutters, anodized storefronts, mesh-screen windows, powder-coated railings, and other touches provide a relaxed, casual atmosphere. The alley was accessorized with brick pavers, light poles, benches, and landscaping. The first-floor was designed for a variety of retail operations as well as public

LEED Scorecard

The UNCW parking facility achieved a total of 33 points to be LEED Certified. Those points were earned in this manner (*=points aided by precast concrete):

Category	Points
1. Sustainable Sites: Site Selection	1
4.1 Sustainable Sites: Alternative Transportation: Public Transportation Access	1
4.2 Sustainable Sites: Alternative Transportation Bicycle Storage & Changing Rooms	1*
4.3 Sustainable Sites: Alternative Transportation: Low-Emitting & Fuel-Efficient Vehicles	1*
5.1 Sustainable Sites: Site Development: Protect or Restore Habitat	1
5.2 Sustainable Sites: Site Development: Maximize Open Space	1
6.1 Sustainable Sites: Stormwater Management: Quantity Control	1*
6.2 Sustainable Sites: Stormwater Management: Quality Control	1
7.1 Sustainable Sites: Heat Island Effect: Non-Roof	1
3.1-3.2 Water Efficiency: Water Use Reduction	2
1. Energy & Atmosphere: Optimizing Energy Performance	2*
3. Energy & Atmosphere: Enhanced Commissioning	1
6. Energy & Atmosphere: Green Power	1
2. Materials & Resources: Construction Waste Management	2*
4. Materials & Resources: Recycled Content	1*
5. Materials & Resources: Regional Materials	2*
4.1 Indoor Environmental Quality: Low-Emitting Materials: Adhesives & Sealants	1
4.2 Indoor Environmental Quality: Low-Emitting Materials: Paints & Coatings	1
4.3 Indoor Environmental Quality: Low-Emitting Materials: Carpet Systems	1
5. Indoor Environmental Quality: Indoor Chemical & Pollutant Source Control	1
6.1 Indoor Environmental Quality: Controllability of Systems: Lighting	1
6.2 Indoor Environmental Quality: Controllability of Systems: Thermal Comfort	1
7.1 Indoor Environmental Quality: Thermal Comfort: Design	1
7.2 Indoor Environmental Quality: Thermal Comfort: Verification	1
8.1 Indoor Environmental Quality: Daylighting & Views: Daylight 75% of Space	1
8.2 Indoor Environmental Quality: Daylighting & Views: Daylight 90% of Space	1
1.1 Innovation & Design Process: Innovation in Design	1
1.2 Innovation & Design Process: Innovation in Design	1
2 Innovation & Design Process: LEED Accredited Professional	1

restrooms.

One of the biggest challenges came in producing the four-sided embedded-brick columns for the first floor, Fawley says. Such columns typically are 2 feet by 2 feet, whereas these were 4’8” wide, with no corner brick. “Alignment and uniformity were very important for the four-sided columns,” he says.

After several experiments, the columns were poured 1/2-inch low and had bricks hand-laid on top similar to laying tile. “This definitely put a lot of trust in the plant employees,” he says. “They had to have a good eye for detail but also lay large areas of brick in a timely manner.” Finishing crews layered a grout mixture on the top-in-form side and created the mortar joints. “The finished product looks very impressive.”

Using a fast-track system, the designers worked from the architects 3D Revit model rather than finished documents. “With not much repetition, the detailing created a large number of piece details,” he says. Out of 851 pieces, 580 unique designs were needed.

The project was designed to have a zero setback, which limited site access. “Precast concrete provided the added benefit of not requiring a staging area for forms, reinforcing steel, scaffolding, plank, miscellaneous materials, and erection machinery. By casting the brick into the columns at the plant, we saved considerable time and improved the quality control,” Fawley says. Materials were delivered in off-peak hours to minimize disruption to the neighborhood.

The result has been a welcome addition to the area that now is used for street parties on a regular basis. The project won the 2010 Florida Main Street Award for Best Public Improvement Project.

Parking Hits Home Run

Another major civic-improvement project involved providing parking facilities for the new Yankee Stadium in the Bronx. Rather than creating one massive parking structure, the program involved five smaller projects, including one with a rooftop park that enhances the public spaces. "From the initial RFP, the design/build team developed the project into what is now a neighborhood feature for locals and game-day visitors to enjoy," says Michael Nelson, senior associate and project architect with Clarke Caton Hintz architects in Trenton, N.J.

The new Yankee Stadium under construction at the time was displacing parks and recreation facilities from the neighborhood. The plan called for replacing seven acres of those facilities atop one of the parking garages. "The phasing of the project provided unique challenges, as it was necessary to have temporary parks and recreation in place atop one structure before gaining control of another," Nelson explains. This was further complicated by the need to maintain space for media staging requirements for game broadcasts during the season.

The project created three parking structures containing 3,140 spaces: Ruppert Plaza Garage, with 1,580 spaces plus the rooftop Macombs Dam Park; 164th Street Garage, with 630 spaces; and 161st Street Garage, with 930 spaces. Two existing structures, with 2,400 spaces, were also substantially modified.

Securing the foundations posed the first challenge, as the site is ringed by subway tunnels, historic bridges and a vibration-sensitive electrical substation. Piles had to be driven carefully, with mini-piles used in several locations and pile-supported cantilever retaining walls up to 25 feet high supporting the building's foundation wall for the Ruppert and 161st Street structures.

All three facilities feature total-precast concrete structural systems. In all, 22.7 miles of precast concrete double tees (1.127 million square feet) and 13,424 linear feet (2.5 miles) of precast concrete beams were used. Unistress Corp. in Pittsfield, Mass., provided the precast concrete components.

Fact Sheet

Project: *New York Yankees Parking Redevelopment Program*

Location: *Bronx, N.Y.*

Project Type: *Parking complex*

Size: *1.54 million square feet (in three structures)*

Cost: *$280 million*

Designer/Landscape Architect: *Clarke Caton Hintz, Trenton, N.J.*

Structural Engineer: *Fay, Spofford & Thorndike, New York, N.Y.*

MEP & FP Engineer: *Kelter & Gilligo Consulting Engineers, Princeton Jct, N.J.*

Civil Engineer: *Yu & Associates Inc., Elmwood Park, N.J.*

Green Roof Consultant: *Jeffrey L. Bruce & Co., N. Kansas City, Mo.*

Owner: *Capital Projects, City of New York*

Contractor: *Prismatic Development Corp./Hunter Roberts Construction Group, joint venture*

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

Precast Specialty Engineer: *Hoch Associates, Fort Wayne, Ind.*

Precast Components: *22.7 miles of double tees, 13,424 linear feet of beams, 213,000 square feet of precast walls and spandrels, 3,500 pieces of thin brick.*

The 1,580-car Ruppert Plaza Garage features a rooftop public park that helps replace some of the park displaced by the new parking structures. Double tees with extra-wide flanges were used to support up to 4 feet of soil for plantings.

The 161st Street garage features precast concrete spandrels embedded with multi-hued green thin brick to complement the green-tinted curtain wall.

The New York Yankee redevelopment program involved three new total-precast concrete parking structures, shown in the bottom half of this layout of the ballpark area.

The new total-precast concrete 164th Street garage is situated on a narrow site adjacent to the ballpark and serves as the stadium's fourth façade.

The 161st Street parking structure connects to the historic Macombs Dam Viaduct bridge, (at right), an elevated roadway 16 feet higher than the building's elevation. The garage features a continuous floor plate and an offset to provide access to the bridge's ramp.

Value-Engineering Saves Time, Cost

The two-level Ruppert Plaza Garage initially was designed as a steel-framed structure, but the design-build team value-engineered it to precast concrete. "We determined that a superior, cost-effective building could be achieved with precast concrete," Nelson says. "The use of precast concrete improved the level of service and provides superior durability. It also enabled the garages and park to be constructed quickly and economically."

The double tees and beams provided the necessary load support to construct the new plaza on the rooftop. It features a variety of park amenities, including a combined soccer and football field, basketball and handball courts, a running track, bleacher seating for 600 and shade structures. Landscaping was provided throughout, including large Paper Bark Maples and Golden Raintrees that were incorporated into grass viewing mounds. These plantings were anchored in up to four feet of soil and strategically placed on beams or columns of the structure below. "It was a very complex multi-layered system of waterproofing, drainage, concrete, and soil that also included electrical, irrigation and AV requirements," Nelson says.

The double tees on this level were designed to be narrower, with thicker flanges, and incorporated a 2-inch field-poured concrete topping slab so they could support the increased soil loads. The structure also had to support emergency vehicles, which use the park as a staging area during track and field events.

The park's perimeter is lined with precast concrete landscape planters, buffering the park from the active street beyond. The rooftop landscaping is designed to merge seamlessly with nearby parks and recreation facilities being constructed in the footprint of old Yankee Stadium.

The Ruppert Plaza project's façade consists of broad precast concrete spandrel beams with a veneer of specially glazed green thin brick. "It created an economical solution for blending the boundary of the garage with the planned adjacent park," he explains.

Narrow Site Maximized

The five-story 164th Street Garage, adjacent to the new stadium, is designed for use by the club and its VIPs, including season-ticket holders. The narrow, rectangular structure runs along the left field wall of the stadium, serving as its fourth façade and screening the loading and service areas behind the ballpark.

The design was deliberately given a modern feel with white precast concrete components and a stainless-steel mesh skin. The precast's color was matched to the adjacent stadium's coloring. "The dialogue between the stainless-steel mesh shrouding the mass of the precast concrete is a deliberate modernist interpretation, which contrasts with the more traditional brick façade of the other two garages," Nelson says.

A 12-inch-thick precast concrete wall was provided along the façade facing the stadium to provide blast resistance in case of security threats.

The façade of the four-story 161st Street Garage features spandrels with multi-hued green thin brick, complementing the green-tinted curtain wall glass shrouding the vertical stair and elevator cores. The clean lines and careful proportions were designed to continue the aesthetic of the Ruppert Plaza Garage nearby.

Despite the complexity and size of the project, the work moved steadily and was completed on schedule, Nelson says. "This is a credit to the entire design/build team along with the precaster. The erection of the precast concrete went very quickly." A staging area was created within the confines of the project, allowing materials to be ready as needed for erection. Trucks delivered materials at night to avoid adding to congestion or disrupting traffic in the area.

The projects logistics, which included connecting to the adjacent historic Macombs Dam Viaduct Bridge, required close coordination. Those efforts paid off with a dramatic combination of facilities. The overall project received Real Estate & Construction Review's Building of America Award. In presenting the award, it said, "The Yankee Stadium Redevelopment Project-Parking Structures was one of the most imaginative, unique, innovative and dynamic projects in the New York/Philadelphia area."

These projects show some of the ways in which precast concrete systems can help parking structures meet a wide range of needs, be they economical, construction speed, sustainable design, revenue generation, or addition of green spaces. As owners' needs grow and sites become more restrained, designers will look to precast concrete designs to help them meet more challenges. ■

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

Meeting the Design Challenges of Today's Parking Structures

Challenges arise for designers as more capabilities are demanded of parking structures

— By Don Monahan, P.E., Walker Parking Consultants

Today's economy and the focus on long-term consequences—both in revenue and environmental impact—are creating new demands for designers of parking structures across the country, for all sizes of projects. Staying abreast of current trends and understanding the challenges that these new requirements will bring can ensure projects are successful from their first day until their last.

Some of the key trends impacting parking structures today include:

1. Multi-Use Capabilities. There is more pressure, especially by city-owned properties, to incorporate retail space into the structure at ground level. Accommodating that need creates a variety of unique challenges that play off of each other.

A key consideration that must be recognized is that such commercial space will raise the per-stall cost of the project. Typically, the first floor of unsupported parking spaces will cost in the \$8- to \$10-per-square-foot range, with supported levels costing \$20 to \$30 per square foot. By removing first-floor spaces to add commercial real estate, the cost per parking space overall rises.

During the preliminary design phase, officials at the University of Virginia decided to add a 44,500-square-foot, two-level bookstore above the new parking structure being built on the historic campus. The facility also includes a police surveillance station. Engineer: Walker Parking Consultants

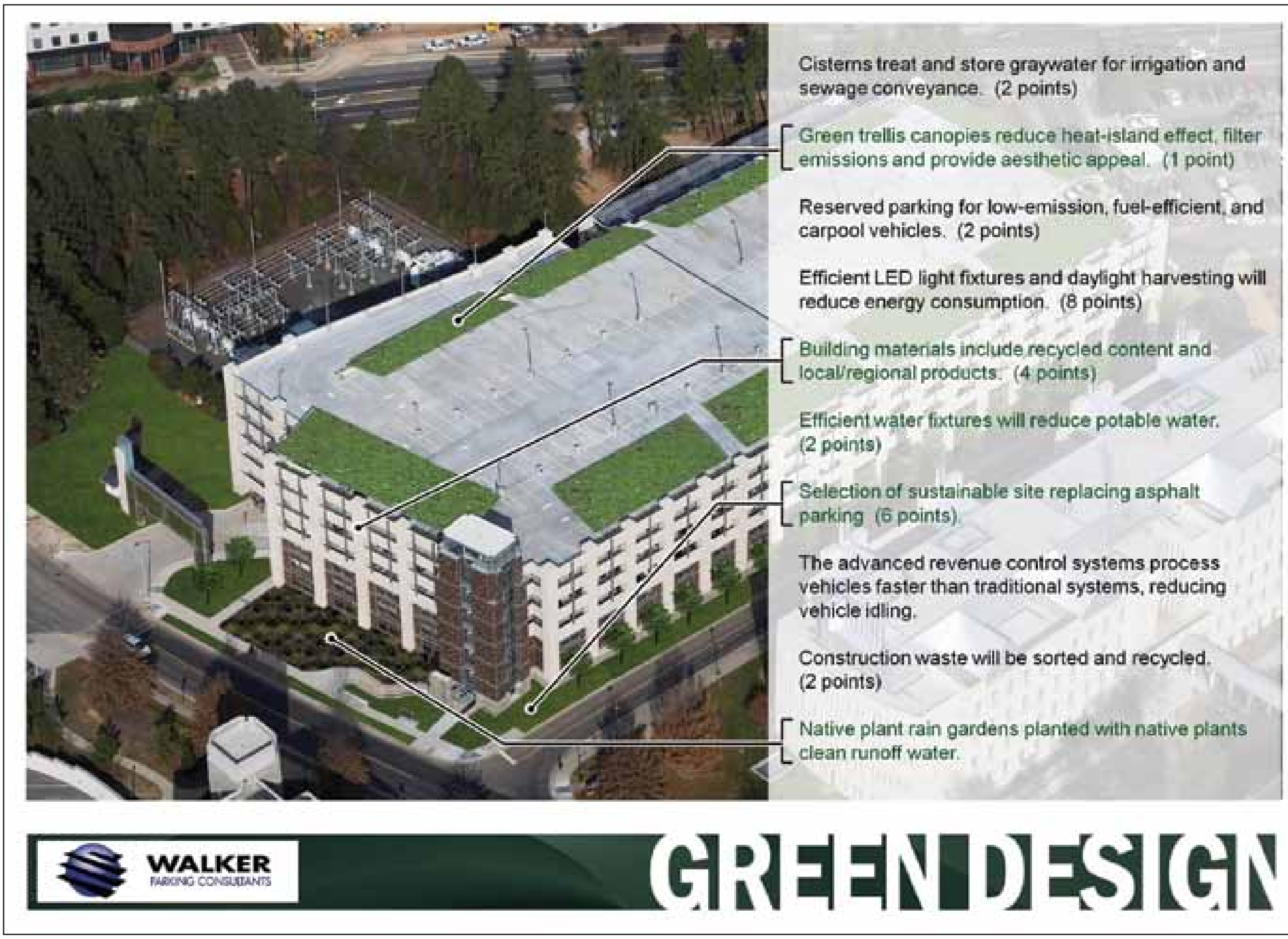
– Don Monahan is vice president with Walker Parking Consultants and is based in Greenwood Village, Colo., a suburb of Denver. To learn more, visit www.walkerparking.com

Typically, retail space juts out from the structure about 20 feet and takes up about 18 feet into the structure. This space eliminates one line of parking stalls, which typically will be along the street frontage or wrap two sides if on a corner. Retail on a full-block structure will eliminate all parking along the exterior sides of the first floor. Offsetting this, of course, are the revenues generated by the tenants in these spaces.

The loss of these spaces will mean their number will have to be replaced with additional spaces higher up, possibly with an additional level or other accommodations. Fortunately, most structures can add vertical space without a problem, as they do not impinge on height limits set by most municipalities. However, this aspect must be determined early to ensure a tradeoff doesn't have to be made of retail space for needed parking slots.

2. Ramping Requirements. The addition of commercial space into the parking structure creates additional challenges, especially in the ramping design. In most cases, retail spaces require about a 15-foot floor-to-floor height (creating a 12-foot clear height in the store) rather than the standard floor-to-floor height of 10 to 11 feet on other parking floors.

The additional height requires adjustments to the ramping position and



Parking structures can provide a variety of sustainable-design attributes, many of which can help the project achieve LEED certification.

slope. The International Building Code (IBC) allows for a 1-in-15 (6.67%) slope with parking on it, but this percentage can be difficult to achieve in most parking structures because the footprint is too small.

That leads to creating a speed ramp with a slope of 10% to 15% for the first portion of the structure, which does not include parking space. Such ramps are inefficient because they eliminate space for parking, increasing the cost per stall even further. If the parking structure is more than two parking modules wide, the second parking level at the retail space could be left out such that there is a two-story high space for the retail and parking floor slopes are not impacted.

3. Market Demand Evaluations. With greater pressure to maximize stalls while increasing revenue on small footprints, requirements of the municipal code come under question more often. These codes often are based on other municipalities' codes established earlier, rather than on actual parking conditions in the municipality where the parking structure is being built. They also were established at an earlier date when conditions could have been significantly different.

More often today, design consultants are being asked to do original market studies to determine the specific property's actual parking needs. This involves creating a recommendation for adapting the zoning requirements, petitioning for a variance and waiver and adding or deleting parking as needed to optimize the use of the space. Accepting the existing zoning code and land-use standards can result in a skewed demand calculation that ultimately leads the structure to be over-sized and more costly than necessary or under-built and not supporting the primary use adequately.

4. Additional Service Needs. The addition of retail space, even general in function, creates the need for fire-separation requirements to meet today's building codes. Until 2003, these requirements were even more significant, as they required that the entire structure to be classified as enclosed parking when retail spaces were available on the first floor. Later editions of the IBC, however, allows mixed-use applications in open parking structures if a fire separator is provided.

Vertical separators can be provided by masonry block wall or concrete walls, either cast-in-place concrete or precast concrete. Horizontal, between-floor separation can be achieved with precast concrete double tees or cast-in-place concrete, either of which can provide a 2-hour fire separation. For situations that require a 3-hour rating, added concrete cover provides sufficient protection.

Providing retail space also impacts the mechanical and electrical services needed in the structure and their accessibility will impact the design. Impacts created by restaurant applications can be more challenging, particularly if they were not anticipated as the design was created.

Restaurants will require grease separators and flues for ovens and grilles. This piping may require penetrations in the structure and can also impact spacing and layout, if the pipes are run up through the structure. This requirement can become an issue if it

Many owners are trying to disguise the appearance of their parking structure to help it blend with the surroundings. The rich tradition of masonry architecture in Fort Collins, Colo., provided the inspiration for this 900-space parking structure, which includes 15,000 square feet of retail on the first floor. Engineer: Walker Parking Consultants

is not considered as soon as the restaurant's needs are known.

5. Sustainable Elements. Sustainable design and adherence to qualities set forth in the Leadership in Energy & Environmental Design (LEED) program administered by the U.S. Green Building Council are becoming dominant factors in building today, and that extends to parking structures. Even if the projects are not submitted for LEED certification, many developers are following those guidelines when economically feasible, as they understand the benefits that can be achieved over the life cycle of the structure.

Precast concrete can help to achieve LEED Certification and contribute to sustainable goals in a variety of ways. Some of these include recycled content, local manufacture, habitat protection, green-roof support, heat-island mitigation, waste and run-off water management, and innovative use of materials. For specifics on options, see the accompanying chart.

One method that aids LEED certification is to use specialized treatments for the top level or roof of a parking structure to minimize the heat gain (albedo) caused by absorption from the sun shining on the exposed roof all day. Concrete is light in color so will re-

The 325 space parking structure, at 915 Walnut in Kansas City, MO, features a 16,000 square feet rooftop garden. The garden serves as a key selling point for the adjacent condominiums and provides residents with a safe, fun, and beautiful area for walks, picnics, or just to enjoy the outdoors. Engineer: FDG, Inc.

flect more light than is absorbed, particularly if white cement is used.

Another way to mitigate this gain that is growing popular is to install a green roof, which also provides benefits in adding vegetation and creating additional user amenities. Solar panels also are being installed more often, as they can generate enough electricity to run the parking structure lighting. Although the solar panels absorb more heat than the roof, the heat energy is converted into electricity which is a more important benefit than the heat island effect. (For more on green roofs, see the Sustainability Insight article starting on page 16.)

6. Lighting Design. One factor in maximizing LEED points unrelated to the structural shell is the choice of lighting fixtures. Because energy conservation is such a significant part of LEED consideration, this specification has become a much more important portion of the parking design.

In the past, most parking structures relied on high-pressure sodium, or metal-halide fixtures. These options are not energy efficient enough for today's designs. They are being replaced with new technologies, such as fluorescent lights with electronic ballasts, which use 40% less energy for an equivalent number of footcandles. Another option is induction lamps, in which the fluorescent bulbs have no electrodes and use a magnetic field to ignite the phosphorous in the bulb, so they last up to three times longer than a typical fluorescent lamp. Another option is light emitting diode (LED) fixtures in which many small silicon chips are provided in a housing and glow when an electric current is passed through.

These newer fixtures are more expensive than traditional lighting, which makes owners hesitant to use them. However, they can provide a 100,000-hour life, which significantly decreases costs over their life span. Energy consumption comprises 85% of the life-cycle cost for lighting in a parking structure, so the payback in investing a few hundred dollars during initial fixture selection pays back its cost rapidly.

In most cases, it is recommended that fixtures should be considered to offer a 25-year service life to calculate their replacement needs. By that point, gaskets will be wearing out and lenses start to yellow, and replacing them is more cost-effective than continuing to maintain them.

7. Maximizing Daylight. In its efforts to minimize energy costs for lighting, LEED places a strong emphasis on maximizing the use of daylight. This can create challenges for parking structures, which don't lend themselves easily to providing atriums or skylights that can draw light into the structure.

Lite walls, which are interior walls that have rectangular openings provided in them, can aid this process when appropriate. These structures also provide more visual connection for users, which enhances safety and their level of comfort in the structure. The use of daylight sensors, which automatically turn off lighting when daylight is sufficient, also can reduce costs while ensuring illumination levels are appropriate regardless of weather conditions.

A key way to bring daylight further into the building is to create courtyards or light wells into the center. These, of course, take up space that could be devoted to parking spaces, so this design proposal requires careful consideration.

Walker recently provided this design for a four-bay, four-level parking structure for the National Renewable Energy Laboratory in Golden, Colorado. Needless to say, they were amenable to using as much daylight as possible in their own facility. But to accomplish that took special consideration of the layout.

Typically, daylight can be considered to penetrate about 60 feet into a building, or about the width of one bay, and this structure was to be 240 feet wide. That meant the middle 120 feet would have no daylight. To avoid this, the structure was split into two with a 12-foot light well down the center. This brought a minimum of 90 footcandles of daylight to the lowest level of the four-story structure, providing lighting to all areas all day. Occupancy sensors keep lights turned off entirely most days. The project now is in its final design.

8. Aesthetics. The architectural style desired for projects varies widely and typically is driven by its location. Influences can include nearby buildings, so the new structure will complement the surrounding neighborhood, or the owner's desire to make a specific statement with the structure, such as

Providing a light well at the center of a parking structure can bring daylight into the center of a wider building, minimizing lighting needs during the day, as in this example at Wells Fargo Financial in Des Moines, Iowa. Engineer: Walker Parking Consultants

to serve as a gateway introduction to a campus of buildings.

Some owners are looking for a highly functional, unremarkable appearance that offers a low-cost way to provide support for other buildings' users. Others want the parking structure to hide its purpose and resemble commercial buildings or storefronts, adding elaborate finish treatments, window details and other amenities.

One treatment that is gaining ground in all types of aesthetic treatments is a desire to reduce light pollution, or the illumination that spills over from the parking structure into the surrounding environment. Architectural mesh is being used more often to dampen this spillover and to provide an aesthetically pleasing appearance. Reducing light pollution also can help in achieving LEED points.

An expert source for more information about achieving this goal with parking structures is the International Dark Sky Association (www.darksky.org), which is drafting a model light ordinance for use by municipalities to help control light pollution. Minimizing this concern will help ensure the structure remains a good neighbor and reduces the chances that local officials will decide that legislation needs to be enacted to control it separately. ■

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 be veneered with other traditional building materials such as brick, granite, limestone, terra cotta, tile, and more. This allows for the look and feel of these materials while adding all the benefits of precast concrete. Different finishes can also be combined for one project, or even into one panel, without the need for multiple trades and additional detailing for movement and waterproofing. Precast concrete offers an efficient way to develop a multitude of façade treatments with less cost and detailing time. The next few pages show a small sample of precast concrete's aesthetic versatility on parking structures throughout the United States.

Publix Greenwise Hyde Park

Tampa, Fla.

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

Structural Engineer: *LEAP & Associates International, Tampa, Fla.*

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

Precaster: *Coreslab Structures (TAMPA) Inc., Tampa, Fla.*

The new Tampa Greenwise Hyde Park store, part of Publix Supermarkets, features nearly 40,000 square feet of retail space on the ground with 2 levels of structured parking above. The design-build contractor chose a total-precast concrete solution featuring thin in-laid brick and architectural detailing in the exterior walls. The exposed double-tee floor system includes roof insulation, eliminating the need for a secondary drop ceiling.

Building M at National Harbor

National Harbor, Md.

Designer: *Hickok Cole Architects, Washington, D.C.*

Contractor: *Coakley Williams Construction Co., Gaithersburg, Md.*

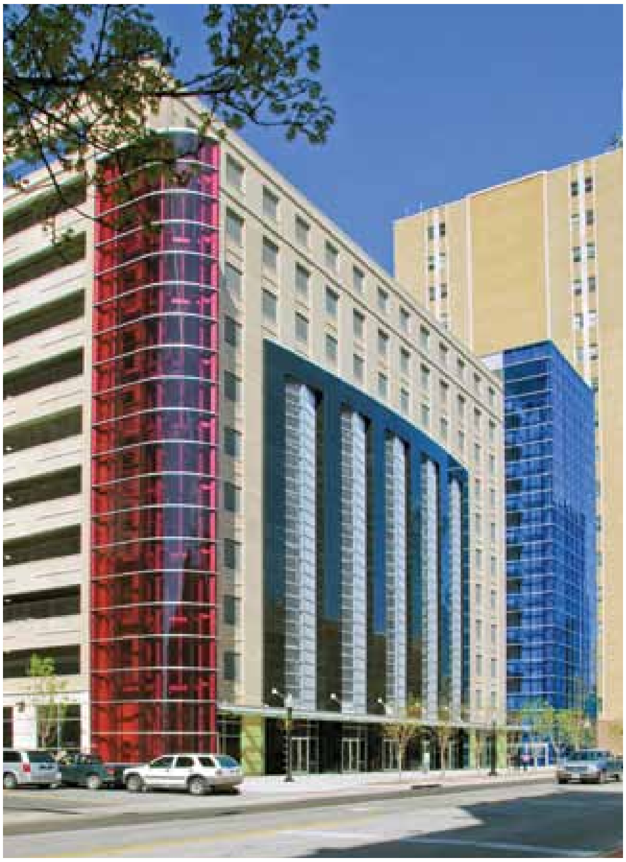
Structural Engineer: *Structura, Rockville, Md.*

Owner: *NH-M Garage LLC, National Harbor, Md.*

Precaster: *Tindall Corp., Petersburg, Va.*

Precast Specialty Engineer: *The Consulting Engineers Group, Mount Prospect, Ill.*

The design for this precast concrete parking structure borrows massing and proportion from the adjacent office building. The architects worked closely with the precast manufacturer to incorporate thin brick and two finishes into the exterior façade, consisting of a main field with a light sandblast and other areas accentuated with a heavy sandblast. The structure's double tees bear on exterior bearing walls and interior lite walls.



Fort Worth Convention Center

Fort Worth, Texas

Designer/Structural Engineer: *Jacobs Engineering, Fort Worth, Texas*

Contractor: *Thomas S. Byrne Ltd. General Contractor, Fort Worth, Texas*

Owner: *City of Fort Worth Transportation & Public Works Department, Fort Worth, Texas*

Precaster: *Gate Precast Co., Hillsboro, Texas*

The 11-story, 1,200-car parking structure features precast concrete spandrel panels and column covers, which work with colored glass panels at the corners. Special formliners were used to match the precast textures to the convention center's natural limestone facing. The center's horizontal limestone banding was mimicked with various exposed-concrete horizontal accents within the spandrel panels.

Village of Libertyville West Parking Structure

Libertyville, Ill.

Architect: *Loebl Schlossman & Hackl, Chicago. Ill.*

Parking Designer/Engineer: *Walker Parking Consultants, Elgin, Ill.*

Contractor: *McShane Construction Corp., Rosemont, Ill.*

Owner: *Village of Libertyville, Ill.*

Precaster: *J.W. Peters/IPC Inc., Iowa Falls, Iowa*

Precast Specialty Engineer: *The Consulting Engineers Group, Mount Prospect, Ill.*

Precast concrete expedited the 10-month schedule for this project to ensure it was completed for shoppers to use during the holiday season. The total-precast concrete structure was wrapped with brick and stone to complement nearby structures. The exterior was enhanced with glass canopies, metal grating, planter boxes and vertical planting screens.

Lancaster Newspapers Parking Garage

Lancaster, Pa.

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

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

Structural Engineer: *Providence Engineering Corp., Lancaster, Pa.*

Owner: *Lancaster Newspapers, Lancaster, Pa.*

Precaster: *High Concrete Group LLC, Denver, Pa.*

Responding to the strictures of the city's Historical Architectural Review Board, the project design team modeled this parking structure on the 18th-century housing nearby. It features thin brick and bands of cast-stone inserts, in a 40-40-20 mix of red brick shades with black ironspot stippling to mimic nearby residences. Windows are simulated by keystones and aluminum-framed openings. The driving surface consists of 15-foot-wide carbon-fiber reinforced double tees.

Memorial Hospital Parking

Colorado Springs , Colo.

This seven level, 1500-space parking structure used a blended three-color thin brick to match the existing hospital, and was complimented by an acid-etched finish. The architect wanted an emphasis on vertical elements to deviate from "a typical parking deck look." The lower level was designed to accommodate truck deliveries and bus traffic with a spacious floor-to-floor height. An emphasis was put on openness and bright lighting to provide for a secure deck (given that it is open 24 hours a day). Thus, moment frames were utilized for lateral resistance and the double tees were painted white to provide intense illumination.

Architect: *Charles L.T. Smith & Assoc., Colorado Springs, Colo.*

Engineer: *HCDA Engineering, Inc., Colorado Springs, Colo.*

Contractor: *JE Dunn Construction, Colorado Springs, Colo.*

Owner: *Memorial Hospital, Colorado Springs, Colo.*

Precaster: *Stresscon Corporation, An EnCon Company, Colorado Springs, Colo.*

Stanford Mall Parking Structure

Palo Alto, Calif.

Designer: *ELS Architcets and HNA Pacific, Calif.*

Contractor: *Charles Pankow Builders, Calif.*

Structural Engineer: *KPFF Consulting Engineers, Calif.*

Owner: *Stanford University Trust/Stanford Mgmt., Calif.*

Precaster: *Midstate Precast, LP, Calif.*

This 475,000 square feet, 1504-space parking structure utilized an innovative Precast Hybrid Moment Resistant Frame system. This allowed for enhanced visibility and security as the need for interior walls was eliminated. Many architectural details were incorporated into the structure to compliment the adjacent shopping center.

Designing for Efficient Maintenance

Considerations that will help owners minimize a parking structure's life-cycle costs

— By Francesco Genoese and Rick Petricca

To provide the ultimate service to parking-structure clients, designers must consider the long-term operational expenditures in their design considerations. Designers can play a key role in educating owners to ensure the structure's efficiency and effectiveness throughout its service life.

The proven durability of concrete, and the 50-year plus service life it can provide, can delude owners into believing that maintenance is not important. The reality is, just as with other buildings, parking structures must be regularly maintained regardless of the materials with which they are constructed. With parking structures, due to the constant exposure to weather and the environment, maintenance becomes an even more important part of ensuring safety and reducing life cycle costs.

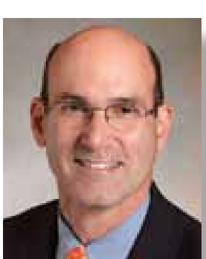
Designers should stress that a regular maintenance program will maximize service life and provide the owner with the greatest return on investment. Effective maintenance programs have proven to be the key to long-term durability and to avoiding major unplanned repairs by detecting problems early and solving them before they grow to be cumbersome and more expensive. Well-maintained parking structures have a much lower maintenance cost per square foot than those in which little or no maintenance is performed. In addition, designing a structure that is easy to maintain throughout its life with planned and predictable maintenance reflects well on the designer and will win repeat and referral customers.

Design Features

Designers can make a significant impact on prolonging the life of a parking structure during the design process. For starters, they should take the time to address maintenance concerns early in the design process and follow through with a comprehensive maintenance program. This is especially true in evaluating several facets of the design of the structure including drainage, water supply, and winter maintenance (if applicable).

The role of proper drainage in minimizing deterioration cannot be overstated. It requires careful attention to details, as any errors can result in increased long-term maintenance costs that are hard to avoid after the fact.

Most importantly, the designer must avoid any situations that allow ponding to occur, which can increase water penetration into the concrete and the potential for freeze-thaw damage. These situations arise in details that are overlooked, such as drain locations, maintaining slopes of 1.5%



– Francesco Genoese is senior director of construction services for High Concrete Group LLC and its garage consulting and service division, StructureCare, in Denver, Pa.

– Rick Petricca is president of Park-Well Inc., a parking-structure maintenance company.

A key goal for designers when planning the structure is to work to eliminate any aspects that encourage water ponding, which can increase water penetration into the concrete and the potential for freeze-thaw damage.

or more, and detailing around stair towers and other elements. For example, at stair towers, a raised curb can be used to redirect water away from the tower, minimizing hazardous conditions, particularly in the winter months. It also is important to ensure positive drainage that minimizes ponding.

Likewise, providing adequate spigots on each level can aid in quickly and easily washing down floors to remove salt, chemicals, and dirt that can harm the structure. For example, chlorides contained in deicing salts can lead to corrosion of connections and reinforcing steel. When spigots are provided only on the lowest level, it makes it difficult or expensive to pump water to the structure's top levels.

Winter maintenance should also be considered during the design stage. Discussing how snow and ice will be handled is important in evaluating the use of designated snow storage areas, dump zones with snow gates, and the use of special admixtures and waterproofing details. In too many cases, owners ask about these activities after the fact when it's too late for the designer to take them into account, hence a designer can be proactive in bringing these concerns up early.

Routine maintenance, such as inspecting and repairing joints, will keep parking structures in good shape and prevent expensive repairs that often result from neglect.

Concrete Quality Key Element

Another key consideration is the quality of the concrete being used. This is one of the most important considerations and will directly impact life-cycle costs. Using a high-quality concrete provides greater durability, including increased resistance to chloride ingress and freeze-thaw damage. Two key factors are using concrete mixtures with low water-to-cementitious ratios and paying close attention to the curing of the concrete, which includes protecting early-age concrete against moisture loss and maintaining temperature within specified limits.

Since all parking structures use concrete, it is important to understand the differences between the two primary methods of casting concrete.

Precast concrete is manufactured offsite, in a controlled environment, which provides a high-quality concrete with consistent qualities. The desired factors mentioned above are inherent in the precasting process: precast concrete uses low water-cementitious ratios (typically between 0.32 – 0.40) and is cast in controlled environments where pieces are protected against moisture loss and temperatures are monitored and maintained.

As a result, precast concrete typically has compressive strengths greater than 6,000 psi. It also arrives on site already meeting or exceeding its design strengths, so daily weather at the site does not impact strength development or quality.

Field-cast, or cast-in-place, concrete typically requires more effort to achieve similar qualities. Casting concrete onsite can be challenging due to the varying weather conditions, temperature fluctuations and potential additional steps necessary to ensure quality, including proper curing procedures. Designers should also specify low water-to-cementitious ratios, which may not be as common for cast-in-place concrete.

Because of its lower design strength and higher water-cement ratio, cast-in-place concrete typically has a silane penetrating sealer applied periodically to enhance its durability. This sealer reduces moisture

Designers should discuss snow and ice removal with the owner to determine if any snow-storage areas, dump zones with snow gates or special admixtures or waterproofing details should be provided.

Ensuring that both the owners and operators are aware of maintenance needs as spelled out in a customized manual for the structure is critical to the success of the maintenance program, which can ensure a long service life.

ingress. Precast concrete structures often have cast-in-place concrete pour strips around their perimeter. Waterproofing details around these areas are important to minimize water penetration.

Periodic chloride-ion tests should be conducted per the manufacturer's recommendations to ensure the alkaline environment of the concrete remains intact. This environment helps create a passive protection around embedded reinforcing steel, but continual exposure to salt and deicing compounds lowers the pH value and turns the composition acidic, which can promote corrosion.

Consider Life-Cycle Costs

Life-cycle costs are important when selecting a material and building system for a parking structure. Typical life-cycle cost evaluations should include routine cleaning and preventative maintenance.

Some routine and preventative maintenance will vary depending on the material system used to build the structure. For example, cast-in-place concrete structures and components often require additional surface sealers be routinely applied to maintain protection against contaminates such as chlorides.

Although precast concrete structures typically provide higher-quality concrete and better protection against chloride ingress, there may be more joint sealants to be maintained and replaced as needed, which can vary depending on the sealant selected, its installation, and exposure environment. Of course, sealants are used in every type of building system, so this would apply to all parking structures and should always be part of the preventative maintenance program.

Other considerations for life-cycle costs include the energy needed to light and operate the structure. This includes electronic exiting and payment systems, as well as any conditioned spaces, such as pay booths or vestibules. Light-fixture selection can also have a great impact on life-cycle costs, since these typically account for about 85% of the energy costs (see Meeting the Design Challenges of Today's Parking Structures on page 30). For hybrid structures, utilizing structural steel, additional costs for painting and maintaining the fire protection of the steel should be included.

> Copies of the maintenance schedule should be given to the maintenance personnel, or they may never learn of the program.

When evaluating life-cycle costs, the long-term service life needs to be taken into account. For example, if a parking structure is to have a 50-year service life, the total costs should include all of the above, as well as first costs, when performing comparisons.

Generally, most systems end up being fairly close in overall life-cycle costs. The primary differentiating factor that results in higher overall costs is usually the lack of routine and preventative maintenance, which in turn escalates repair costs and shortens service life.

Three Levels

Required maintenance can be divided into three general types: housekeeping, preventive maintenance and repairs. These typically are spelled out in a maintenance manual detailing procedures and activities required of the owner or operations personnel. Designers should discuss these needs with the owner and present him with a manual customized to the structure's needs. When a parking structure is made of precast concrete, the precaster can supply much of the information that is compiled in this manual.

1. Housekeeping. These activities are performed by the owner or operator and include general clean-up, window cleaning, elevator maintenance, restriping, fixture cleaning, sign maintenance and security-systems checks. Some of these items, such as cleaning, will take place daily or weekly; others, such as restriping, will occur annually. These details can be spelled out in the manual.

2. Preventive maintenance. These activities are performed on a periodic basis and include washing down the floors twice-per-year, sealing cracks, reapplying floor sealers, inspecting caulked joints, repointing and recaulking as needed and tightening guardrail bolts. These activities are the responsibility of the owner, or the operator, as they are geared toward preserving the owner's investment. Some of these items can be self-performed, but frequently a qualified contractor is engaged to complete this work.

3. Repairs. Generally, repairs are necessary due to a lack of preventive maintenance, which allowed the problems to grow beyond the point where prescriptive measures could stop the deterioration. These activities may include patching potholes, removing and replacing reinforcing steel, repairing floor-slab overlays, replacing expansion joints and bearing pads. These become costly not only due to the repair expense but because spaces often are eliminated while repairs are done in each area.

In many cases, more costly repairs arise because a maintenance program was not in place to identify and remedy small items when they first appeared. Sometimes, the symptom is cheaply or improperly addressed without finding the root cause that created the outward signal of a problem.

This 'Band-Aid' approach will have a short life and potentially create a worse condition. Any indication of a problem should be traced to its source and the flaws resolved or the problem will recur, creating ineffective use of maintenance funds and increased repair costs in the future. Depending on the severity and nature of the deterioration, a design professional should be consulted. A qualified contractor familiar with parking structure restoration and repair should be engaged to make any structural repairs.

Developing a Maintenance Plan

Developing a maintenance plan for the owner of an existing parking structure may require additional considerations than those needed for an original design. This situation will arise if the designer becomes involved in additions, repair work or renovations for an existing parking structure.

A key factor in developing a maintenance and repair program for an existing structure is the age of the parking structure, or more specifically its design era. Every five years or so, designs evolve sufficiently due to new material introductions and casting techniques. These are additional considerations to evaluate beyond a structure's age. Designers cannot assume that parking structures from even a few years earlier feature current design techniques.

Some of the elements that may be different include:

- Pre-topped double tees
- Black steel rather than stainless-steel connections
- Black reinforcing bar rather than epoxy-coated bar
- Areas of field-poured concrete
- Ductility of connections and use of expansion joints
- Use of recycled materials in the concrete mixture
- Concrete admixtures, such as corrosion inhibitors, fly ash, silica fume, air entrainment, etc. as well as the quantity of supplementary cementitious materials
- Changes in code requirements affecting design and rigidity of structures

Code requirements have changed little regarding the allowable cracking in a newly designed parking structure, but seismic design issues have tightened significantly in most areas. These especially will affect the ductility of connections and shear walls.

A survey of all conditions must be done in conjunction with an eye on identifying any looming or immediate safety or structural issues. The goal is to create a plan that is within the owner's repair budget but focuses on the most critical issues first.

Ideally, a plan can be developed

Creating a maintenance program for an existing structure will depend on its age and the amount of maintenance performed over the years. A survey of all conditions should identify immediate safety issues while working to create a three- to five-year plan for restoring the structure's condition.

that can bring the structure up to date with a three- to five-year plan that incrementally improves maintenance each year. From there, a five- to ten-year plan can be developed. A yearly survey of all repairs and maintenance needs should be completed by a qualified professional, with an annual review of the plan to adjust it for budget needs and additional concerns that have arisen.

With any maintenance program created by the designer, copies should be given to the owner when the project is completed. Even more importantly, the plan should be given to and reviewed directly with the maintenance personnel. Ensuring that facility staff is provided with education and training is critical to the success of the maintenance program—and the structure itself. Copies of printed warranties should be included, too, to ensure all involved with maintaining the structure know their protection.

Maintaining a parking structure is an on-going activity that requires a dedicated plan that is respected and carried out. That effort will be repaid many times over by avoiding more significant repairs that can be costly and disrupt service to users.

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

For More Information

For guidelines on developing a maintenance program for parking structures, check out these resources:

- Precast/Prestressed Concrete Institute (www.pci.org), specifically "Maintenance Manual for Precast Concrete Parking Structures" and "Maintenance of Precast Prestressed Concrete Parking Structures Brochure." Both are available on the site; search "parking."
- National Parking Association (www.npa.org), especially its "Parking Garage Maintenance Manual."
- American Concrete Institute (www.concrete.org), especially its "Guide for Maintenance of Parking Structures Manual."

Precast Concrete Expands Rental-Car Facility's Capabilities

California's largest precast concrete parking structure features creative seismic and rental-car designs that expand the facility's capabilities

— By Craig A. Shutt

The San Jose International Airport's $260-million improvement project creates the state's largest precast concrete parking structure, with 1.8 million square feet of raised levels. The project also includes an innovative seismic design and a creative application of rental-car operations, including features that other airports will want to adopt.

"The rental car companies love this facility," says Jeff Fredericksen, project manager for Hensel Phelps Construction Co. in San Jose, which led the design-build team. "The design has cut their operational costs substantially, and the schedule was tremendously efficient. I think when other airports look at this design, they're going to ask, 'If San Jose can do that, why can't we?'"

'The rental car companies love this facility.'

Many airports and rental car companies are consolidating their operations into one master facility. This reduces the amount of land required, number of buses, and helps make their operations more efficient. This also makes it easier on their customers, as they only have one facility to pick-up and drop-off from. These combined facilities are incorporating time and energy saving ideas such as the refueling stations in this project.

The eight-level, total-precast concrete structure is nearly twice the size of the state's previously largest precast concrete parking structure, the 1-million-square-foot facility at Universal Studios. The new 3,350-car structure contains 3,817 precast concrete components, consisting of 32,600 cubic yards of concrete. The components include the precast concrete structural system, containing double tees, L beams, inverted-tee beams, transfer girders, rectangular collector beams, columns and spandrels.

The 1.8-million-square-foot parking structure was erected while airport operations continued around the construction.

Precast Saves Five Months

One reason precast concrete was chosen for the project was the speed with which it could be constructed, fabricating components off-site while other work progressed and delivering components as needed. This approach saved five months in scheduling, which was critical for the airport, as all operations continued during its construction. Not only did construction end earlier, reducing disruption, but the airport had faster use of the structure, which provides car-rental customers direct access to the facility without added transportation needs.

The facility features a consolidated rental-car facility and a Quick Turnaround (QTA) area adjacent to the parking structure that provides fast servicing of vehicles. The three QTA levels, which include refueling stations and car washes, were constructed at intermediate levels of the garage so each QTA can service two parking levels.

The project provided the first-ever use of refueling and washing capabilities on supported levels. "Rental-

The San Jose International Airport's $260-million improvement project includes a three-level quick-turnaround area (at narrower end of structure) that connects to the main rental-car facility via ramps.

car companies have always wanted to have this ability, but it was never possible," Fredericksen says. "It was a challenge, but we were able to supply it."

The design-build process helped emphasize constructability, Fredericksen says. "We worked with the precaster to analyze all of the options and ultimately found the best approach to achieve the airport's goals for economy, efficiency and service. City and airport officials stressed the need for quick construction to alleviate disruptions to the airport. Time is money, and the ability of the precast concrete to save five months in the schedule was critical." The design team included A/E firm TranSystems in Phoenix, structural engineer Watry Design in Redwood City, Calif., and precaster Clark Pacific in West Sacramento and Woodland, Calif.

"The design-build process definitely aided our fast-track approach," says Norman Lin, project manager and senior architect with TranSystems. "The needs of the city, airport and rental-car companies had to be balanced, because they had different

Precast concrete collector beams were placed on top of the shear walls to support the double tees, which were then post-tensioned to provide the seismic support required to minimize the shear walls used, opening up the space.

An M250 crane was used to erect the components, positioned at each corner as needed. The site was constrained both by airport activity and busy highways surrounding the airport.

Collector beams on top of the shear walls were post-tensioned using between 19 and 38 strands per beam. This achieved a compressive force of 1.8 million pounds.

First-floor service levels feature all the accoutrements of rental-care facilities, allowing quick access to cars on upper levels.

Fact Sheet

Project: *San Jose International Airport parking structure*

Type: *Parking structure for rental cars and quick turnaround services*

Location: *San Jose, Calif.*

Designer: *TranSystems Corp., Phoenix, Ariz.*

Engineer: *Watry Design, Redwood City, Calif.*

Contractor: *Hensel Phelps, San Jose, Calif.*

Owner: *City of San Jose, Calif.*

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

Project Size: *1.8 million square feet*

Precast Components: *3,817 pieces, including double tees, various beams, girders, columns and spandrels*

Project Cost: *$260 million*

An array of 4,680 photovoltaic solar panels were installed on 3.4 acres of the roof to supply about 20% of the facility's electrical needs on an annual basis.

priorities, so the design team needed to be on the same page. There was a high intensity to the work for four months, when we were virtually able to read each other's minds to solve problems."

The site posed a number of challenges, due to its nonrectangular shape and nearby obstructions. The 6-acre footprint had to be accommodated on a 6.5-acre site hemmed in by highways and other airport functions. Delivering 5,000 loads of precast concrete components into this space, via construction roadways that encircled the site, required careful coordination, Fredericksen notes. "Using precast allowed much of the structural work to take place offsite, which greatly aided maneuvering on the congested site."

Providing Open Spaces

A key element for the design was meeting the unique needs of rental-car companies, which require open expanses to allow visual connections for renters and to eliminate obstructions as drivers flow through the space. This created challenges for both the ramping and seismic designs.

"Rental-car facilities want to be high in customer service, and that means no internal ramps with cars parked on them," Fredericksen explains. To alleviate that need, circular helix ramps were placed so incoming cars enter at one end and vehicles exit from the other down these selfcontained structures.

The seismic design was complicated by the need for open spaces, which minimized support options, explains John Purinton, CEO and principal at Watry. "In high-seismic zones, a lot of shear walls are needed, but rental-car companies don't want shear walls on what is essentially their showroom floor. We needed an approach that resolved the high-seismic requirements without placing shear walls throughout the space."

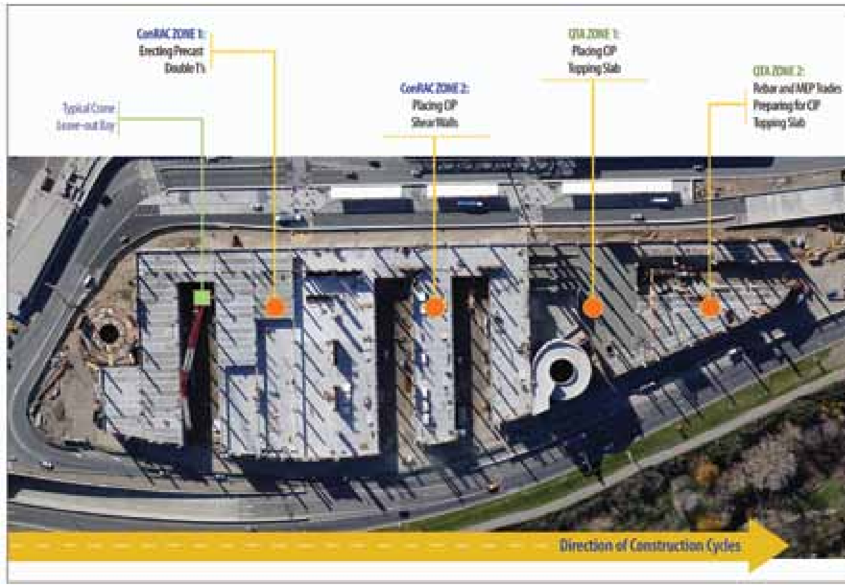
The team initially looked at moment frames, but the distance between columns needed to achieve the facility's open-space requirement created spans that were too long, says Don Clark, president of business development with Clark Pacific. That led back to shear walls—with a structural load-collection system that could shift the loads in the decks to a smaller number of strategically placed shear walls.

"We needed to create large collectors for the loads without requiring a lot of walls," Purinton says. The initial design proposed cast-in-place beams to act as drag struts, with precast concrete L beams on either side. To save time and money, the precaster suggested replacing the cast-in-place beam and precast L beams with rectangular precast collector beams to support the double tees. The precast collector beams used post tensioning to bring the load to the shear walls that were located from 90 to 150 feet from the ends of the decks.

"Using precast concrete collector beams avoided the wait that would have been required while the cast-in-place concrete beams were formed and poured on the site," Clark explains. "This way we could fabricate those beams away from the site and deliver them as they were needed along with the other pieces."

The collector beams aligned with the shear walls. The joints between the beams and the columns were grouted, and the system was post-tensioned using between 19 and 38 0.6-inch strands per beam. This achieved a compressive force of 1.8 million pounds, which was transferred to the beams. The design was created in conjunction with consultant Susie Nakaki of the Nakaki Bashaw Group, who has done extensive research on precast concrete systems in high-seismic regions.

"The collector beams and the shear walls had to align with very tight toler-



Clark Pacific used a "Push" schedule, in which each subcontractor followed the preceding one rapidly to finish each 260,000-square-foot level every four weeks, with the full project completed in eight months. Note locations where bays were left open to facilitate crane access until erection was completed.

Providing the fuel and water requirements for these levels created structural challenges.

The quick turnaround area features special services for washing (bottom) and refueling (top) vehicles, the first time such activities have been provided on elevated levels of a parking structure.

The structure's east façade features dramatic full-length murals that were decided on after the precast had been erected. Embeds in the spandrels allows the artwork to be attached after construction.

ances" Clark says. They also couldn't take a lot of time doing it, he notes. "This project was all about scheduling."

Push Schedules Speeds Work

Indeed, the team created what Clark Pacific calls a "Push" schedule, with each subsequent activity following rapidly—usually the next day—behind the previous one. The shear walls were poured, followed by the erection of the precast collection beams, installation of double tees and pouring of the deck in each section of the structure as work progressed horizontally, one level at a time.

"Crews have an easier time pouring the deck when they can do it prior to the deck above being installed," says Thad Saunders, Clark Pacific senior project manager. "This approach allowed everyone to do their part efficiently and keep up the pace. The precast scheduling created and sustained the pace of the project." If any disruptions caused a subcontractor to fall behind, he notes, they were required to make up the time in overtime or weekend work to ensure the next crew coming right behind could begin on time.

The project progressed at a rate of one floor every four weeks, comprising 260,000 square feet. In all, the project took just eight months to erect, using a just-in-time delivery process for the precast concrete components. Additional components were staged at an area 2 miles away to provide a cushion. "There was rebar, precast and concrete trucks coming and going every day, with the terminals active all around us," Saunders says.

An M250 crane was used to erect the components, Because of the tight construction site in some locations, parking bays were left out to facilitate crane and truck access. The double tees in these locations were easily backfilled to complete the bay once the balance of the structure was complete.

The erection was complicated by the narrow, curved shape of the north end, required to maximize space in the QTA, explains Lin. "The owners wanted to use every square foot possible, and squaring off the end of the structure would not have achieved that goal."

To meet that need, both the shear walls and double tees in that area were curved, with the tees cast in a pie-shaped wedge to perfectly align with the curve of the wall. "Precast concrete made it much easier to complete that curve from an architectural standpoint," says Lin. Adds Clark, "There were large forces on these tees due to their shape and the structural loads in the QTA, but they were erected without any difficulty."

Once the frame was completed, another nine months were needed to install the equipment, Lin says. "This was a big project with many more services than a typical parking garage would require."

Services Added On Floors

That was especially true for the QTA and its need to refuel and wash cars. It was designed as a separate section that connects to the rental-car structure via vehicle ramps. Floor-to-floor heights of 12'2" were created for the rental-car levels, and they connect to the QTA, where floor levels are 24'4" apart. That allows two rental-car floors to connect to one intermediate QTA level via sloped ramps.

Providing the fuel and water requirements for these levels created additional structural challenges. Wash and rinse water was provided in multiple 2,000-gallon tanks on each level, including a reverse-osmosis system for spot-free rinsing. To protect against moisture penetration with such high water use, the floors in this area feature added water resistance. A $3^1/_2$-inch topping was applied on top of the double tee, followed by a hot asphaltic waterproofing layer and another 4-inch topping.

Meeting fire concerns around refueling stations proved more challenging. The main fueling tanks are secured at grade level, with fuel delivered to pumps on each QTA level via pressurized pipes. But a variety of objections were raised by the fire marshal before approval was given for them to be installed.

"We worked closely with the fire department to alleviate their concerns as each arose, digging in to find a way to overcome it to their satisfaction," says Fredericksen. "None of them was too unusual, but there were many to address from a safety standpoint."

The structure's west façade features architectural metal panels and mesh to dampen lighting and create an attractive finish.

For instance, a key concern was protecting the pumps on each level from accidental vehicle damage that could spill gasoline and cause an explosion or fire. This was met by adding shear valves to the pumps that stop the flow if the equipment is hit. Additional bollards were added around the fuel dispensers, delineated striping was provided, and 8-inch curbs separate inbound and outbound car lanes to ensure no vehicles drift and cause collisions.

"We created exercises to deal with each possible scenario and devised a plan to prevent any damage," Fredericksen says. "It was a true partnership of the entire team."

Façade Added Afterward

The partnership extended to the façade treatments, which were still being discussed as the structure was built. City officials were considering a variety of options for façade treatments, so precast concrete spandrels were installed that serve as car-impact shields as well as a base skin. Metal mesh and metal panels were later applied to these spandrels on three sides, while large artwork murals were applied to the east side, adding visual interest.

To allow for these variations, the precaster placed embeds every 12 feet along the face of the spandrels to allow for whatever curtain wall was later specified, Purinton says. "We worked closely with Clark Pacific to ensure we created an envelope to which any finish could be applied once the plan was decided."

Providing the fuel and water requirements for these levels created structural challenges.

As a finishing touch, a 1.12-mw modular system of 4,680 monocrystalline solar panels were installed on 3.4 acres of the roof. The panels are expected to produce an annual output of 1.7 million kWh, which will offset at least 20% of the facility's electrical needs, according to reports.

The design-build process ensured challenges were met promptly to keep the project on schedule. "The project came together very well, with no surprises," Lin says. "The precast concrete tees worked well to achieve the intensive loads we required, and the spandrels provide the flexibility to accommodate the interesting façades."

The design offers creative techniques that other projects can adapt to solve similar challenges, especially in high-seismic zones and where speed of construction is a high priority, says Purinton. "These aren't techniques that solve problems that arise every day, but they're definitely worth having in your arsenal."

Involving the precaster in the design-build process was a key to the smooth process, he adds. "That helped foster solid teamwork, which led to unique solutions for integrating the different functions of this multifaceted building," he says. "The combination of pretensioning and post-tensioning was the best solution to meet the client's needs for wide-open floors while minimizing the number of shear walls." ■

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

Acceptability of Appearance

designer'snotebook

Acceptability of Appearance

For the acceptability of color, finish, and texture, one person should have final authority. Contract documents must clearly identify who the accepting authority will be: architect, owner, general contractor, or site inspector.

Determining acceptable uniformity of color, finish, and texture is by visual examination, and is generally a matter of subjective, individual judgment and interpretation. Acceptable color and texture variations, surface blemishes, and uniformity should be determined at the time the sample, mockup, or initial production units are approved. Accordingly, it is beyond the scope of this publication to establish precise or definitive rules for product acceptability on the basis of appearance. However, a suitable criteria for acceptability requires that the finished concrete surface should have a pleasing appearance with minimal color and texture variations from the approved samples. The finished surface on the face should show no readily visible imperfections other than minimal color and texture variations from the approved samples or evidence of repairs when viewed in typical daylight illumination with the unaided eye consistent with the viewing distance of the structure but not less than a 20 ft (6.1 m) or greater viewing distance. Appearance of the surface also should not be evaluated when light is illuminating the surface from an angle, as this tends to accentuate minor surface irregularities due to shadowing.

Building facades may be oriented such that sunlight just grazes the surface at a particular time of day. This causes otherwise imperceptible ripples, projections, and misalignments on the surface to cast long shadows and be grossly exaggerated in appearance. The shadows may last briefly. The actual time at which they appear varies with the season for a particular elevation.

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

The importance of using small mockups to establish and verify expectations of color, texture, and range cannot be over-emphasized. Their use is especially important when casting difficult mixes, finishes, or shapes.

The following is a list of finish defects and/or problems that are normally unacceptable in high-quality architectural precast concrete. Blemish repairs to meet the acceptability criteria should be permitted provided appearance, structural adequacy and durability are not impaired.

1. Ragged or irregular edges. When sharp edges are specified, minor chips and irregular edges are unavoidable and should be acceptable.

   Edge details should be reviewed with the precaster during the design and mockup approval process. It is recommended that all edges be detailed with a chamfer, reasonable radius (eased edge), or quirk. It is impossible to cast concrete into a 45-degree or sharper corner because large aggregate, consolidation, and segregation issues prevent the concrete matrix from completely filling the sharp corner. Further, sharp edges and mitered corners without quirks chip easily and are difficult to manufacture and erect within acceptable dimensional and aesthetic parameters. Mitered corners should have a cutoff or quirk, not less than ½ in. (13 mm) with ¾ in. (20 mm) preferred, nor less than 1.5 times the maximum aggregate size used in the concrete mixtures.

2. Excessive air voids (commonly called bugholes) evident on the exposed surface. Products with deep returns and sculptured units may have visible air voids on the returns. Air voids become accentuated when the surface is smooth, acid etched, or lightly sandblasted. If the air holes are of a reasonable size, $^1/_8$ to $^1/_4$ in. (3 to 6 mm) and not clustered into objectionable patterns, it is recommended that they be accepted as part of the texture. Filling and sack-rubbing could be used to

eliminate the voids. However, this procedure is costly and may cause color differences. Samples or mockup panels should be used to establish acceptable air void size, frequency, and distribution.

3. Adjacent flat and return surfaces with greater texture and/or color differences than the approved samples or mockups. Returns in some finishes will not appear exactly like the front face (down-face) due to a number of factors such as mixture proportions, variable depths, and small differences in consolidation techniques. This is particularly the case with intricate shapes and complex placement requirements. The effect of gravity during consolidation tends to force the large aggregate downward and the smaller aggregate, sand and cement paste, upwards. Consequently, the down-face in the form/mold will generally be more uniform and denser than the returns or upper radius.

   The surface of large panels should be divided into smaller areas by means of rustication or reveals to minimize the perception of textural differences.

   For large returns, or situations where it is necessary to minimize variations in appearance, the two-stage or sequential production technique should be used. If feasible, concrete mixtures should be selected where the aggregate gradation can be uniformly controlled and preferably fully graded. Exposures should be medium to deep, and color differences between the ingredients of the mixture should be minimal.

4. Casting and/or aggregate segregation lines evident from different concrete placement lifts and consolidation.

5. Visible form/mold joints, seams, or irregular surfaces in excess of or larger than those acceptable in the approved samples or mockups.

6. Rust stains on exposed surface. Rust stains caused by reactive iron pyrites or other contaminants will occur where such contaminants are found as part of the aggregates. Rust stains may also be caused by particles of steel left by the aggregate crusher, pieces of tie wire from the cage assembly, or particles of steel burned off in welding or drilling. These stains (and steel particles) should be removed from the surface. Rust stains due to corrosion of connection hardware should not occur if the hardware has been protectively coated or where it is entirely behind a weatherproofed joint.

7. Excessive variation of texture and/or color from the approved samples, within the individual unit or compared with adjacent units. Some color difference between nominally identical precast concrete units is inevitable. Color variation, between and within panels, should be kept within a range established through range samples. Uniformity in color is primarily related to variations in the water-cement ratio, concrete mix materials, and curing conditions for the concrete.

   Units containing aggregates and matrices of contrasting colors will appear less uniform that materials of similar color. As the size of the coarse aggregate increases, less matrix is seen, which results in a more uniform color. The architect should specify that the matrix's color or tone match that of the coarse aggregate so that variations in the depth of exposure and concentration of aggregate will not be as noticeable.

   Color uniformity is more difficult to achieve on gray, buff and pigmented concrete surfaces. The use of white cement will usually provide better color uniformity than gray cement. Typical color variation in gray cement is sufficient to cause noticeable color differences in precast concrete panels. The slightest change of color is readily apparent on the uninterrupted surfaces of smooth-as-cast concrete, and any variation is likely to be regarded as a surface blemish. As a general rule, a textured surface provides a better aesthetic finish than a smooth surface. The degree of uniformity (different shadings and to some extent, color intensity) between panels and within panels is generally in direct proportion to the depth of exposure. Color variations will normally decrease to some extent with exposure to sunlight and other environmental elements.

It is very difficult and often deceiving to try to assess color variations during cold, damp, and/or freezing conditions. It is also difficult to assess color variations just after the panels have been erected and before they have been cleaned.

8. Blocking stains evident on exposed surface. Blocking used to separate production units in the storage yard or during shipment should be made with non-staining materials. Blocking should not trap moisture or prevent air circulation that may disrupt uniform curing conditions. Plastic bubble type pads are well suited for this purpose. Lumber or padding wrapped with plastic should not be used for blocking for extended periods, unless in an area that is not visible in the final structure.

9. Areas where the backup concrete penetrated through the facing concrete.

10. Foreign material embedded in the face of the unit.

11. Repairs visible at 20 ft (6m) or greater viewing distance. A certain amount of product repair is to be expected as a routine procedure. Repair methods should ensure that the repaired area will conform to the balance of the work with respect to applicable requirements for appearance, structural adequacy, serviceability, and durability. Slight color variations may occur between the repaired area and the original surface due to the different age and curing conditions of the repair. The repair will generally become less noticeable over time (at least one month) with exposure to the environment and should blend into adjacent surfaces so it becomes less noticeable. Excessive variation in color and texture of repairs from adjacent surfaces may be cause for rejection until the variation is minimized.

12. Reinforcement shadow lines. Reinforcing steel in some finishes may show up as light or dark shadow lines usually directly over the steel depending on the mixture, concrete cover, and vibration of reinforcement. Reinforcement shadow lines may be more prevalent in as-cast or lightly textured finishes.

13. Cracks visible at a 20 ft (6 m) or greater viewing distance. The acceptability of cracks should be determined with respect to actual service condition requirements, structural significance, and aesthetics. Every effort should be made to promptly identify the cause of any cracking and to document the pattern, particularly when several units display similar cracking. Such cracking is often the result of a single design, manufacturing, or handling problem, which can then be rectified to prevent any recurrence.

    The cement-rich film on smooth concrete may develop a network of fine random hairline cracks (crazing) in an approximate hexagonal or octagonal pattern. A hairline crack is defined as a surface crack of minute width and rarely more than 1/8 in. (3 mm) deep, visible to the naked eye but not measurable by ordinary means.

    Crazing is merely a surface phenomenon (penetrates only as deep as the thin layer of cement paste at the surface of the panel) and has no structural or durability significance but it may become visually accentuated when the surface is wetted or dirt settles in these minute cracks. Crazing is more predominant in as-cast or lightly textured finishes. Such crazing cracks are of little structural importance and should not constitute a cause for rejection.

    It should be recognized that a certain amount of crazing or cracking may occur without having any detrimental effect on the structural capacity of the member. It is impractical to impose specifications that prohibit cracking.

    A key point is cracks do not always result in corrosion of reinforcement. Corrosion depends not only on the width of the crack and whether it reaches the reinforcing steel, but also on the presence of chlorides or low pH in combination with oxygen and moisture. For surfaces exposed to the weather, cracks up to 0.005 in. (0.13 mm) wide have no influence on the corrosion of reinforcement and should be acceptable from an aesthetic viewpoint as shown in viewer's reactions, Fig. 1.

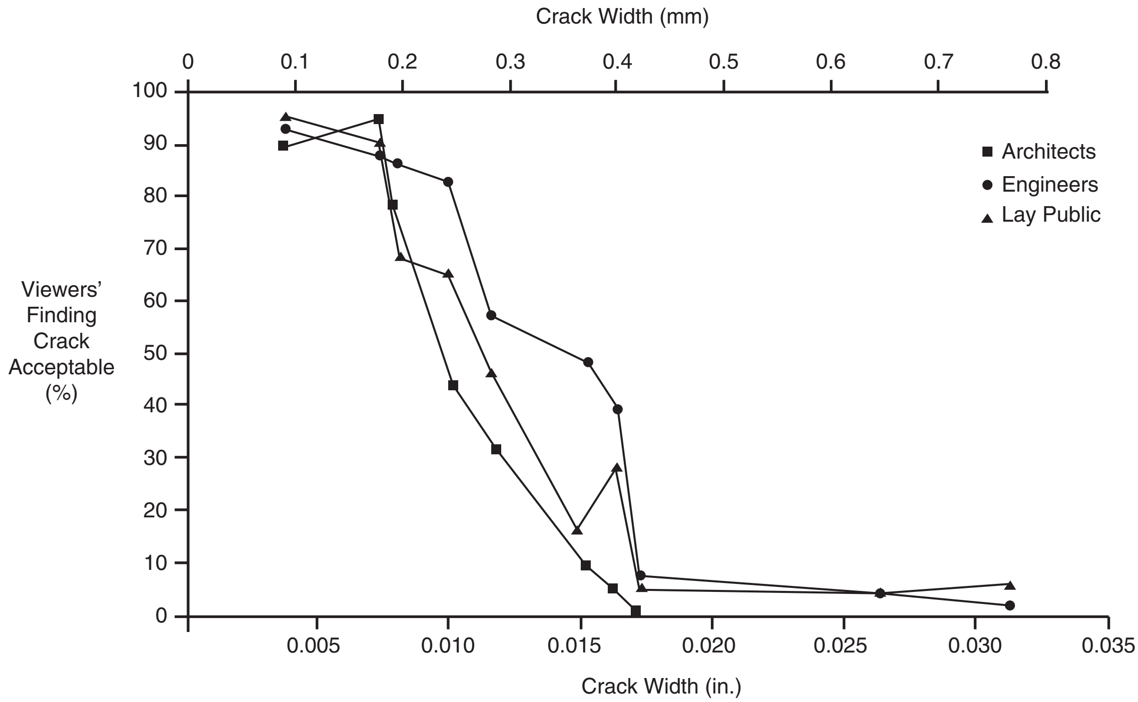


Figure 1Viewer reaction to cracks of different widths.

If the crack width is narrow, not over 0.012 in. (0.30 mm), the structural adequacy of the casting will remain unimpaired and the crack will have little influence on the potential for corrosion of the reinforcement. The limitation on crack-size specified is for structural reasons. The aesthetic limitation will depend on the surface texture and the required appearance. On coarse textured surfaces, such as exposed-aggregate concrete, and on smooth surfaces comparable to the best cast-in-place structural concrete, the structural limitation would be aesthetically acceptable. In addition, it should be noted that cracks may become more pronounced on surfaces receiving a sandblasted or acid-etch finish.

If crack repair is required for the restoration of structural integrity, cracks may be filled or pressure-injected with a low-viscosity epoxy. The acceptability of the crack repairs should be governed by the importance and function of the panel. The decision regarding acceptability must be made on an engineering basis as well as on visual appearance.

AIA Learning Units

This program is registered with the AIA/CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product. Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

The Precast/Prestressed Concrete Institute (PCI) is a Registered Provider with the American Institute of Architects Continuing Education Systems. Credit earned on completion of this program will be reported to CES Records for AIA members. Certificates of Completion for non-AIA members are available on request.

Instructions

Review the learning objectives below.

Read the AIA Learning Units article.

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

Learning Objectives

After reading this article, readers will be able to explain how and when to view a structure to determine if its appearance is acceptable, define "crazing cracks", identify potential causes for various defects in panels, and describe the appropriate samples needed to accurately understand potential color and texture variations.

Ascent 2011 – Acceptability of Appearance

Name (please print): ______________________________

Company Name: ______________________________

Address: ______________________________

City: ____________________ State: __________ Zip: __________

Phone Number: ______________ Email Address: ______________________

Title: ______________________________

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

1. At what minimum distance should a structure be viewed for determining acceptability of appearance?
   a. 20 feet
   b. 30 feet
   c. 5 feet
   d. No specific distance

2. Viewing a structure for acceptability of appearance should NOT be done when light is illuminating the structure at an extreme angle (T or F)

3. Range samples should be:
   a. 2 x 2 in size and made in the QC lab
   b. 2 x 2 in size and made from production concrete
   c. 4 x 4 in size and made in the QC lab
   d. 4 x 4 in size and made from production concrete

4. To minimize chips in sharply designed edges:
   a. Design edges with a cutoff or quirk, not more than $^3/_4$ in. (20 mm), nor less than 1.5 times the maximum aggregate size used in the concrete mixtures
   b. Design edges with a cutoff or quirk, not less than $^3/_4$ in. (20 mm), nor less than 1.5 times the maximum aggregate size used in the concrete mixtures
   c. Design edges with a cutoff or quirk, not less than $^1/_2$ in. (14 mm), nor less than 1.5 times the maximum aggregate size used in the concrete mixtures
   d. Design edges with a cutoff or quirk, not less than $^3/_4$ in. (20 mm), nor less than 1.0 times the maximum aggregate size used in the concrete mixtures

5. Reasonable sized air voids or bugholes should be accepted if their diameters are not greater than:
   a. $^1/_{16}$ in (1.5 mm)
   b. $^1/_8$ in. (3 mm)
   c. $^1/_4$ in (6 mm)
   d. $^1/_2$ in (12 mm)

6. Which of the following is NOT a factor in influencing color and texture differences between a flat surface and an adjacent return?
   a. Small differences in consolidation techniques
   b. Form material
   c. Mixture proportions
   d. Gravity

7. Materials in contact with the exposed surfaces of precast concrete used in shipping and storage should:
   a. be covered in plastic bags to avoid staining
   b. not be in contact with the precast for more than 24 hours at a time
   c. not trap moisture or prevent air circulation
   d. trap moisture and prevent air circulation

8. Which of the following statements is NOT true about crazing cracks?
   a. Crazing are random hairline cracks that form in the cement-paste film on the surface of concrete
   b. Crazing cracks are of little importance and should not constitute a cause for rejection.
   c. Crazing cracks are not common on flat cement-rich surfaces.
   d. Crazing cracks are rarely more than an ⅛ inch in depth.

9. Typically as the exposure of coarse aggregate increases in the finish:
   a. Uniformity of color and texture is not affected
   b. Uniformity of color and texture decreases
   c. Uniformity of color and texture increases

10. The appropriate acceptable aesthetic crack width for a precast panel exposed to weather is:
    a. 0.005 in.
    b. 0.012 in.
    c. 0.010 in.
    d. 0.05 in.

11. What is the minimum distance from which to view a repair for color and texture blending?
    a. 30 feet
    b. There is no minimum distance
    c. 10 feet
    d. 20 feet

To receive credit, please submit completed forms to:

Attn: Education Dept. – Alex Morales • Fax (312) 312-361-8079 • Email amorales@pci.org

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200 West Adams Street | Suite 2100 | Chicago, IL 60606-5230
Phone: 312-786-0300 | Fax: 312-621-1114 | www.pci.org

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PCI webinars are presented live each month by industry experts on a variety of topics from design and construction to sustainability and more. All webinars are FREE, one hour long, and scheduled to start at noon in each time zone in the contiguous United States. Webinars provide an inexpensive way to stay up to date on new materials, products, concepts, and more while earning continuing education credits. Visit www.pci.org/webinars for the full webinar schedule and registration information.

Upcoming Webinars:

- Parking Structures: Historical Development and Emerging Trends
  May 31 and June 2, 2011
- Parking Structures and Their Role in Sustainable Design
  June 21 and 23, 2011

PCI eLearning Center

The PCI eLearning Center is the first education management system dedicated to the precast concrete structures industry. This free 24-hour online resource provides an opportunity for architects and engineers to earn continuing education credits on demand. Each course includes a webinar presentation recording, reference materials, and a quiz. Visit this new resource at www.pci.org/elearning.

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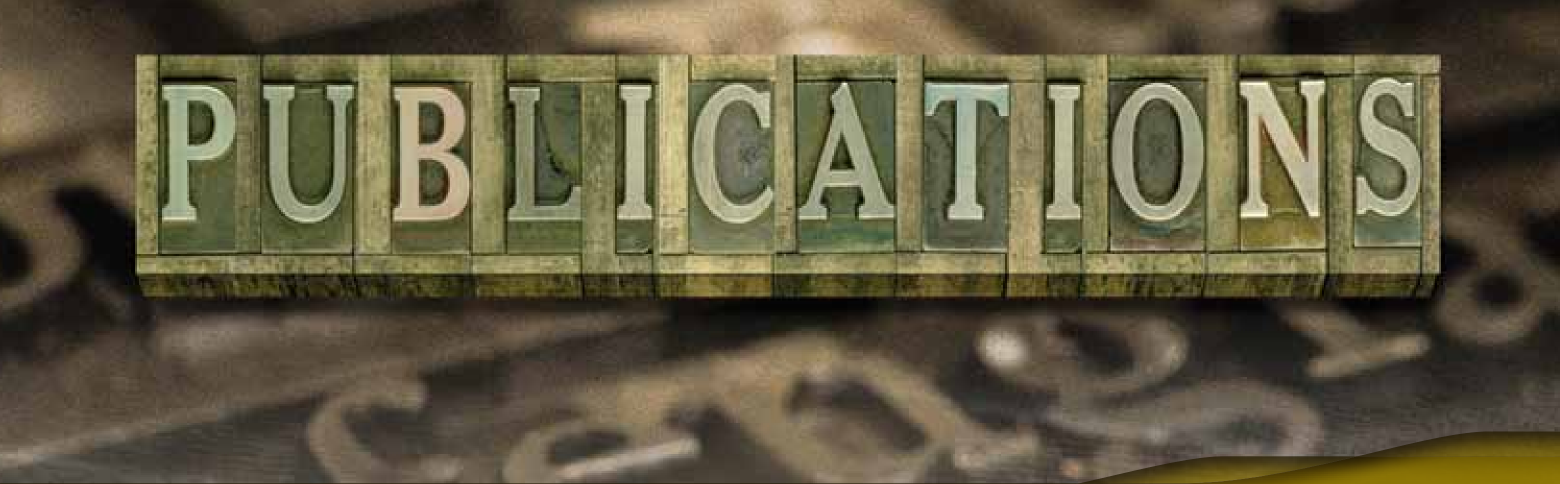
PCI and its regional affiliates offer seminars all over the United States on a variety of topics. Visit www.pci.org/education for up-to-date seminar listings, additional information, and registration.

Upcoming Seminars:

- PCI Structural Design Seminar
  May 11, 2011, Waukesha, Wis.
  June 9, 2011, Omaha, Neb.
- Designing with Architectural Precast Concrete Seminar
  June 9, 2011, Omaha, Neb.
- Quality Control School
  Level 1/2, September, 14-16, 2011, Chicago, Ill.
  Level 3, September 13-16, 2011, Chicago, Ill.

Lunch-and-Learns

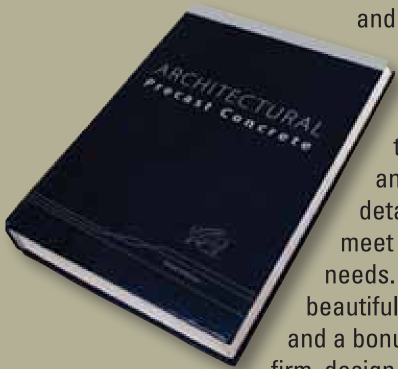
PCI's lunch-and-learn/box-lunch programs are a convenient way for architects, engineers, and design professionals to receive continuing education credit without leaving the office. Industry experts visit your location; provide lunch; and present on topics such as sustainability, institutional construction, 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.



New Publications from PCI

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

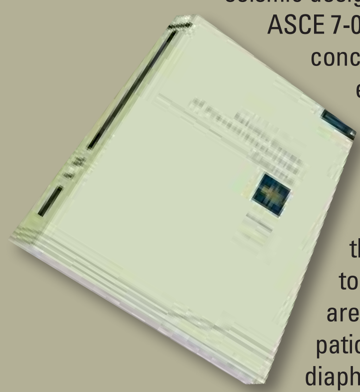
This fully revised edition of *Architectural Precast Concrete* includes new sections on sustainability, condensation control, and blast resistance. You'll get extensive updates in the areas of color, texture, finishes, weathering, tolerances, connections, and windows, along with detailed specifications 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*, Sixth Edition**. The standard for the design, manufacture, and use of structural precast/prestressed concrete and architectural precast concrete.
MNL-120-04. ISBN: 0-937040-71-1 / 0978-0-937040-71-7
$260 / PCI Members $130

***Manual for the Evaluation and Repair of Precast, Prestressed Concrete Bridge Products*, First Edition**. Includes information on imperfections or damage that can occur during production, handling, transportation, and erection.
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.
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PCI-Certified Plants

(as of April 2011)

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

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

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

Guide Specification

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

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

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

Product Groups and Categories

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

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

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

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

GROUPS

GROUP A – *Architectural Products*

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

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

GROUP B – *Bridges*

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

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

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

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

GROUP BA – *Bridge Products with an Architectural Finish*

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

GROUP C – *Commercial (Structural)*

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

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

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

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

GROUP CA – *Commercial Products with an Architectural Finish*

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

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

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

ALABAMA

Gate Precast Company, Monroeville (251) 575-2803 — A1, C3A
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 — C2
Hanson Structural Precast, Irwindale (626) 962-8751 — C4
Hanson Structural Precast, San Diego (619) 423-9030 — C4
Kie-Con Inc. - Kiewit Corporation, Antioch (925) 754-9494 — B2, C3
Mid-State Precast, L.P., Corcoran (559) 992-8180 — A1, C3A
Pomeroy Corporation, Perris (951) 657-6093 — B4, C2A
StructureCast, Bakersfield (661) 833-4490 — A1, B3, C3A
Walters & Wolf Precast, Fremont (510) 226-5162 — A1, G
Willis Construction Co., Inc., San Juan Bautista (831) 623-2900 — A1, C1, G

COLORADO

EnCon Colorado, Denver (303) 287-4312 — B4, C2
Plum Creek Structures, Littleton (303) 471-1569 — B4, C3A
Rocky Mountain Prestress, Inc., Denver (303) 480-1111 — B4, C4
Rocky Mountain Prestress, Inc., Denver (303) 480-1111 — A1, AT, 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., Gretna (850) 875-4651 — B4, C2
Cement Industries, Inc., Fort Myers (239) 332-1440 — B3, C3
Colonial Construction, Concrete, Precast, LLC, Placid (941) 698-4180 — C2
Coreslab Structures (MIAMI) Inc., Medley (305) 823-8950 — A1, C4A
Coreslab Structures (ORLANDO) Inc, Orlando (407) 855-3191 — C2
Coreslab Structures (TAMPA) Inc., Tampa (813) 626-1141 — A1, B3, C3A
Dura-Stress, Inc., Leesburg (800) 342-9239 — A1, B4A, C4A
Finfrock Industries, Inc., Orlando (407) 293-4000 — A1, C4A
Florida Precast Industries, Inc., Sebring (863) 655-1515 — C2
Florida Rock and Sand Prestress Precast Co., Inc., Florida City (305) 247-9611 — B3, C3
Florida Rock and Sand Prestress Precast Co., Inc., Miami (305) 247-9611 — B3
Gate Precast Company, Jacksonville (904) 757-0860 — A1, B4, C4
Gate Precast Company, Kissimmee (407) 847-5285 — A1
Metromont Corporation, Bartow (863) 440-5400 — A1, C3
South Eastern Prestressed Concrete, Inc., West Palm Beach (561) 793-1177 — B3, C3
Stabil Concrete Products, LLC, St. Petersburg (727) 321-6000 — A1
Standard Concrete Products, Inc., Tampa (813) 831-9520 — B4, C3
Stress-Con Industries, Inc., Fort Myers (239) 390-9200 — B3
Structural Prestressed Industries, Medley (305) 556-6699 — C4

GEORGIA

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

HAWAII

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

IDAHO

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

ILLINOIS

ATMI Precast, Aurora (630) 896-4679 — A1, C3A
Avan Precast Concrete Products, Lynwood (708) 757-6200 — A1, C3
County Materials Corporation, Champaign (217) 352-4181 — B3, B3-IL
County Materials Corporation, Salem (618) 548-1190 — A1, B4, B4-IL, C4
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

INDIANA

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

IOWA

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

KANSAS

Coreslab Structures (KANSAS) Inc., Kansas City (913) 287-5725 — B4, C4
IPC, Inc., Pleasanton (913) 352-8800 — B3, C3
Prestressed Concrete, Inc, Newton (316) 283-2277 — A1, B4, C4
Stress-Cast, Inc., Assaria (785) 667-3905 — C3A
Waffle-Crete International, Inc., Hays (785) 625-3486 — C3A

KENTUCKY

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

LOUISIANA

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

MAINE

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

MARYLAND

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

MASSACHUSETTS

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

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

MICHIGAN

Grand River Infrastructure, Inc., Grand Rapids (616) 534-9645 ___ B4, C1
International Precast Solution, LLC, River Rouge (313) 843-0073 ___ A1, B3, C3
Kerkstra Precast Inc., Grandville (800) 434-5830 ___ A1, B1, C3A
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
Cretex Concrete Products North, Inc., Elk River (763) 545-7473 ___ B4, C2
Fabcon, Savage (800) 727-4444 ___ B1, C3A
Hanson Structural Precast Midwest, Inc., Maple Grove (763) 425-5555 ___ A1, C4A
Molin Concrete Products Co., Lino Lakes (651) 786-7722 ___ C3A
Wells Concrete Products, Albany (320) 845-2299 ___ A1, C3A
Wells Concrete Products Co., Wells (507) 553-3138 ___ A1, C4A

MISSISSIPPI

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

MISSOURI

Coreslab Structures (MISSOURI) Inc., Marshall (660) 886-3306 ___ A1, B4, 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

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, AT

NEW HAMPSHIRE

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

NEW JERSEY

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

NEW MEXICO

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

NEW YORK

David Kucera Inc., Gardiner (845) 255-1044 ___ A1, G
Lakelands Concrete Products, Inc., Lima (585) 624-1990 ___ A1, B3A, C3A
Oldcastle Precast Building Systems Div., 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 ___ B3, C3

NORTH CAROLINA

Gate Precast Company, Oxford (919) 603-1633 ___ A1, C2
International Precast Inc., Siler City (919) 742-3132 ___ A1, C3A
Metromont Corporation, Charlotte (704) 372-1080 ___ A1, 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.VValley City (330) 483-3111 ___ C2
Prestress Services Industries LLC, Grove City (614) 871-2900 ___ B4, C1
Sidley Precast, Thompson (440) 298-3232 ___ A1, C4A
United Precast, Inc., Mt. Vernon (800) 366-8740 ___ B4, C3
United Precast, Inc., Mt. Vernon (740) 393-1121 ___ B3, C1

OKLAHOMA

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

OREGON

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

PENNSYLVANIA

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

SOUTH CAROLINA

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

SOUTH DAKOTA

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

TENNESSEE

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

TEXAS

Coreslab Structures (TEXAS) Inc., Cedar Park (512) 250-0755 ___ A1, C4A
CXT, Inc., Hillsboro (254) 580-9100 ___ B1, C1
Eagle Precast Corporation, Decatur (940) 626-8020 ___ A1, AT, C3
Enterprise Concrete Products, LLC, Dallas (214) 631-7006 ___ B3, C3
Gate Precast Company, 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 Precas, Shaftsbury (802) 442-4418 ____ A1, B4A, C3A
J. P. Carrara & Sons, Inc., Middlebury (802) 388-6363 ____ A1, B4A, C3A
S.D. Ireland Companies, South Burlington (802) 658-0201 ____ A1

VIRGINIA

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

WASHINGTON

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

WEST VIRGINIA

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

WISCONSIN

Advance Cast Stone Co., Inc., Random Lake (920) 994-4381 ____ A1
County Materials Corporation, Eau Claire (800) 729-7701 ____ B4
County Materials Corporation, Roberts (800) 426-1126 ____ B4, C3
International Concrete Products, Inc., Germantown (262) 242-7840 ____ A1, C1
MidCon Products, Inc., Hortonville (920) 779-4032 ____ A1, AT, C1
Spancrete Industries, Inc., Waukesha (414) 290-9000 ____ A1, B2A, C3A
Spancrete, Inc., Green Bay (920) 494-0274 ____ B4, C4
Spancrete, Inc., Valders (920) 775-4121 ____ A1, B3, C3A
Stonecast Products, Inc., Germantown (262) 253-6600 ____ A1, C1
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
Lafarge Canada Inc., Winnipeg (204) 958-6381 ____ C2

NEW BRUNSWICK

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

NOVA SCOTIA

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

ONTARIO

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

QUEBEC

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

MEXICO

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

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PCI-Qualified & PCI-Certified Erectors

(as of January 2011

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

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

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

Guide Specification

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

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

Erector Classifications

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

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

MNL–132 Erection Safety Manual for Precast and Prestressed Concrete

GROUPS

Category S1 - Simple Structural Systems
This category includes horizontal decking members (e.g. hollow-core slabs on masonry walls), bridge beams placed on cast-in-place abutments or piers, and single-lift wall panels.

Category S2 - Complex Structural Systems
This category includes everything outlined in Category S1 as well as total-precast, multi-product structures (vertical and horizontal members combined) and single- or multistory load-bearing members (including those with architectural finishes).

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

Certified erectors are listed in blue.

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

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

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

COLORADO
Colorado Fabricators & Constructors, Inc., Centennial (303) 471-9902 — S2, A
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 — S2, A
Gate Precast Erection Co., Kissimmee (407) 847-5285 — 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
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

INDIANA
National Steel Erectors, Inc., Indianapolis (317) 481-0388 — A
Stres Core Inc., South Bend (574) 233-1117 — S1

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

Concrete Structures, Inc., Marshfield (781) 837-1931 ________ S2, A
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) 965-3455 ________ 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
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

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

NEVADA

Cedco Commerical, LLC, Las Vegas (702) 361-6550 ________ 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

NEW YORK

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

NORTH CAROLINA

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

NORTH DAKOTA

Northwest Contracting Inc., Bismarck (701) 255-7727 ________ S2
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
Bennet Steel, Inc., Sapulpa (918) 260-0773 ________ S1
Coreslab Structures (OKLA), Inc., Oklahoma City (405) 632-4944 ________ S2, A

PENNSYLVANIA

Century Steel Erectors, Kittanning (724) 545-3444 ________ S2, A
Conewago Enterprises, Inc., Hanover (717) 632-7722 ________ S2
High Concrete Group, Denver (717) 336-9300 ________ S2, A
Maccabee Industrial, Inc., Belle Vernon (724) 930-7557 ________ S2, A
Nitterhouse Concrete Products, Inc., Chambersburg (717) 267-4505 ________ S2
Patterson Construction Company, Inc., Monongahela (724) 258-4450 ________ S1
Structural Services, Inc., Bethlehm (610) 282-5810 ________ S1

SOUTH CAROLINA

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

TENNESSEE

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

TEXAS

Empire Steel Erectors LP, Humble (281) 548-7377 ________ A
Gate Precast Company, Pearland (281) 485-3273 ________ S1
Gulf Coast Precast Erectors, LLC, Hempstead (832) 451-4395 ________ S2
Precast Erectors, Inc., Hurst (817) 684-9080 ________ S2, A

UTAH

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

VERMONT

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

VIRGINIA

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

WASHINGTON

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

WISCONSIN

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

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