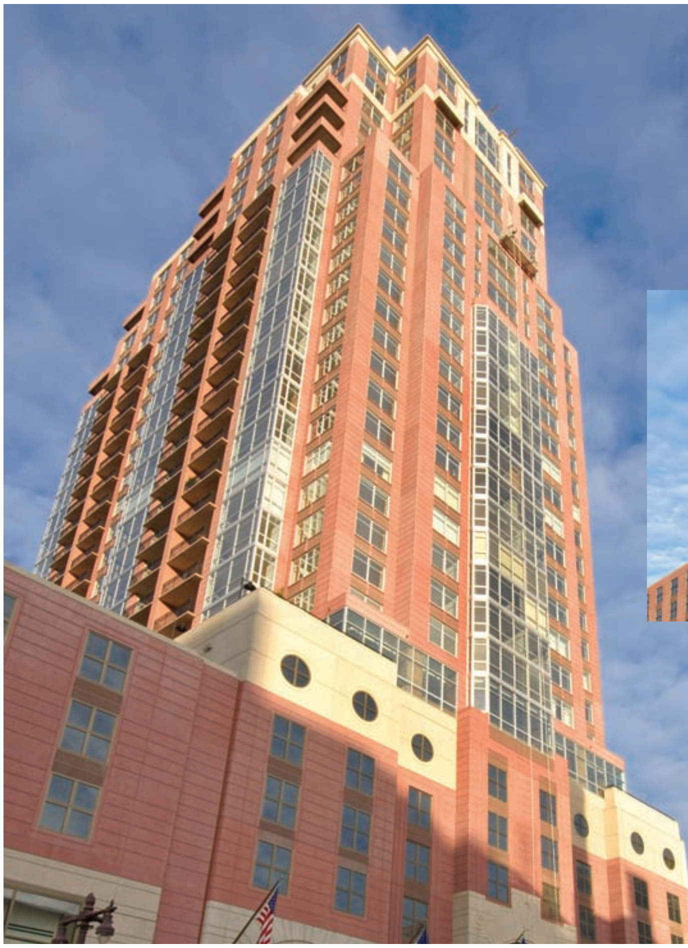
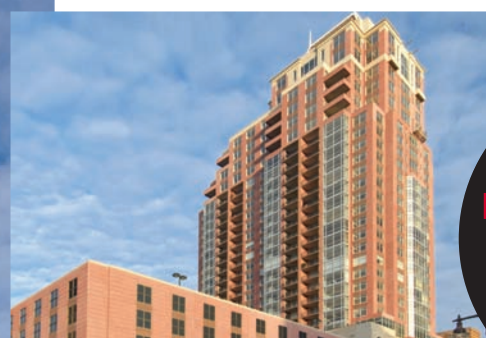
CONCRETE
INNOVATIONS & ANSWERS®

News from High Concrete Group LLC

Winter Issue 2009



Symphony House Recognition at World of Concrete 2009



Earn 1.0 AIA HSW Learning Unit

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Earn 1.0 AIA HSW Credit — Insert

The 32-story Symphony House luxury condominiums and theater in Philadelphia, Pa., has been selected as the winner of the high-rise category in the GreenSite Project of the Year 2008 contest. Sponsored by *Concrete Construction* and *The Concrete Producer* magazines, the GreenSite award recognizes concrete buildings that are built using sustainable design practices.

Winners were selected based on such factors as innovative techniques, use of innovative materials or products, cost- or time-saving methods, innovative engineering design, workmanship, and creativity. Completed in fall 2007, the Symphony House used lightweight CarbonCast® carbon fiber-reinforced precast concrete architectural cladding that reduced superstructure requirements. Innovative slab attachment also reduced the number and size of columns in the tower, permitting more open floor plans.

The project will be on display at the GreenSite exhibit at World of Concrete 2009, February 3–6, 2009 at the Las Vegas Convention Center in Las Vegas, Nev. A slideshow with full descriptions and photos of the Symphony House project and other GreenSite winners may be found at www.theconcreteproducer.com.

Jeff Smith—President

Letter from the President

Winter may be here, but the green movement is going strong here at High Concrete Group. Even as the economy presents deep challenges, we are getting into gear to supply the sustainable products you need by the most environmentally conscientious means possible.

High Concrete Group committed to the Sustainability Committee of the Precast/Prestressed Concrete Institute to undertake a life cycle assessment of our Denver manufacturing facility, one of three precast industry plants that will participate. The results of this study will let our customers know the carbon footprint of precast materials, so they can make informed decisions. It will also inform and give guidance to the precast industry itself, showing where processes and products can be improved to become more sustainable and more economical.

For High, the effort will contribute to a new initiative in which all the High companies will cooperate to define our corporate carbon footprint.

High Concrete Group's environmental commitment to date includes a ground-breaking water reclamation system, Eco-Mix® concrete mixes with 50% or greater cement replacement with recycled materials, and carbon fiber reinforcement for larger, lighter and more durable precast members that are recognized around the world as the future of the precast industry. Against this backdrop, it should come as no surprise that this newsletter will be changing as well.

Starting with the spring 2009 issue, readers of the Concrete Innovations & Answers® newsletter will receive the latest in precast technologies, innovations and products online, and not in paper format. This change allows us to give you more information, more regularly and in greater detail. You'll also have more opportunities for AIA-registered distance learning credits that fit with your schedule.

We're not saying we won't ever mail a newsletter to you again. But print copies will be special events. So, if you want the spring issue, please be sure to sign up at www.highconcrete.com, or call Gary Reed at 1.800.PRECAST.

Thanks for your business.

PRECAST NEWS

High Concrete Group Wins Award of Excellence, Six Merit Awards at PPA

A precast parking garage built by High Concrete Group LLC has been recognized with an Award of Excellence by the Pennsylvania Parking Association (PPA). The Hawks Landing Saint Joseph's University Parking Garage and Retail Facility in Philadelphia, Pa. received the annual competition's award in the New Design Less than 450 Spaces division.

The awards were given at the PPA's 2008 Conference in Pittsburgh, Pa. Designed by architect Burt Hill, Philadelphia, Pa., the Saint Joseph's garage is a gateway to the school's urban campus, transitioning visitors from the busy city to the quiet campus environment. The project is replete with gothic cues in keeping with prominent historic university buildings. First floor retail spaces provide an anchor and make the garage itself a destination.

Shoemaker Construction Company of West Conshohocken, Pa. was the general contractor; O'Donnell & Naccarato, Philadelphia,Pa. was the structural engineer. The Saint Joseph's garage was featured in the October 2008 issue of *The Parking Professional,* the official monthly publication of the International Parking Institute.

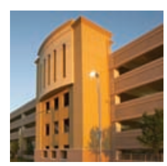
The PPA competition recognized six other High Concrete Group projects with Awards of Merit in each of the three New Design divisions:

A.I.DuPont Hospital for Children, Wilmington, Del.
Award of Merit, New Design More than 1,000 Spaces.
Architect: Payette Associates, Inc.
Engineer: Walker Parking Consultants.
General Contractor/CM: Gilbane Construction Company.

Hershey Intermodal Commuter Station Garage, Hershey, Pa.
Award of Merit, New Design Less than 450 Spaces.
Architect: Buchart Horn, Inc.
Engineer: Basco Associates.
General Contractor/CM: Lobar, Inc.

Lehigh Valley Hospital and Health Network Garage, Allentown, Pa.
Award of Merit, New Design 450–1,000 Spaces.
Architect: Freeman White, Inc.
Engineer: O'Donnell & Naccarato.
General Contractor/CM: Whiting/Turner Contracting Company

Millersville University Parking Garage, Millersville, Pa.
Award of Merit, New Design Less than 450 Spaces.
Architect: Greenfield Architects, Ltd.
Engineer: Providence Engineering Corporation.
General Contractor/CM: High Construction Company



Penn National Racetrack Garage, Grantville, Pa.
Award of Merit, New Design More than 1,000 Spaces.
Architect: Urban Design Group, Inc.
Engineer: Gregory P. Luth and Associates.
General Contractor/CM: Penn National Gaming, Inc.

York Hospital Patient & Visitor Parking Garage, York, Pa.
Award of Merit, New Design More than 1,000 Spaces.
Architect/Engineer: Timothy Haahs & Associates, Inc., Blue Bell, Pa.
General Contractor/CM: Alexander Building Construction LLC.

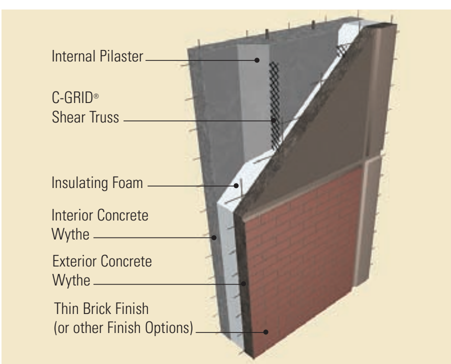
The Pennsylvania Parking Association was formed in 1985. The Association comprises over 130 active members and is allied with the International Parking Institute (IPI), Fredericksburg, Va. The PPA hosts an annual conference, golf outings, awards competitions, regional lunch workshops and a meeting at each IPI conference. More information is available at www.paparking.org.

High Concrete Group Walls Are Structurally Composite and Thermally Efficient

High has made structurally composite CarbonCast® precast concrete sandwich panels its standard wall offering. The walls are used in university, K–12, healthcare, office and other commercial projects to provide high quality, fast, reliable, aesthetically appropriate, energy-saving enclosure systems.

High made the line change due to gains in thermal efficiency achieved by its use of carbon fiber shear trusses and expanded polystyrene (EPS) insulating foam in the wall panels. As a fabricator of structural and architectural precast components, High can build walls with thermal resistance of R-13 to R-40, using up to 10" thicknesses of rigid EPS insulating foam board within the wall section.

Structurally composite sandwich walls are preferred because both the inner and outer wythes of concrete can be load-bearing together, allowing more usable interior space within the same building footprint. The wythes are joined by specially designed connectors that extend through the insulating layer to resist in-plane shear forces. High CarbonCast® walls eliminate thermal breaks caused by conventional metal connectors, using C-GRID® carbon fiber shear trusses that allow continuous edge-to-edge insulation ("ci") as defined by the ASHRAE 90.1 energy code. The trusses have more than four times the tensile strength of steel.



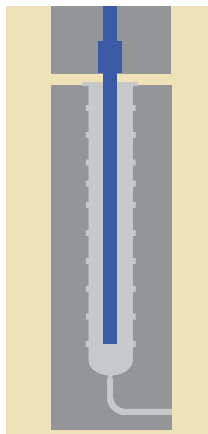
Fully Composite Insulated Wall Panel

High Concrete Group will continue to manufacture structurally non-composite insulated panels to meet specific project requirements, and also offers extruded polystyrene (XPS) foam board for sandwich wall designs where closed-cell insulation is specified.

New High Concrete Accessories Tube Drains Water Away from Concrete Connections

High Concrete Accessories, a subsidiary of High Concrete Group LLC, has expanded its line of plastic concrete embedment products to include a grouted connection tube with a weep hole. The innovation allows water to drain away from dowel-type connections and also permits grout to be pumped into the joint.

Made of high strength, blow-molded plastic, High Concrete Accessories' grouted connection tubes are pull-out tested and supplied with covers to help keep rain and moisture out. The weep hole feature provides an added measure of protection to ensure that, should the covers be damaged or removed for any reason, water that may enter the tube is removed before grouting. Water left inside the tube may displace grout or freeze, creating possible problems in the joint.


Grouted Connection Tube with Weep

High Concrete Accessories offers the grouted connection tube with weep hole in two standard diameters. A 2" diameter tube with an inside clear dimension of 1⅝" is available in standard lengths ranging from 6" to 24"; a 3" diameter tube with an inside clear dimension of 2⅝" is available in standard lengths from 10" to 30." The weep hole has a 1" nipple that accepts a flexible plastic tube of ½" diameter that may be ordered from others. Load test data is available to assist in design.

PRECAST PUBLICATIONS

Transmaterial II

The sequel to the critically acclaimed and best-selling book *Transmaterial*, *Transmaterial 2* is a clear, concise, accessible and carefully edited resource that provides information about the latest and most intriguing materials commercially available. CarbonCast is the first product listed. Learn more at www.transstudio.com.

Opus C

A sister publication of *Concrete Products International* magazine (CPI), Opus C shows excellent, forward-thinking precast concrete projects and the technologies that make them possible. Topics range from architecture and engineering to landscape design to concrete furniture and art, outstanding photography and interviews. Subscribe at www.opusc.com.

Feature Project ▶

Project: Hershey Intermodal Commuter Station and Parking Garage
Location: Hershey, Pa.
Type of Precast: Structural (15'-wide double tees, shear walls, spandrels)
Architectural wall panels
Size: Station: two stories, 2,500 sq. ft.
Garage: two levels, 124,000 sq. ft.
343 parking spaces
Architect and Engineer: Buchart Horn, Inc./Basco Associates, York, Pa.
General Contractor: Lobar, Inc., Dillsburg, Pa.
Owner: Township of Derry Industrial and Commercial Development Authority, Hershey

Project: Ivy Pointe Office Building
Location: Cincinnati, Ohio
Type of Precast: Architectural wall panels
Size: Four stories, 100,000 sq. ft. (23,904 sq. ft. exterior walls)
Architect and Engineer: Stephen Schaefer Associates, Cincinnati
General Contractor: Cincinnati United Contractors, Cincinnati
Owner: Cincinnati United Contractors

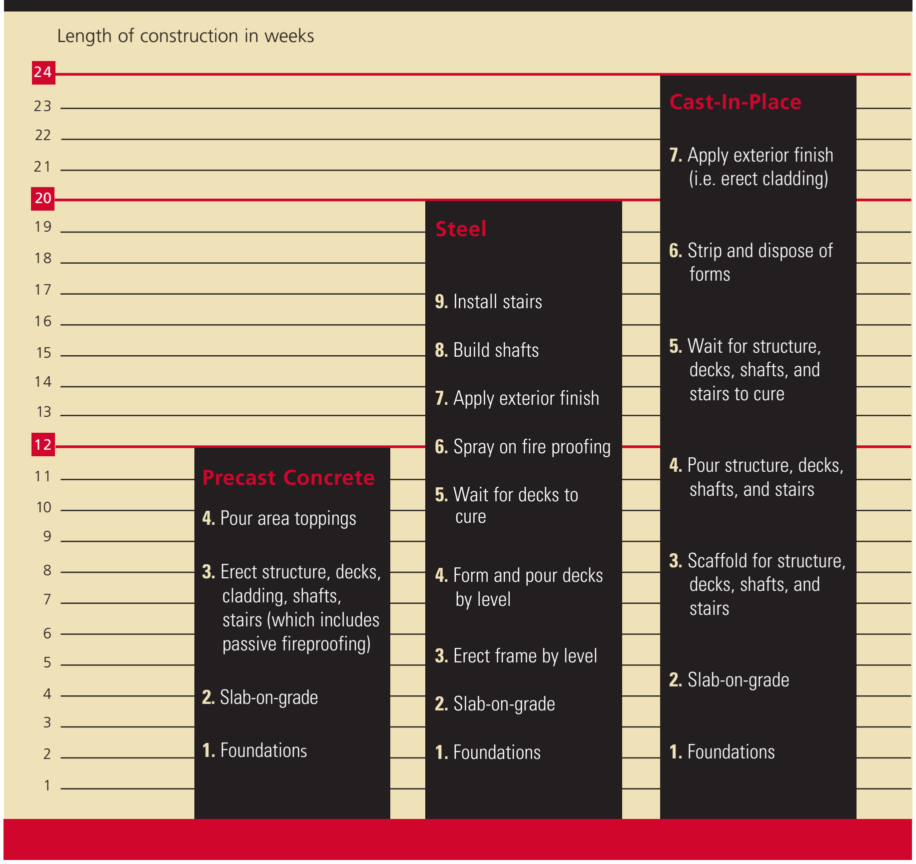
Why Precast Garage Systems? A Quick Comparison

Faster and Lower-Cost Fast-Track Construction

Factory-cast and factory-cured components are manufactured year-round and installed in almost any weather, which results in fewer schedule delays and faster occupancy. Construction costs may also be reduced by:

- Single-source fabrication and erection
  - Less on-site labor with its associated congestion, cost, and schedule delays, and fewer quality problems due to manpower shortages
  - Eliminates the usual delays caused by multiple trades
- Just-in-time delivery
  - Reduces site disruption by requiring fewer trades on site and reducing onsite storage, and often allows erection within the structure's footprint
  - Reduces general conditions, construction financing and other carrying costs
- Rapid installation
  - Simultaneous erection of structural elements and enclosure
- Use of 15'- and 16'-wide MEGA-Tees
  - Fewer, larger components go up faster with fewer joints
  - Fewer columns and footings
- Earlier project delivery and occupancy
  - Reduces general conditions, construction financing, and other carrying costs

Parking Garage Construction Phases and Time Line.



Why Hollowcore and Precast Building Systems? A Fire in Philadelphia Reminds Us.

"The disaster was 'totally predictable'"

This headline from an Aug. 16, 2008 story in the *Philadelphia Inquirer* describing a fire that burned an apartment complex to the ground was the expert opinion of Vincent Brannigan, professor of fire-protection engineering at the University of Maryland. A spectacular fire had just ravaged the Riverwalk at Millennium luxury apartment complex, a wood and masonry structure under construction on the Schuylkill River in Conshohocken, Pa.

According to the article, Mayor Joseph Collins said borough inspectors regularly checked the construction site and found no violations. Sandra Caterbone, the borough council president, offered a strong defense of the developer, saying he "follows our codes to a T."

Brannigan, the UM fire authority, said the codes are precisely the problem. He didn't suggest that the developer or the building contractor violated regulations. Putting up a wood-frame apartment next to other, occupied structures is perfectly legal—but dangerous, he said. A wood-on-masonry construction site is basically "a vertical lumber yard," he said. "This is a fundamental code failure," he said, "The codes are totally inadequate."

Recent building code revisions, with extensive sprinkler trade offs and other concessions, have significantly reduced structural fire protection and related life safety. Now more than ever, building with non-combustible precast concrete designs can better provide lasting and effective passive structural fire protection.

Lives and property can be saved if owners and designers understand that building-code standards represent a legal minimum level of protection, not the best level. The consolidation of building codes has led to tradeoffs that have weakened fire-protection requirements. Active protection systems such as sprinklers, while effective in some cases, are not the entire solution and can fail to perform at critical moments. This is especially important if materials have been used that rely on sprinklers to slow their combustibility.

The best approach is a balanced design that combines active and passive protection systems. A passively designed building system using precast, prestressed concrete structural and architectural components offers inherent fire protection because its noncombustible composition inhibits fire's spread. Designing for compartmentation, which divides the structure into smaller modules, helps ensure a blaze remains contained and provides more time for detection, evacuation and suppression.

Precast, prestressed components—including hollowcore slabs, wall panels, double tees, columns and beams—provide a host of advantages unavailable with other materials. These include its natural fire resistance, the absence of toxins when burned, heat absorption, structural integrity, fast construction and single-source supply. With increasing emphasis on risk avoidance, insurance companies are taking note of precast's fire advantages, offering lower rates for All-Precast

structures in some cases. Combined with other economies provided by the material, this long-term savings represents a compelling reason to use precast—in addition to its ability to save lives. The message for architects, building owners and public officials is simple – combustible building materials burn. Precast concrete, a non-combustible building material, simply does not burn.

Sources: *Philadelphia Inquirer*, "The disaster was 'totally predictable'"; August 16, 2008; Precast Concrete Fire Prevention, Precast/Prestressed Concrete Institute, 2007

THE BIG BEAM

Big Beam Contest Winners are in

At their meeting at PCI on August 1, 2008, the Student Education Judging Committee selected the Engineering Student Design Award (Big Beam Contest) winners. First place winners from each of the six PCI Zones, along with the International entries considered as Zone 7, competed for the Overall Championship.

Organized by PCI's Student Education Committee, the objective of the annual Engineering Student Design Competition is for student teams to learn through fabricating and testing a 16 ft. span precast, prestressed concrete inverted tee beam with the help of local precast concrete producer members. The competition is important for the precast industry, because it exposes young engineers to the world of precast while deepening their understanding of structural engineering. High Concrete Group is an active participant and supporter of The Big Beam Contest and other learning activities for students, and was a co-sponsor of this year's PCI Architectural Student Design Competition.

Overall (National) Championship
United States Military Academy (Team #1), West Point, New York (Zone 5)
Faculty Advisor: Fred Meyer
Student Team: Bailey Harrington, Aurimas Metrikis and Ross Dula
PCI Producer: Oldcastle Precast Building Systems, South Bethlehem, New York (Rita Seraderian)
Award: $2000 along with other prizes

A High Concrete Group team placed as follows in the Zonal Competition:
Zone 5 Third Place:
Co-Winner #1: Lehigh University, Bethlehem, Pennsylvania (Team #2)
Faculty Advisor: Clay Naito
Student Team: Linda Kaplan, Justin Lockman and Josh MacCallister
Precast Producer: High Concrete Group, Denver, Pennsylvania (Monica Schultes/Ken Baur)
Award: $375 along with other prizes

A High Concrete Group team placed as follows in the Outstanding Report Winners:
Honorable Mention #1:
Lehigh University, Bethlehem, Pennsylvania (Team #1)
Faculty Advisor: Clay Naito
Student Team: Daniel Cook, Cliff Jones and Chris Trautner
PCI Producer: High Concrete Group, Denver, Pennsylvania (Ken Baur/Monica Schultes)
Award: $500 along with other prizes

Prizes were awarded for the most efficient design, highest load capacity, best report, and other categories, and included cash prizes sponsored by Sika Corporation. First place winners from each of the six PCI Zones, along with the International entries considered as Zone 7 competed for the overall championship.
For complete listings, please visit http://www.pci.org/education/big_beam/competition.cfm?id=11.

LEED®ing the Way: Use ID to Get LEED Credit for Supplementary Cementitious Materials

Design Mix	Strength psi	Quantity poured for project (cy)	GGBFS in project mix design (lbs/cy)	GGBFS in project mix design (lbs)	Portland Cement in project mix design (lbs/cy)	Portland Cement in project mix design (lbs)	Baseline Portland Cement mix (lbs/cy)	Baseline Portland Cement (lbs)
#4251	7,000	1,000	350	350,000	350	350,000	700	700,000
#4252	7,000	765	250	191,250	450	344,250	700	535,500
#4253	7,000	254	150	38,100	450	114,300	650	165,100
#4254	7,000	21	60	1,260	540	11,340	650	13,650
#3250	10,000	5671	275	155,925	525	297,675	800	453,600
#5463	5,000	435	288	125,280	300	130,500	588	255,780
Total		**3,042**		**861,815**		**1,248,065**		**2,123,630**

Reduction in Portland Cement (lbs) **875,565** Percentage reduction in Portland Cement **41%**

In the US Green Building Council's (USGBC) LEED rating system, MRc4 Recycled Content (Materials and Resources Credit 4) awards one point if the sum of the post-consumer recycled content plus one-half of the pre-consumer recycled content constitutes at least 10% of the total value of the materials in the project. The value of the recycled content of a material is the weight of the recycled content in the item divided by the weight of all materials in that item, and then multiplied by the total cost of the item. 10% of the total value of materials in the project is worth one point in Credit 4; 20% or more is worth two points.

Supplementary cementitious materials (SCMs) such as fly ash, silica fume and slag cement are industrial byproducts that are taken from the waste stream and are considered pre-consumer. Also called pozzolans, SCMs enhance desirable concrete characteristics such as flowability and durability. Using recycled concrete or slag instead of extracted aggregates would qualify as post-consumer. Most reinforcing bars are manufactured from recycled steel and count toward the credit separately from concrete.

A typical precast project will qualify for one point under Credit 4 for use of rebar. However, high slag and other SCM mixes are not enough to earn the second point (20%) because the dollar value of the SCMs is very low relative to the total materials used in the project. Since the USGBC recognizes the importance of replacing cement with SCMs as a significant step to reducing global greenhouse gas emissions, an Innovation & Design point is awarded to make up for any expected second point for SCM usage.

Projects in Progress ▶

Meadowlands Stadium, East Rutherford, N.J.
Amylin Manufacturing Facility, Hamilton, Ohio ▶

CONCRETE INNOVATIONS

Accomplishing Multiple Radius Curves in Precast

By Rick Thomsen
Chief Engineer, Helser Industries

Typically architectural precast projects utilize custom-built plywood forms for panel fabrication. However when repetition and complexity converge, steel forms may permit greater control, improved scheduling and better economics. This was the case with the boomerang-shaped Varsity Village Lindner Center designed by Bernard Tschumi Architects of New York, N.Y. as the athletic headquarters of the University of Cincinnati in Cincinnati, Ohio.

Completed in 2006, this unique building features a five-story ribbon-like facade comprising eight different radii. There are six convex, two concave and eight compound transition curves in the horizontal plane. 567 compound-curved precast concrete panels wrap a structural steel "diagrid" frame. Inverted triangular window returns penetrate into and through the steel; upright triangular windows are fitted between the panels. The light gray panels have a light sandblast finish.

Design work for Varsity Village began in 2002, with Form Z used for the 3D reference model. Structural steel details were worked out in Tekla with inputs from the design engineer's RAM program. Precast details were created in Form Z and were output as 2D drawings. Since the Form Z model didn't store all the data required, High Concrete Group used Excel spreadsheets to verify diagrid nodes, determine the azimuth angle for perimeter nodes, and calculate most of the panel dimensions including window blockouts. The Form Z model was exported in dxf format and given to Helser, the form fabricator. Both AutoCad and Autodesk Inventor were used by Helser to manipulate and interpret the models via taking slices at consistently placed work planes. The result was directly measurable set-up data that was then transferred to form fabrication drawings.

Steel forms were justified by the number of castings and the casting schedule. Nine forms were built solid for a single radius that could be poured every day. One was adjustable whereby the base form could be set to any radius the project demanded. Whether concave, convex, or two different radii meeting at an inflection point, the form skin could be quickly laminated to predefined understructure plates provided by Helser. This method removed virtually any possibility of set up error. Portions of window block-outs and sides were able to be re-used from panel to panel via strategically placed construction joints, but for the most part were specific to each shape.

To make the steel forms, Helser Industries utilized the extracted data from the manipulated models to create real world jigs and fabrication stops. Each individual form piece was literally cradled in its spatially correct locations as the form was pieced together. The modeling process in effect allowed us to hold the form skin components at their correct locations to automatically create the real world full size casting.

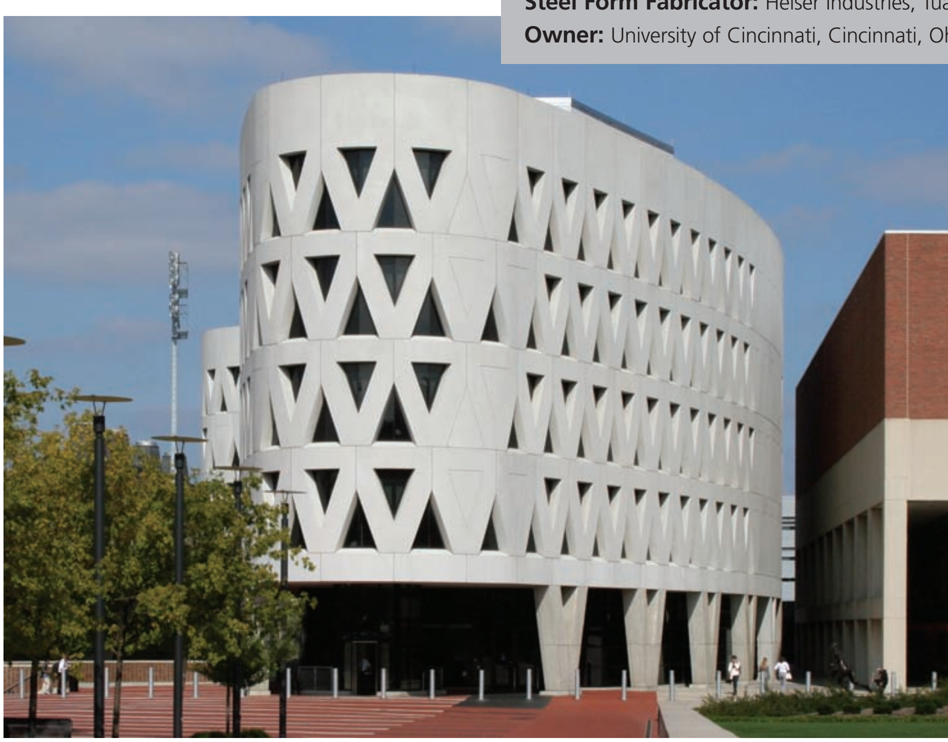
Several "oddball" panels were handled directly by High Concrete Group using wood forms. These included the V-shaped precast column base covers that have helical warped surfaces varying in width throughout their height.

Steel forms contributed a high degree of precision to the fabrication of the Varsity Village project at High Concrete Group's Springboro, Ohio plant. The forms virtually eliminated the opportunity for human error in panel fabrication, helping to keep the precast cost within approximately 10% of the total project cost. Recent advances in Building Information Modeling promise to make dynamic designs like this even easier, more practical and more affordable.

High Concrete Group welcomes guest columnist Rick Thomsen, chief engineer for Helser Industries, Inc. Helser is a fabricator specializing in steel forms for architectural and structural precast projects. For more information, please visit www.helser.com

Quick Facts:

Project: Varsity Village Lindner Center
Location: Cincinnati, Ohio
Size: 236,000 square feet (63,120 square feet of precast cladding) 8 stories, 5 stories above ground
Design Architect: Bernard Tschumi Architects, New York, N.Y.
Architect of Record: Bernard Tschumi Architects, New York, N.Y.
Architect of Record: glaserworks, Cincinnati, Ohio
Structural Engineer: Arup Structural Engineers, New York, N.Y.
Engineer of Record: THP Limited, Inc., Cincinnati, Ohio
Steel Form Fabricator: Helser Industries, Tualatin, Ore.
Owner: University of Cincinnati, Cincinnati, Ohio



Recent Work Won

Monmouth University Residential Hall, West Long Branch, N.J.
Justice Center Parking Garage, St. Louis, Mo.
Miami Valley Hospital Heart Tower, Dayton, Ohio
Gill Simpson Headquarters Office Building, Baltimore, Md.
Lutron Electronics Parking Garage, Coopersburg, Pa.
Flair Tower Project, Chicago, Ill.

Eco-Mix® for Sustainable Design

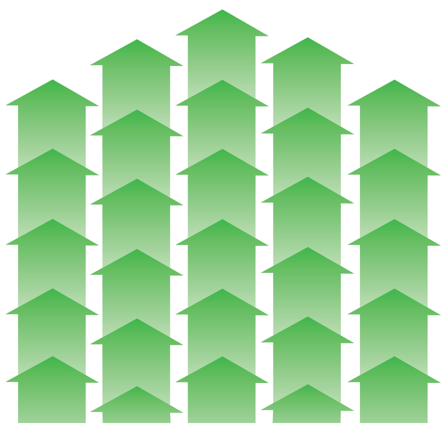
By reducing consumption of Portland cement, precasters can control their carbon footprints and those of their customers. Recently High Concrete Group introduced Eco-Mix® precast concrete mixes which use at least 50% less Portland cement than standard precast concrete.

The supplementary cementitious materials (SCMs) or pozzolans used in these mixes include slag and silica fume, with the types and amounts determined in part by the end use application. In addition to reducing Portland cement, these products impart properties that can improve precast concrete performance.

A byproduct of the steelmaking process, slag is a fine white powder that bonds well in standard precast mix designs as well as self-consolidating concrete. The white color helps to lighten the concrete, contributing to a higher solar reflective index. Silica fume, a byproduct of the manufacture of silicates, is a fine powder that contributes to the workability and ultimately the durability of precast concrete mixes. Both slag and silica fume would be destined for the waste stream if they were not used in concrete. Both are considered by LEED in MRc4 Recycled Content and ID credits.

While it is not uncommon to have up to 20% SCM content in precast mixes, Eco-Mix designs are carefully balanced to match the most demanding performance requirements with solid environmental practice. Replacing 50% or more of the Portland cement in a mix design can not only provide a better-performing concrete member, it can generate lower initial costs as well

For more information and an Eco-Mix specification, call 1.800.PRECAST.



News from AltusGroup®

Double Tees Recognized in Architectural Record 2008 Product Reports

Each fall since 1972, a panel of editors, consultants and architects has selected the most innovative and useful building product options of the year and presented them in Product Reports, a major editorial feature in the December issue of *Architectural Record*. In 2008's Product Reports, architects, specifiers and designers can find CarbonCast® Double Tees. Reinforced with C-GRID® high strength carbon fiber grid, these lighter weight precast double tees liberate parking garages from costly corrosion problems by replacing steel flange reinforcement with non-corrosive carbon fiber that has five times the tensile strength of steel.

Following extensive prototype work in 2006–7, High Concrete Group now produces CarbonCast double tees using a specially-designed machine that reduces costs and increases productivity. AltusGroup precast members including High Concrete Group introduced the new tees at key parking industry events during 2008, with focused efforts on educating parking consultants and engineers.

StructureCare®

Maintenance Program Reaches 3,000,000 Square Feet

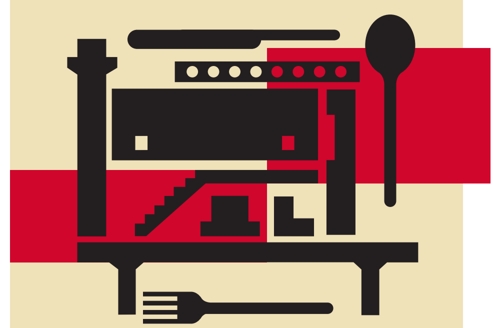
Franc Genoese, director of High Concrete Group's StructureCare division, has added two new parking garage customers to its clientele, bringing the total square footage under its unique maintenance program to 3,000,000.

StructureCare customers contract with High Concrete Group for annual inspections, wash-downs and minor repairs that customer maintenance staffs may not be prepared to perform. The concept is working for some 15 precast and cast-in-place garages across New Jersey, Delaware, and Pennsylvania.

"Our goals are to identify problems when they're small, stop them by resolving the root cause, and help owners train their staff in procedures that can improve the performance of their garages," says Genoese. "We're delighted that owners of all garage types are thinking of us as a way to control costs and prevent headaches."

Typical problems found by the StructureCare program include damaged pourstrips and washes, failed sealants, corroded steel, parking deck surface wear and tear and plow damage from snow removal operations. High Concrete Group originated the StructureCare program in 2004 as an output of its new product development process.

New Box Lunch Program!
CALL 1.800.PRECAST



High Concrete Group LLC
125 Denver Road
Denver, PA 17517

Plant locations:
Buena, N.J., Denver, Pa.
Springboro, Ohio, Paxton, Ill.

Concrete Innovations & Answers®
1.800.PRECAST (1.800.773.2278)
concrete.answers@high.net
www.highconcrete.com

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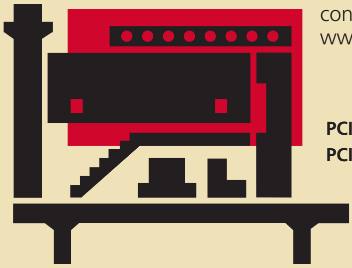

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CONCRETE ANSWERS

Ken Baur, P.E.,FPCI—Director of Research and Development

C-GRID® Carbon Fiber Saves Up to 5% in Parking Garage Initial Cost, More in Life Cycle Cost

Every so often the old adage, "You get what you pay for," gets turned on its ear. Such is the case with CarbonCast® parking garage double tees reinforced with carbon fiber. The inert, high-strength carbon fiber grids in these tees make them far more corrosion-resistant, lighter in weight and longer lasting than steel-reinforced precast concrete double tees. So how can they cost less?

Recently, the price gap between steel and carbon fiber has certainly narrowed. But the true cost savings in CarbonCast double tees lies in the fact that carbon fiber C-GRID doesn't corrode like steel reinforcement. And corrosion—and corrosion-proofing—costs money. High calculates that it costs about 5% more to corrosion-proof a steel-reinforced double tee than to make and install one with carbon fiber.

Steel corrosion in parking garages is such a widely recognized problem that the ACI 362 guideline recommends a corrosion-preventive sealer to be applied to all new steel-reinforced parking garages, which High estimates as a $0.25 per square foot premium. Then comes another $0.12 per square foot for the corrosion inhibitor that's specified by most design firms to further protect reinforcing steel. With that, the same old conventional precast double tees can cost 5% more to produce and install than the better performing CarbonCast double tees. Plus sealer has to be replaced every five to seven years, increasing lifecycle costs.

CarbonCast tees have other advantages over steel reinforced tees, such as thinner flanges. At a 3½" thickness, a CarbonCast double tee flange meets the one-hour fire code requirements typical in garages, while saving costs on concrete. Also, High accomplishes C-GRID embedment using a specially designed, patent-pending machine. The embedment machine efficiently places the carbon fiber grid, yielding savings on labor versus older manual steel installation methods. Thinner flanges and automation reduce the parking garage's carbon footprint.

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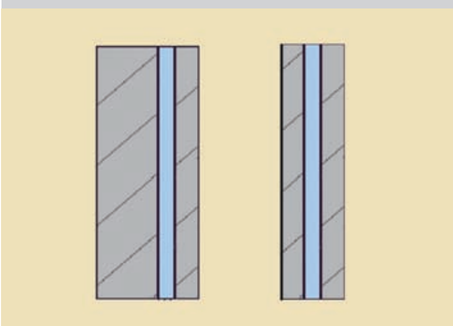
AIA Distance Learning Program: Precast Concepts II

Supplement to High Concrete Group LLC
Concrete Innovations and Answers®—Winter 2009

1. THERMALLY EFFICIENT PRECAST SANDWICH WALL PANELS

Thermally efficient precast sandwich wall panels are used in university, K-12, health-care, office and other commercial projects to provide high quality, fast, reliable, aesthetically appropriate, energy-saving enclosure systems. With a rigid insulating foam layer locked between two concrete wythes, sandwich walls can deliver thermal resistance of R-13 to R-40, using up to 10" thicknesses of insulation within the wall.

Sandwich precast wall panels provide edge-to-edge insulation for "ci" as defined by ASHRAE 90.1.



Structurally non-composite walls (left) use a thicker inner wythe for load bearing; structurally composite walls permit more usable interior space.

Structural Designs

Two major thermally-efficient sandwich wall panel design types include fully structurally composite and structurally non-composite designs.

Fully structurally composite walls are preferred because both the inner and outer concrete wythes can work together to resist wind and gravity loads, keeping wall sections efficient to preserve usable interior space. Similar in thickness, the concrete wythes are joined by carbon fiber trusses that extend through the insulating layer to transfer in-plane shear forces. The shear trusses virtually eliminate thermal breaks caused by conventional metal connectors and allow continuous edge-to-edge insulation ("ci") as defined by the ASHRAE 90.1 energy code. Typically placed in pilasters for approximately every two feet according to design, the trusses contribute over four times the tensile strength of steel.

Structurally non-composite sandwich walls provide similar thermal efficiency using a thicker wall section. In load-bearing conditions, the inner concrete wythe is two to three times thicker than the outer wythe and provides the structural support. The concrete wythes are joined by rows of thermally nonconductive fiberglass pins, eliminating thermal breaks and facilitating "ci". Partial shear transfer is possible, and some designs have been considered partially structurally composite. The overall thicker wall section reduces usable interior space.

Concrete itself is thermally conductive contributing an R-value of only .10 per inch. Air film layers are typically counted in the thermal resistance of the assembly at R-0.68 on the interior side and R-0.25 on the exterior.

Insulation Options

Two common rigid foam insulation board options include expanded polystyrene (EPS) and extruded polystyrene (XPS). Typically unfaced, each type of foam has unique properties, and when used at recommended thicknesses in precast sandwich panels, the foams produce assemblies with an M (permeance) of <1.0, qualifying as vapor retarders as defined by Chapter 2 of the 2003 International Building Code. Designers select foams based on project-specific requirements including location, end-use, R-value and budget.

EPS is a closed-cell, lightweight foam board that meets or exceeds the requirements of ASTM C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation. EPS offers a long-term stable R-Value, dimensional stability, compressive strength and water resistant properties. EPS foams at densities of 1 to 1.8 pcf provide R-values of 3.8 to 4.2 per 1" thickness and a compressive strength of 13 to 25. White in color, EPS foams have a flamespread of <75 as measured by ASTM E84 and may include pre-consumer and up to 10% post-consumer recycled content.

XPS is a closed-cell, lightweight foam board that also meets or exceeds ASTM C578. The closed-cell structure, responsible for the foam's excellent moisture resistance, also contributes to its high compressive strength and superior thermal performance. XPS foams at typical densities of 1.3 to 1.8 pcf provide an R-value of approximately 5 per 1' thickness with a compressive strength of 15 to 40 psi. Pink or blue in color, the superior R-value of XPS foams make them an appropriate choice for extreme thermal gradients as found in northern climates and cold storage applications.

R-values are additive, and, together with dew point temperatures, they must be investigated to create or eliminate the potential for condensation within a precast sandwich wall assembly. Acting as vapor retarder and insulator, the foams can cause the dewpoint temperature to fall within the foam insulation layer or outside the envelope minimizing the opportunity for condensation in the wall assembly. Insulation thickness may be increased to achieve specific R-value requirements.

2. STUDY SHOWS LIGHT LEVELS THE SAME IN PRECAST AND CAST-IN-PLACE GARAGES

Recently the Colorado Prestressers Association retained Walker Parking Consultants to perform a study comparing lighting systems for precast concrete parking structures versus post-tensioned (cast-in-place) concrete parking structures. This study indicates that there is no difference (within the accuracy of the calculation procedure) in horizontal illuminance on the floor, or vertical illuminance on the perimeter walls, for identical lighting configurations in precast concrete and post-tensioned concrete parking structures. This conclusion is provided that the bottoms of the luminaires are properly mounted between the 5 ft. stem spacing of 10'-wide double tees. 15'-wide double tees with 7 ft. 6 in. stem spacing add greater spread but were not considered in the study.

Parking Structure Configuration

The most common parking structure configuration throughout the United States consists of a row of 90-degree parking spaces at 8 ft. 6 in. to 9 ft. (2.6 m to 2.7 m) wide by 18 ft. (5.5 m) long on each side of a two-way traffic aisle in a 60-ft.-wide (18 m) parking module. The width of the parking structure is approximately 120 ft. (36.5 m) plus the thickness of perimeter walls.

Recommended maintained illuminance for parking structures

		Minimum horizontal illuminance, FC*	Horizontal uniformity ratio, maximum: minimum†	Minimum vertical illuminance, FC‡
Basic		1.0	10:1	0.5
Ramps**	Day	2:0	10:1	1:0
	Night	1:0	10:1	0.5
Entrance areas††	Day	50	—	25
	NIght	1:0	10:1	0.5
Stairways		2.0	—	1.0

Source: Data from *Lighting for Parking Facilities, Illuminating Engineering Society of North America, publication RP-20-98, Table 1*
Note: FC=footcandle.
* Depreciated (maintained) illuminance in footcandles at the time of lamp replacement calculated on the parking surface without any shadowing effect from parked vehicles or columns.
† Highest horizontal illuminance divided by the lowest horizontal illuminance should not be greater than the ratio indicated
‡ Measured or calculated at 1.5 m (5 ft) above the parking surface.
** Applies to clearway ramps (no adjacent parking)
†† Includes daylight infiltration plus electric lighting for a distance of 20m (66 ft) inside the entry portal of the parking structure to facilitate the transition from bright daylight into the darker parking facility.

The intent of this study was to create two parking structures that were as identical as possible except that one would have a cast-in-place structural system while the other would have a precast concrete structural system. The column spacing in a cast-in-place parking structure is typically on the order of 18 ft. to 24 ft. (5.5 m to 7.3 m). The column spacing in a precast concrete parking structure is typically 30 ft. (9.1 m). A 20 ft. (6 m) column span was used for the cast-in-place parking structure so that it could be modular with the precast concrete column spacing. The end spans were set at 15 ft. (4.6 m) to accommodate end parking. The length of the parking structure was then set at 330 ft. (100 m) so that it would be compatible and modular with each structural system.

Lighting Configuration

There is not a code requirement for general parking area lighting; however, owners may be at risk for damages in the event of personal injury lawsuits that allege poor lighting was a contributing factor. Therefore, the lighting must meet industry standards. The Illuminating Engineering Society of North America (IESNA) is considered the authority for lighting of interior and exterior spaces. The recommended practice for parking facility lighting is contained in IESNA publication RP-20-98, Lighting for Parking Facilities Table 1 which contains recommended illuminance values.

Due to light source color and environmental temperature considerations, a 200-watt metal halide fixture was chosen for this study at a 40 ft. (12.2 m) longitudinal spacing and 30 ft. (9.1 m) lateral spacing. The fixture consisted of a Lithonia PGR luminaire, though equivalent fixtures are also available. The lighting configuration was designed to comply with IESNA parking facility lighting standards. Two rows of luminaires were provided in each parking module 15 ft. (4.6 m) to either side of the drive aisle centerline. The longitudinal spacing of the luminaires in each row was 40 ft. (12.2 m), such that the luminaires were centered between post-tensioned beams or precast concrete double tee stems. One row of luminaires was staggered 20 ft. (6.1 m) with respect to the row on the opposite side of the drive aisle. This configuration results in illumination of more of the ceiling soffits, providing a brighter perception of the entire space.

The lighting configuration was identical to the configurations used in the precast concrete parking structure and in the cast-in-place parking structure. The only variable was the mounting height of the luminaires.

The interiors of precast concrete and post-tensioned parking structures used for illuminance comparison.

The depth of the fixture was about 12 in. (300 mm), so luminaires that were flush-mounted to the ceiling have the bottom of the fixture 12 in. below the ceiling. The mounting height was then varied at 16 in., 19 in., and 22 in. (406 mm, 483 mm, and 559 mm) below the ceiling to determine the variation in illuminance at those mounting heights in the two parking structures. Because the precast concrete double tee stems were 22 in. deep, the fixture mounting heights were 10 in., 6 in., 3 in., and 0 in. (250 mm, 150 mm, 75 mm, and 0 mm) above the bottom of the double tee stems.

Lighting Calculations

The lighting calculations were performed by computer modeling using a 3D software program. Four different luminaire mounting heights were considered for use in each parking structure. The effect of light blockage and light reflectance is included; photometrically correct renderings were produced.

The illuminance was analyzed on level 1 and level 2 due to the difference in floor-to-floor height at those levels (11 ft. 8 in. [3.6 m] at level 1 and 10 ft. 6 in. [3.2 m] at level 2). The horizontal illuminance was determined on the floor at a calculation point spacing of 5 ft. (1.5 m) in each direction over the entire floor area, and the vertical illuminance was determined at a lateral point spacing of 5 ft. at an elevation of 5 ft. above the floor along the perimeter walls.

Results

The results indicate that there is significant light blockage in the precast concrete parking structure when the luminaires are mounted directly to the ceiling, as expected. However, when the luminaires are pendant mounted with the bottom of the fixture at 6 in. (150 mm) or less above the bottom of the double tee stems (22 in. [559 mm] below the ceiling), then there is no light blockage.

Excerpted with permission from "Precast Concrete Parking Structure Lighting Study," PCI Journal, November-December 2007, pp. 89-97. The lighting study was co-sponsored by PCI and the Colorado Prestresser's Association. Copyright PCI.

3. CONTROLLING EFFLORESCENCE

Any brick, concrete or masonry wall is prone to efflorescence—undesirable white blotches of salt deposits that may appear on the surface of exterior walls. Though virtually impossible to stop, efflorescence in concrete can be minimized.

According to ACI 116R, Cement and Concrete Terminology, efflorescence is a deposit of salts that has emerged in solution from within either concrete or masonry and is then precipitated by carbonation or evaporation. Three conditions are required for efflorescence to occur: the presence of soluble salts; a source of water in contact with the salts to form a salt solution; and a pathway for the salt solution to migrate to the surface and evaporate.


Efflorescence

Common salts found in Portland cement, particularly high-alkali cements, may effloresce including calcium hydroxide $Ca(OH)_2$, which reacts with carbon dioxide in the air to form water-insoluble calcium carbonate ($CaCO_3$). Sodium sulfate (Na_2SO_4) and potassium sulfate (K_2SO_4) are also common salts in cement. High-alkali cements introduce more soluble sodium hydroxide and potassium hydroxide ions, in turn reducing the solubility of calcium hydroxide and allowing it to come out of solution more easily. High-alkali cements also make more CO_2 available for reaction with salts, further increasing the likelihood of efflorescence. Salts in aggregates and ion-exchanged water may also contribute to efflorescence.

Salts travel to the surface of masonry through water-filled capillaries that transport Ca_2+ ions to the surface. The deposits are more likely to occur in new construction and particularly in cold weather when low temperatures make salts more soluble and the rate of evaporation is slow. The darker the masonry surface, the more noticeable are the deposits.

Primary efflorescence occurs during the initial cure of the concrete as excess water of manufacture that has not chemically reacted with cement is available for transport of soluble salts. Primary efflorescence may be delayed in panels erected when the weather is warm and dry, appearing later in the year when conditions are cooler and moister. As with site-constructed walls, these panels may be cleaned up as part of the punch list.

Precasters control primary efflorescence by optimizing cement-water ratios and mix design, curing and storing conditions, minimizing porosity through aggregate grading, blending gray with white cement or slag, and by waiting until the concrete reaches its design maturity, or 18-day strength, and then performing a thorough washing before panels are shipped. Admixtures providing efflorescence protection may also be used. These include plasticizers that increase concrete density and pore-blocking components that enhance surface tension.

Secondary efflorescence occurs when water from an outside source is absorbed into the concrete product, dissolving any available salts within the concrete matrix. Drying results in these dissolved salts leaching to the surface where the water evaporates leaving the salt residue.

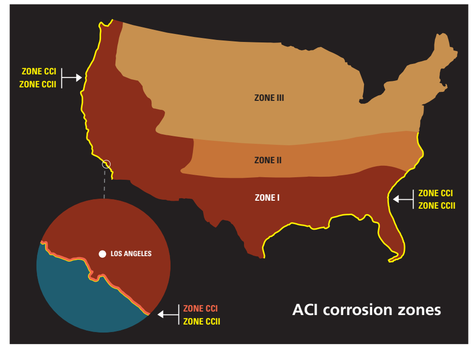
Secondary efflorescence is controlled by good design and building practice, ensuring proper drainage and protection of vertical surfaces from continued exposure to water. Correctly install waterstops, flashing and copings per design details. If secondary efflorescence has occurred, the deposits may be cleaned by dry brushing or rinsing and brushing with a stiff brush. Heavy deposits of calcium carbonate in particular may require a dilute solution of muriatic acid followed by brushing and rinsing. Alternatively, given enough time, efflorescence will often disappear on its own.

4. PARKING GARAGE CODE CHANGE

Recently the ACI Technical Committee decided to recommend a sealer on new concrete parking garages to protect against chloride permeation. This decision will be reflected in ACI 362, *Standard Practice for the Design and Construction of Durable Concrete Parking Structures,* addressing the widely recognized problem of chloride-related corrosion of steel reinforcement. The final ACI 362 document has not yet been issued.

The sealer recommendation applies to precast concrete, cast-in-place concrete and hybrid concrete-steel parking garages constructed in geographies defined by ACI as Zones II, CC-I, III and CC-II (see map, top right). Zones II and CC-I are considered areas of moderate chloride exposure; Zones III and CC-II are severe chloride exposure zones.

In Zones II and III, steel-reinforced parking surfaces are affected by chloride-laden water carried in by cars that travel roads treated for winter snow and ice. Salts and deicers may also be used by maintenance personnel, contributing further exposure. In Zones CC-I and CC-II, defined as coastal areas near oceans and salt water bays, parking garages are vulnerable year round to airborne chlorides from saltwater spray. Where the coastal zones intersect with Zones II and III, particularly in the Mid-Atlantic and Northeast regions of the country, parking garages are exposed to both road salts and saltwater spray. The high quality concrete of precast parking garages (typically 7,000 psi or greater compressive



ACI corrosion zones

strength) is highly impermeable and normally protects reinforcing steel from the effects of chlorides. This protection depends somewhat on proper maintenance, which is defined by precast producers, but typically includes an annual washout and inspection, a protocol governing the types of deicers to be used and frequency, and methods of snow removal including equipment types and specifications.

Sealers considered acceptable by ACI 362 meet specific criteria for water repellency, chloride ion screening, scaling resistance, weather and UV stability and water vapor transmission. The application of sealers will contribute to the initial cost of parking garages, and will increase long-term maintenance costs over time as the sealers must be reapplied every five to seven years. Calcium nitrite (CNi) corrosion inhibitor, which some designers specify as an additional form of protection in the concrete mixture, is considered in the standard but is not part of the recommendation.

ACI 362 has acknowledged carbon fiber reinforcement as a non-corrosive flange reinforcement material, and does not call for sealer on precast parking garages with carbon fiber-reinforced flanges.

Also contributing to increased costs is a new minimum cover recommendation for steel reinforcement placed under field topping. In Zones II and CC-I the minimum cover thickness will be 1½"; in Zones III and CC-II it will be 2". The minimum cover increase acknowledges the generally more permeable nature of field topping used in washes and seismic diaphragms. In order to attain the minimum cover thickness, seismic diaphragm pour strips can be expected to be longer and consume more field topping than has been commonly used in the past.

As an alternate, it is possible to eliminate cast-in-place pour strips by casting the precast tee flange at the full thickness in combination with welded seismic connections. These connections have been tested at Lehigh University in Allentown, Pa. and at the University of California, San Diego and have been found to be acceptable for all areas except those of very high seismicity. In general, the connections used in this case will be stainless steel. Use of this system will provide the quality of precast concrete throughout the garage and can improve the overall construction schedule while controlling cost. As with any garage, special attention is needed to ensure proper drainage.

5. CURING AND HYDRATION

To perform as designed, concrete must be mixed appropriately and placed, then cured in a suitable environment during the early stages of hardening. Active curing by knowledgeable personnel facilitates the hydration of cement, a chemical reaction in which the major compounds in cement form chemical bonds with water molecules and become hydrates or hydration products.

The objective of curing is to keep the concrete as saturated as possible until the products of hydration replace the water-filled spaces in the cement paste. Control of temperature also promotes the curing process.

Moisture. Hydration requires internal relative humidity of at least 80% to prevent moisture movement. It also requires that the amount of water present in the cement paste be at least twice that of the water already combined. Manufacturers control moisture content through humidity probes and wet and dry tests of weight and strength.

Heat. Hydration is an exothermic reaction. Adding heat speeds the reaction, allowing the precaster to turn forms faster, potentially economizing the mix and making product easier to handle. Besides consuming energy, possible downsides are that applied heat can cause short crystal formation that may lower ultimate strengths.

After curing, hydration of concrete can continue for months or years with the result that concrete increases in strength and durability over time.

Curing is carefully controlled as moisture loss can lead to poor strength development, plastic shrinkage, increased permeability and reduced resistance to abrasion. In precast operations, concrete mixes typically have a maximum water-cement ratio of 0.40 or less. The low water-cement ratio ensures that the finished concrete has a high density which is important for preventing water permeation. Low water-cement ratio distinguishes precast from field applied concrete and toppings.

Curing only affects the outer surface zone of a concrete product, usually to a depth of 30 mm to 50 mm. Curing improves the durability of the surface, which is of the highest importance as it is the area of the precast member that is subject to the stress of weathering, abrasion, freeze-thaw, etc.

Once it is poured, the filled precast form is covered with plastic for 24 hours to prevent the concrete from self-desiccating and to hold in heat. Internal relative humidity of the concrete is maintained at a minimum of 80%. Test apparatus monitors the cure through temperature and humidity probes in the form. Wet unit strength and dry unit weights and strengths are tested to ensure the rate and consistency of hydration. Following an initial cure of six to 18 hours, precast attains initial strength that allows the component to be stripped from the form.

6. DEFORMED AND EXTRUDED WELDED WIRE FABRIC

For steel-reinforced applications, precast producers use both deformed and smooth extruded mild steel welded wire fabric (WWF) for reinforcement. Over the past 10 years, in areas of the country where it's readily available, deformed WWF has been taking the place of smooth extruded WWF in parking decks for performance and cost reasons. The more expensive extruded WWF now is usually reserved for architectural cladding and wall panel products.

Independent testing shows that deformed WWF has a shorter development length than extruded WWF, meaning it won't slide through concrete as easily. This also means it is better at controlling cracking. Like rebar, deformed WWF is made in a rolling mill process that results in a more economical product than extruded WWF. It also has a cross-hatched surface similar to rebar that helps it bond to concrete better both chemically and mechanically.

These characteristics make deformed WWF a better choice for double tee flange reinforcement. Particularly when the tees are cut down in width, deformed wire maintains its developed length while extruded wire may lose the "second wire," or 2" on-center cross wire, that causes its development. However, the same rolling mill process and cross-hatching that allows deformed WWF to bond to concrete more readily can also invite corrosion. At 7,000 psi or more, precast concrete is a low permeability material that will prevent moisture from reaching the reinforcing steel of most components for a very long time. Still, in northern and coastal environments where chloride-laden water may be present, garage owners concerned with long-term performance are justified in taking a closer look at their choices of reinforcing materials.

Corrosion control is the main motivation for owners and consultants to choose carbon fiber reinforcement for double tee flanges instead of WWF. Carbon fiber is inert in the presence of chloride ions, and therefore does not need the minimum concrete cover defined by ACI 318. As a result, carbon fiber permits thinner flanges that consume less concrete and therefore less greenhouse gas-contributing cement. The double tees are also lighter in weight, saving energy in shipping and erection and helping to reduce structural and foundation requirements.

Carbon fiber grids bond to concrete better than smooth extruded steel wire. Repeating every 2.7" on center, the perpendicular mesh further ensures that the grid maintains its development length.

Using carbon fiber, designers can improve long-term garage performance by taking the corrosion-prone carbon steel out of the double tee flange area entirely. In new designs, carbon fiber reinforcement replaces WWF, and stainless steel welded connections take the place of carbon steel.

7. ALL ABOARD! HERSHEY INTERMODAL COMMUTER STATION AND PARKING GARAGE TREAT CUSTOMERS TO A TASTE OF THE PAST WITH MODERN CONVENIENCE

Strategically located near the offices of a major resort, the 2,500 square foot Downtown Intermodal commuter station in Hershey, Pa. is the main access point for employees and visitors who park in the adjacent 124,000 square foot precast parking garage. Together, the two structures make up the second phase of a project that now serves an office development and museum expansion scheduled to open at the end of 2008.

The design goal for the project was to separate car and bus traffic to ease congestion on the site and to increase safety while maintaining the historic references of the surrounding town. Key in the decision to use precast was the schedule for the project, which was tied to the neighboring development, as well as economics, and the ability to mimic surrounding early 20th century construction forms.

An Influx of Design Ideas

The station takes its design cues from the heyday of rail travel. Buff-color architectural panels made with local aggregates have repeated rounded archways with formliner creating the look of stone ashlars at the base. A green metal hipped roof with vented gable ends and decorative bracketing completes the appearance of a rail station of days gone by. The roof and precast color relate to several historic buildings nearby, notably a famous hotel and a live performance theater.

Presently used for bus traffic transfers, plans for the station include a rail platform to allow customers to easily access a future commuter train. A glass-enclosed foot bridge connects the two structures which are located to either side of the existing track.

Pocketed structural spandrels on the precast parking garage were finished in a basket weave thin brick island pattern with square precast accents. The image was taken from a nearby historic building that had housed garage allow light to pass through for maximum safety and security. The garage is naturally ventilated with shear walls at the ends.

The garage provides 343 parking spaces with 90° front-in parking and two-way traffic. It is joined to a 252-space precast garage that has a separate entrance/exit. Typical bay spacing is 45' and 36' by 61' 2" long with two levels of elevated parking. The garage is accessed 24 hours free of charge, with accommodation for ticketing in the future; the pedestrian bridge is closed during off peak hours.

Quick Facts:

Project: Hershey Intermodal Commuter Station and Parking Garage
Location: Hershey, Pa.
Types of precast:
Structural (15'-wide double tees, shear walls, spandrels)
Architectural wall panels
Size: Station: two stories, 2,500 sq. ft.
Garage: two levels, 124,000 square feet; 343 parking spaces
Architect and Engineer: Buchart Horn, Inc./Basco Associates, York, Pa.
General Contractor: Lobar, Inc., Dillsburg, Pa.
Owner: Township of Derry Industrial and Commercial Development Authority, Hershey, Pa.

Formliner created the distinctive "retro" look of the wall panels on the commuter station.

Thin brick captured the spirit of the period brickwork of the nearby historic press building that was restored in the project.

Precast Advantages

The architect notes that the construction site was confined, and that the project team appreciated that precast contributed minimal disturbance, especially when compared with the scaffolding and additional personnel required for other construction techniques. Precast also allowed the team to lessen impact along a large original stone railroad retaining wall that helped preserve the authenticity of the site. Project complexity was increased by the number of authorities involved, including the railroad, state funding agencies, municipal authorities and local manufacturing. Every eight minutes one of the three rail lines feeds local processing plants with raw materials. Special consideration was taken when the line had to be shut down for the pedestrian bridge installation. The location of the station was dictated by site constraints on either side of the tracks, including several overhead lines that had to be relocated to complete the project.

They don't build 'em like they used to, but with precast you can capture the spirit of the past with a modern material that performs better during construction and long afterward.

8. SPEED WITHOUT SACRIFICE AT OHIO SCHOOL

In sports, it's a common tenet that there's no substitute for speed. The same can be said for construction. The ability for major building components to be erected quickly and properly translates to a multitude of benefits during and after construction. That precept held true with the Cincinnati Public School District's Academy of Multilingual Immersion Studies World Languages (AMISWL). The citywide magnet school attracts preschool to eighth-grade and offers immersion and partial immersion curriculums aimed at fluency in foreign languages. With a tight deadline, the architect turned to a precast concrete system. And with the use of innovative precast sandwich wall panels, the school did not need to sacrifice performance for speed.

Project architect Randy Merrill from McGill Smith Punshon, Inc. says, "We tried to keep the design simple, sleek and high-style. It's truly an international style, in keeping with the school's mission. It could be built anywhere in the world and still fit in."

Precast means aesthetics and savings in any language

The school's 173 precast sandwich panels and 633 hollowcore planks were fabricated off-site and delivered in a kit of parts for immediate erection. The precast wall panel fabricator subcontracted with a second precaster for hollowcore plank.

The building took shape piece by piece. The panels varied in size from 15'-7" to 41'-0" in height and 11'-4" to 12'-7" in width.

Quick Facts:

Project: Academy of Multilingual Immersion Studies World Languages
Location: Cincinnati, Ohio
Types of precast:
Thermally Efficient Sandwich Wall Panels and Hollowcore Plank
Square footage: 85,599 square feet
(42,100 sq. ft. Load-Bearing Walls)
(70,000 sq. ft. Hollowcore Plank)
Architect: McGill Smith Punshon, Cincinnati, Ohio
Engineer: M-Engineering, Westerville, Ohio
General Contractor: Monarch Construction, Cincinnati
Owner: Cincinnati Public Schools

The Academy of World Languages in Cincinnati features thermally efficient sandwich wall panels.

Exposed aggregates and tile accents create a dynamic exterior.

Because precast concrete is manufactured in a controlled factory environment, the wall panels achieved a level of uniformity unmatched by field construction. Precast delivered consistent door and window openings, which eliminated the need for costly fieldwork to correct gaps and irregularities.

Precast helped maintain aesthetic consistency as well. The strikingly attractive building features several complementary finishes within each panel. Exposed aggregate provides bold texture and an earthiness that befits the school's wooded surroundings. A subtle, uniform sandblast finish appears alongside an acid-etched treatment that deepens colors for contrast and imparts a stone-like appearance. Horizontal lines of vibrant ruby red tiles below crimson-framed windows add contrast across the facade, while vertical lines of blue tiles almost make the seam between panels an aesthetic feature. Finally, insets of alternating yellow and blue tile provide a visual counterpoint to the exterior light fixtures directly above them. Overall, it's a colorful exterior that reflects the energy and discovery of learning.

Merrill praised the aesthetic versatility of precast. "It allowed us to play with colors and textures, maintaining a simple yet still attractive building," he says. "We were able to gain economies through repetitive patterning and use scale and massing to keep the building interesting and not overwhelming to the kids."

The benefits extended to the interior walls as well. The precast sandwich wall panels were prefinished on the inside with paint filler and institutional grade paint. Durable concrete will withstand decades of heavy use and abuse from energetic children. Furthermore, the prefinished interior eliminated the expense and time that a field-constructed interior would have entailed.

Precast accrued several other advantages. Weather delays and other setbacks were virtually circumvented with factory fabricated precast elements, which helped keep the project on schedule. Precast reduced the need for on-site material and equipment storage compared to other conventional building systems. Scaffolding (and its cost and risk) was avoided. Fewer people were required on the job site, reducing the risk of accident or injury as well as the associated insurance expenses.

Sandwich wall panels provide excellent building envelope

But these weren't conventional precast wall panels. During the project the design team decided to convert the wythe connection system in their structurally non-composite 3-2-6 wall design from fiberglass pins to high-strength carbon fiber grid shear trusses to add strength and stability with 100% structurally composite performance.

Over four times the tensile strength of steel, carbon fiber is a low thermal conductance material that transfers in-plane shear forces between concrete wythes in sandwich wall panels. When considered at the start of a project, the trusses permit concrete wythes of equal thickness to perform as a structural composite. When both wythes are load-bearing, wall sections can be thinner and lighter, use less concrete and cement, reduce associated shipping costs, and allow more interior space within the same building footprint.

The sandwich panels used 2" of extruded polystyrene (XPS) insulation between the two wythes. Carbon fiber grid's relatively low thermal conductivity virtually eliminates any hot or cold spots on wall surfaces, cutting back significantly on heating and cooling costs. Conversely, brick-and-block cavity wall construction often suffers from temperature fluctuation: cold in the winter, and hot in the summer. It can create an uncomfortable learning environment, especially around the perimeter of the building. And with high energy costs and heightened public awareness of sustainable construction practices, AMISWL and Cincinnati Public Schools will reap the benefits of the green, energy-efficient system for years to come.

Precast sandwich panels on the AMISWL also provide two levels of protection against mold and mildew, an all-too-frequent problem with masonry cavity walls. First, concrete's high density renders it virtually impermeable to water. Second, eliminating drywall removes a potential food source for spores. AMISWL's precast system will deliver decades of insurance against the unpleasant realities of a mold-related problem: irate parents followed by facility shutdown and remediation.

Overall, the Thermally Efficient Sandwich Wall Panels and the entire precast system saved time, reduced cost, improved durability and enhanced aesthetic options among other benefits. Subsequently, precast has readily become a preferred building system in the Cincinnati Public School District. The AMISWL joins Cincinnati magnet schools Roberts Paideia Academy and Fairview-Clifton German Language School as monuments to the versatility, efficiency and effectiveness of precast concrete.

1.0 AIA HSW

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3. Controlling Efflorescence
4. Parking Garage Code Change
5. Curing and Hydration
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Check the best answer for each of the following questions. Answers must be postmarked by December 1, 2009

1. There is no light blockage in precast parking structures when the bottom of the luminaire fixture is mounted:

○ Directly to the ceiling
○ 16" below the ceiling
○ 19" below the ceiling
○ 10" above the bottom of the double tee stem
○ 6" above the bottom of the double tee stem

2. A shorter development length means:

○ Wires slide easily
○ Carbon fiber is inert
○ Better crack control
○ Better corrosion control
○ None of the above

3. Efflorescence occurs when salts travel through ______to the masonry surface.

○ Evaporation
○ Capillary action
○ High-alkali cements
○ CO_2
○ All of the above

4. Choose the best answer: Thermally-efficient sandwich wall panels provide continuous insulation through the use of:

○ Shear pins
○ Pins and trusses
○ Shear trusses
○ Thermal breaks
○ High compressive strength

5. Short crystal formation may:

○ Follow initial cure
○ Continue for years
○ Lower ultimate strengths
○ Promote curing
○ All of the above

6. In Zones III and CC-II, ACI recommends that double tee flanges NOT reinforced with carbon fiber have:

○ Sealer
○ CNi
○ Impermeable field topping
○ Chlorides
○ All of the above

7. In a structurally composite design, a thermally-efficient sandwich wall panel of 7" thickness made with R-4 EPS foam will have an assembly R-value of:

○ 16.33
○ 13.33
○ 12.33
○ 12
○ 9.33

8. When carbon fiber flange reinforcement is used, ACI 362 recommends:

○ Sealer
○ CNi
○ Impervious field topping
○ All of the above
○ None of the above

9. Structurally non-composite wall designs may be converted to 100% composite performance by replacing connectors.

○ True
○ False

10. Shear walls in the middle of a garage allow light to pass through for maximum safety and security.

○ True
○ False

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