

precast **SOLUTIONS**

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ON THE COVER:

Follow the LEEDer: Olympian Precast of Redmond, Wash., manufactured a variety of precast concrete products including exterior panels, stair treads and planters - to help Seattle's Stone34 mixed-use building earn LEED Platinum certification. Discover how precast's many sustainable properties offered the perfect solution for project owners. Story on page 16.

Photo courtesy of Michael Walmsley.

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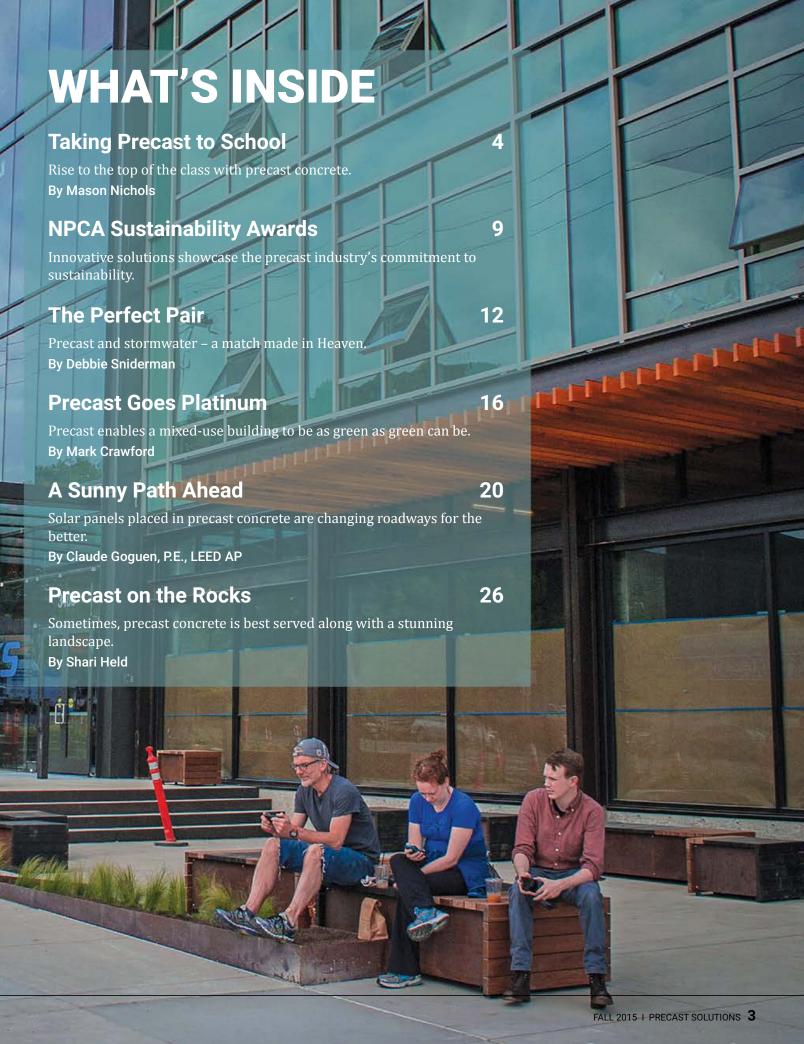
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Taking Precast to School

Specifiers turn to precast concrete for a wide variety of projects at educational institutions.

By Mason Nichols

From the moment we enter the world, life is filled with endless possibilities. As we gain control of our basic senses, we realize we can see, hear and feel new things. In turn, our environments become infinitely complex. And just when we think we have a grasp on all there is to know about life, everything is turned upside down when our parents send us to school for the first time.

A solid education serves as the foundation for a successful career and helps us unlock our full potential. Precast concrete functions in much the same way, enabling architects, engineers and project owners alike to accomplish nearly anything. As the projects below demonstrate, precast solutions save money and reduce on-site construction time at schools, providing the durable backbone educational institutions need to consistently provide students with the training necessary for their lives ahead.

TOP-NOTCH WALL FOR MIDWAY

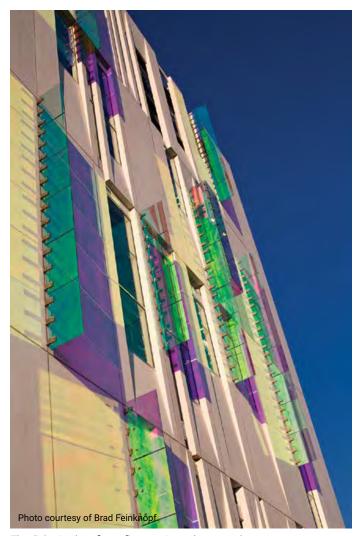
Last summer, a retaining wall at Midway Middle School in central Tennessee began to fail, resulting in portions of the wall spilling onto the adjacent roadway. School administrators knew they had to act fast to correct the problem.

"We had less than 30 days to install the structure, which needed to be in place and functioning before the new 2014-15 school year," said Kevin Alley, operations manager for contracting firm Charles Blalock & Sons, Inc., of Sevierville, Tenn. "That timeline gave us no room for error."

With a compressed schedule and the need for a new retaining wall that would function for the long term, administrators chose precast concrete. According to Eric Barger, vice president of C.R. Barger & Sons in Lenoir City, Tenn., precast provided a variety of advantages.

"We've found the Stone Strong block to be very competitive compared to a pour-in-place product," he said. "The choice of material provided an economical solution to meet the budget for the project and the school, allowing the school to once again use





The dichroic glass fins reflect varying colors onto the precast concrete panels based on the angle of the sun.

the road for bus traffic."

Barger & Sons manufactured 170 precast concrete blocks of varying sizes for the job. The new wall, which covers a total area of 2,140 ft², was erected in under a week thanks to the precaster's close proximity to the construction site. This allowed the entire project to be efficiently completed within the short timeframe.

In addition to the new wall's extended service life, each block's chiseled granite pattern provides the aesthetic touch school administrators sought in their solution. Barger said the result was a happy customer.

"We've heard nothing but great comments from the school," he said. "We expect the school to have safe access to the back of their building for years to come."

CHILLING OUT

Ohio State University is one of the most respected universities in the U.S., recognized internationally for strong research programs and solid educational opportunities. It's also one of the largest, boasting the third highest total enrollment in the country. The



school's College of Medicine mirrors this scale and esteem, serving thousands of patients who check into OSU's facilities each year.

In 2013, the university constructed a new chiller plant to distribute cold water throughout the medical district. Given the high-profile nature of the selected site, school officials wanted a solution that would broadcast wide visual appeal while providing maximum utility. According to Eric Martin, AIA and principal at Ross Barney Architects of Chicago, the initial idea for the structure was to enclose the chiller equipment in glass. This would allow it to be viewed from the outside.

"We learned that with a glass box design, we would have to add cooling to the building and literally chill the chiller," he said. "So we began looking for an alternate solution and precast concrete was chosen for its thermal properties."

RBA connected with High Concrete Group of Springboro, Ohio, to design and develop more than 200 precast concrete panels for the chiller plant. Using a combination of extensive planning and building information modeling, the two parties devised an effective solution for the project.

Dwayne Robinson, midwest sales manager for High Concrete, said collaboration with RBA played an important role in the

"It was a real pleasure [working with RBA] because it was something different for us," he said. "They were really helpful and gave us an idea of what vision and design concept they wanted. We worked well in tandem to get to where we're at on the project."

Each of the 11 different panel types making up the structure is fitted with dichroic glass fins. As rays of sunlight pass through a fin, various colors reflect on the surface of the concrete. The color patterns change based on the angle of the sun.

To make the effect more pronounced, all of the panels were polished – atypical for exterior precast of this type – to give them a noticeable sheen. The result is a stunning structure that's as pleasing to the eye as it is functional. As Martin explained, precast



Georgie D. Tyler Middle School is the first public middle school in Virginia to use structural and architectural precast concrete wall panels.

was the optimal choice to accomplish all of the project's goals.

"The design team felt that precast concrete panels were the best choice for the project given its demanding schedule," he said. "The size of the panels were also maximized to reduce the number required to clad the building while keeping in mind the capabilities of transporting them to the site."

A FIRST FOR PRECAST

Originally constructed in the 1950s, Georgie D. Tyler Middle School in Windsor, Va., was in need of a rebuild. As the design team from RRMM Architects got to work on the project in 2011, they realized a building material that could offer more permanence was necessary - one that would serve the sixth, seventh and eighth graders of the local community for decades to come. Their choice to make that possible was precast concrete.

Tindall Corp. of Spartanburg, S.C., was selected to manufacture the nearly 200 precast concrete panels that compose the exterior of the school. Working closely with general contractor Ritchie-Curbow Construction of Newport News, Va., Tindall developed a precast solution that provided many advantages to the project.

"There was plenty of thin brick cast in our pieces, so the project owners didn't have to worry about having that trade set up on site after some other system was used," said Patty Peterson, senior project manager for Tindall.

Chris Andrews, sales engineer with Tindall, added that speed of erection helped contribute to the success of the project. Workers were on site erecting the panels for just one month out of the 14-month construction period.

According to Summer Oostra, LEED AP and project manager for Ritchie-Curbow, the two companies had previously worked

together on other projects, which led to efficient interaction as they developed a joint solution.

"We always appreciate that Tindall has the expertise to come in, review the design and suggest some really valuable, time-saving options," she said. "They have always provided material on time and met or exceeded our schedule, so we're very happy to work with them."

Completed earlier this year, the resulting building is the first public middle school to use structural and architectural precast concrete wall panels in Virginia. And even though such a solution is a new concept for the state, all parties involved foresee a bright future packed with continued use of precast concrete products.

HONOR ROLL

From retaining walls to exterior panels and beyond, precast concrete is consistently the go-to building material for specifiers looking to ensure success with school projects. As professionals in the architectural, engineering and construction industries continue to push the boundaries of design, precast remains a top performer, rising to the head of the class with unmatched advantages. PS

Mason Nichols is the managing editor of Precast Solutions magazine and NPCA's external communication and marketing manager.



DRAINAGE

Innovative, hollow design provides built-in drainage.



LIGHTER

Lighter weight makes jobs go faster, easier, at a lower cost.



BIGGER

Its 24-sq-ft, size reduces labor costs and installation time.



INTERLOCKING

System designed to ensure blocks stay secure and level.

STATE OF THE BLOCK.



There are Stone Strong blocks. Then there's everything else. With the biggest, best and most innovative block in the industry, Stone Strong Systems delivers fully and intelligently engineered retaining wall solutions that greatly reduce installation time and labor costs – with unmatched safety, durability and aesthetics. State of the art? We go one better. This is state of the block.



stonestrong.com



NPCA Sustainability Awards

NPCA's Sustainability Awards recognizes excellence in sustainable products, practices and operations among NPCA members, highlighting the precast concrete industry's continuing commitment to sustainability. The 2015 award winners are outlined below.



High-efficiency LED lighting reduces the environmental impact of everyday operations at Anchor Concrete Products in Kingston, Ontario.

PRODUCER CATEGORY

FIRST PLACE PROJECT

StructureCast (structurecast.com) **Project:** Wilmington Drain Trash Trapper **Location:** Machado Lake, Calif.

The Wilmington Drain is a 150-foot-wide, 1/2-mile-long channelized river that conveys urban runoff and stormwater flows to Machado Lake and ultimately the Los Angeles Harbor. Originally a natural river, most of it is now concrete-lined. The drain is currently managed by Los Angeles County as a flood control channel. The lake and drain have both been identified as impaired water bodies as a result of pollution in stormwater and urban runoff flowing from the lake's 15,553-acre watershed. As part of a \$140 million clean-up project, a precast concrete trash-trapping net and bypass system was designed, casted and installed across the flood control area.

Fresh Creek Technologies designed a system of 11 precast concrete netting trap chambers and two bypass structures and partnered with StructureCast over a four-year period in the

development and engineering of the system. Once the project moved into the implementation phase, time was of the essence. Basic submittals were completed in one week, shop drawings were completed in four weeks and delivery of the structures took place just 40 business days after approval of the shop drawings.

Casting the structures on site would have taken more than three months. The precast solution not only saved time, but some serious money. The result? A happy customer, repeat business and, most importantly, a cleaner environment. Win, win, win!

FIRST PLACE PLANT

Anchor Concrete Products

(anchorconcrete.com)

Project: High-Efficiency LED Plant Floor Lighting

Location: Kingston, Ontario

Adequate lighting is essential for safe working conditions in a precast plant. By switching to new, high-efficiency LED lights, Anchor Concrete Products significantly reduced its utility bill while providing employees with a brighter working environment. The LED lights turn on instantly, a drastic improvement over the old, high-pressure sodium lights that took 15 minutes to power up. Additionally, by switching to LED lighting, Anchor was able to participate in a community program offered by a local energy provider aimed at reducing the demand of local utilities.

Before making the switch, Anchor tested the new lighting with employees to gather feedback. One suggestion was to include automatic, area-specific sensors that turn lights on and off according to where workers are on the plant floor. This feature is especially useful in swing shifts, when some areas of the plant are inactive.

Anchor's LED lighting solution is applicable to the entire precast industry. Any plant can save money and provide improved working conditions by simply making the switch. And because of their exceptionally long life span and low energy consumption, LEDs reduce the load on the local energy grid and lessen impact on the environment, making them a truly sustainable choice.

PRODUCER PROJECT HONORABLE MENTION

Leesburg Concrete Co. Inc.

(leesburgconcrete.com)

Project: Mayport Naval Air Station Structures

Leesburg Concrete Co. manufactured a variety of precast concrete products for Mayport Naval Station in Jacksonville, Fla., including architectural panels and stair systems. To help achieve the project's goal of attaining LEED Silver status, Leesburg adhered to sustainable building practices, including reducing waste, sourcing local materials and more.

PRODUCER PLANT HONORABLE MENTION

Hanson Pipe & Precast

(hansonpipeandprecast.com)

Project: Building on the Past. Restoring the

Balance. Creating the Future.

Hanson Pipe & Precast produced various precast concrete structures to create a 10-acre underwater artificial reef system for a marine environment near Daytona Beach, Fla.



BASF's EPD Manager Program allows precasters to easily quantify the environmental attributes of their products.

ASSOCIATE CATEGORY

FIRST PLACE PRODUCT

BASF Admixture Systems

(master-builders-solutions.basf.us)

Project: BASF EPD Management System

Location: Cleveland, Ohio

As the construction industry continues to pursue sustainable building practices, suppliers are required to quantify the environmental impact of their products. With sustainable construction expected to surpass half of all new construction in the near future, this requirement will become increasingly common.

For precast concrete manufacturers, providing sustainable practices documentation can be daunting. While concrete is considered a sustainable product based on its durability, use of recycled materials and ability to be recycled at the end of its useful life, quantifying the environmental attributes of a concrete solution has been challenging.

BASF Admixture Systems developed a new program to streamline this complex process. The BASF solution incorporates the Environmental Product Declaration as its key component. The EPD has been compared to a nutrition label. However, instead of

noting a food product's nutritional attributes, the EPD denotes the environmental results associated with the life cycle of a product. The EPD, based on ISO standards, is considered a verifiable means for reporting the environmental performance of a product. The challenge in generating an EPD for a precast concrete producer is the complexity associated with the process. From data acquisition and evaluation to third-party registrations, the time, money and energy expended can be overwhelming.

To simplify the process for the precast producer, BASF has developed a unique EPD Manager Program. The system eliminates the precast manufacturer's need to complete external evaluations and reduces the overall cost and time required to deliver a verified EPD. The EPD Manager Program delivers a streamlined, costeffective approach to creating an externally verified EDP to the industry. The application of knowledge, tools and innovations of this type will continue to drive sustainable development in the precast concrete industry.

ASSOCIATE PRODUCT HONORABLE MENTIONS:

Concrete Batch Solutions (concretebatch.com) **Product:** Thermal Energy Unit

Concrete Batch Solutions created an energy-efficient "Turbomatic" heating unit that limits energy output while allowing concrete to be manufactured at specified temperatures.

HELIX Steel (helixsteel.com) **Product:** HELIX Micro-Rebar

HELIX Steel's Micro-Rebar solution serves as a replacement for traditional reinforcing steel in precast concrete products. Among other sustainable benefits, HELIX Micro-Rebar can reduce CO₂ emissions and increase product life cycle.

Hyster Company (hyster.com) **Product:** Fuel-Saving Big Trucks

Hyster Company's new Tier 4 Final compliant lift trucks keep sustainability in mind through low emissions output and a variety of other green considerations.

Mi-Jack Products (mi-jack.com) **Product:** RTG Crane + Power on Demand

Mi-Jack Products' smart crane system senses the power necessary to perform an operation, signaling the engine to automatically deliver optimum power. This results in significant fuel savings and reduced environmental impact.



Precast & Stormwater:

The Perfect Pair

Unique underground precast projects help customers become more environmentally sound.

By Debbie Sniderman

Using traditional concrete products for innovative projects excites specifiers and precast manufacturers alike, challenging them to think outside the norm. In many cases, such projects benefit local communities and the Earth as a whole. Two recently completed underground precast projects did just that, addressing the everpresent need for effective stormwater solutions.



Each of the 14 large precast stormwater structures contains a vortex swirl chamber that removes waste, oil and sediments from the captured water.

UNIQUE STORMWATER TREATMENT SYSTEMS

The Mississippi State Port Authority is investing more than \$57 million in construction projects to extend and deepen the Port of Gulfport. When MSPA completes the restoration program's environmental plan, the Port of Gulfport could become the second coastal port in the U.S. to successfully achieve a green designation. Precast concrete is playing an important role in the unique stormwater treatment systems that are a major part of this plan.

Travis Dickey, director of business development, marketing and sales at Design Precast & Pipe of Gulfport, Miss., said his company provided a wide variety of underground precast products for the Port's 60-acre expansion. In addition to massive stormwater treatment systems, Design Precast & Pipe manufactured precast for the 140 electrical transport systems and more than 15,500 linear feet of reinforced concrete pipe and reinforced concrete arch pipe.

With the help of CONTECH Engineered Solutions, Design Precast & Pipe produced 14 large stormwater structures: 12-foottall boxes with 15-foot-by-22-foot and 14-foot-by-20-foot inner diameters. They contain integrated vortex swirl chambers that thoroughly clean the stormwater before it is released into the Mississippi Sound.

Each box weighed more than 100,000 pounds and the entire structure - including its large aluminum vortex chambers -

weighed 250,000 pounds. When water enters the box through an entry hole, it spins as it goes through the vortex chamber. Waste, oil and sediments are captured in filters on the inside before the water is released.

CHALLENGES ENCOUNTERED

Although Design Precast & Pipe is experienced making large precast structures, this is the company's first job that includes swirl chambers. Teaming with another company and learning how to add an element to a structure for the first time was a challenge. Instead of simply adding wire and rebar, this project involved adding a metal structure that was engineered before the precaster was involved. Constructed from bent and shaped aluminum sheets, it was fixed inside the box and bolted into the wall.

Initially, the precaster didn't know how to assemble the large aluminum swirl chambers, but designers came to the precast plant and showed them how to build the first one. Design Precast & Pipe built the rest without assistance.

SAVING TIME, PROTECTING WORKERS

Other than having high strength and an extended service life, the main reason the underground precast stormwater treatment structures were specified was time constraint. Due to the project's location on the water and the complexity of the port expansion,



A series of precast concrete cisterns is installed for a fire department in Green Hills, Tenn.

excavation and installation needed to be completed in a matter of days. As such, casting in place wasn't possible.

Safety factors also came into play. The sheer size of the structures was very concerning to the installation contractors. They didn't want workers to remain in such large structures in such large holes for a long time. Precast helped minimize these concerns.

BRINGING CONVENIENCE

Dickey said compared to casting in place, digging a hole and placing a precast product makes the project much easier. Using a precast structure is also more convenient for on-site contractors that have multiple projects going on - when they are ready, the structures are ready.

Four boxes were installed at a time, each set close to one another: two large 15-foot-by-22-foot pieces with 8-foot-by-10foot structures in between them. All boxes were tied together with pipe to make the stormwater loop. Dickey said the precast structures saved time and money during installation.

"They were built to grade and there were no hiccups," he said. "The contractors did a good job digging to the depth they needed, and the surface was prepared well. Unique jobs like this show that there's no limitation to what precast can do. If engineered and built properly, precast technologies can be used to solve almost any problem."

WATERTIGHT, DONE RIGHT

Located near Nashville, Green Hills, Tenn., is a hot area for development. But with so many people moving in, infrastructure changes are necessary. One necessary upgrade was the town's local fire station. Inspired by the nearby town of Brentwood, the Green Hills fire chief sought to save money on the city's water bill by installing a cistern that holds rainwater on site, making it available for re-use.

The Green Hills chief wanted a rechargeable system that would hold rainwater to irrigate the grounds and supply hoses for training exercises. This type of system allows the fire department to use less city water, providing both environmental advantages and cost savings. Directly and indirectly, taxpayers benefit over time.

After experimenting with non-concrete solutions that did not perform to expectations, the Green Hills fire chief became frustrated. He then mandated the system be absolutely watertight, with a simple design and easy installation. A precast concrete cistern design met all of the criteria, bringing speed, efficiency and quality control to the project.

Sherman-Dixie Concrete Industries of Nashville bid on and won the project. Along with a consulting engineer and an installation contractor, Sherman-Dixie put together several design options. According to Michael Kusch, Sherman-Dixie's director of technical marketing, the one that was ultimately selected was a series of large vault catch basins.

THE CISTERNS

Measuring 9 feet on all sides, the selected model allowed for a total monolithic pour with no horizontal seams or joints. Sherman-Dixie created a series of boxes suitable for sanitary or water-lined applications where nothing can get in or out, other than through a hatch on top used for servicing and a series of pipes that feed the system.

The system consists of five identical boxes linked together and installed underground that holds 27,300 gallons of rainwater harvested from roof drains. Gaskets in the walls ensure the cisterns are absolutely watertight.

There are many ways to hold water, but precast concrete offers the most efficient solution. Kusch said one reason precast concrete was used for this project was because of the speed of installation. All five vaults could be set in one day. With cast-in-place, it would have taken two weeks.

While there was no design criteria for product lifetime specified for the project, precast cisterns are built to last. Where flexible products have 25-year life spans, precast concrete products can last 70 to 100 years. According to Kusch, over the life of the concrete, this can save owners the headache of having to consistently re-install tanks made from plastic or fiberglass.

INFINITE POSSIBILITIES

Precast concrete products offer endless advantages and can often be used in unexpected situations. As the stormwater systems above highlight, precast provides an adaptable, long-term solution with the ability to lead any project to success. PS

Debbie Sniderman is an engineer and CEO of VI Ventures LLC, an engineering consulting company.





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Concrete (Untreated)



Xypex Crystallization (Initiated)



Xypex Crystallization (Mature)

Xypex Admix offers a powerful and effective solution for increasing the service life of buried precast concrete products. When added to the concrete mix, it provides integral waterproofing as well as increased acid resistance and sulfate protection. When you select Xypex you've chosen the best — more than 40 years of independent testing and still No Equal.





Precast Goes **Platinum**

An urban mixed-use building in Seattle makes extensive use of precast to earn LEED Platinum certification.

By Mark Crawford

Seattle's 120,000-square-foot "Stone34" building isn't just pleasing to the eye - it's also about as green as green can be. Thanks to the use of a variety of sustainable building materials, including exterior precast concrete panels, the U.S. Green Building Council certified Stone34 as LEED Platinum earlier this year.

The five-story, urban mixed-use building blends sustainable design with the elements of two eclectic neighborhoods. Stone34 serves as a visible beacon for an energetic community, acting as a trailhead for the neighborhood.

Developed and constructed by Skanska, Stone34 became the first project to use Seattle's Living Building Pilot Program, which requires exceptional performance for water and energy resources along with social goals that far exceed criteria for LEED certification. These goals include adhering to market-rate pricing, achieving 75% reductions in energy and water use, and creating a community hub on the popular Burke-Gilman Trail.

The building's design provides 8,500 square feet of open area at street level, providing ample public space to support the outflow of retail on three sides of the structure. The upper four floors contain office space. Attractive, two-tone precast exterior panels also help reflect heat. A grand exterior stairwell, clad in energy-efficient glass, moves the ground-floor activity up the building.

"[This] celebrates the act of taking the stairs and creating a close relationship between the tenant and the community," said Wendy Pautz, partner with LMN Architects, the architectural firm for the project. "The office floors are highly visible to the street, with a digitally-modeled glazing pattern that balances daylight, views, glare and heat gain considerations."

The social aspect of the street plaza continues upward by way of two terraces and a rooftop deck, creating continuous connections with the outdoors and the public. Green walls call attention to the building's sustainable design while also providing habitat for birds and insects.

In 2014, Brooks Sports moved its global headquarters into Stone 34, occupying more than 70% of the space.

ADDING VALUE WITH PRECAST

Precast played a crucial role in Stone34 meeting its LEED Platinum standards and its ongoing Living Building Pilot Program commitments. Olympian Precast in Redmond, Wash., manufactured the architectural precast components for the project. These included precast exterior panels, integrally colored precast stair treads and landings for the main staircase, and precast planters that help make the roof deck an attractive gathering place for local residents.

Designers selected precast for the building's exterior for several reasons. Use of precast concrete panels in conjunction with a dual sealant system and careful detailing eliminated the need for exterior sheathing and a separate water and air barrier assembly, which reduced building costs. Going with precast also reduced the number of materials used in the wall assembly. This resulted in fewer trips to the project site. In addition, waste reduction and recycling were more efficient because both occurred at the precast plant instead of on site.

"Precast was part of an energy-efficient wall system that facilitated use of a continuous air barrier and insulation," said John Mrozek, an LMN architect who worked on the project. "Because precast concrete systems require a limited number of points of connection to the structure, minimizing thermal bridges through the assembly is greatly simplified."

The unique location of the project resulted in a formal massing solution that integrated folded planes of glazing and precast concrete panels in response to the irregular urban street grid.

"The construction of the concrete panels produced well-crafted



Nearly all of the materials used to manufacture the precast concrete for Stone34 were mined or processed within 300 miles of the construction site

obtuse angles that resolved one geometry to the next," Mrozek added.

The design intent for the precast concrete wall panels was to achieve a uniform, light color. Careful consideration was given to the type of aggregate and sand color used to consistently distribute an even color across the face of the panel and achieve the desired aesthetic. For contrast, charcoal-colored panels were used at the base of the building.

In addition to the exterior precast panels, the main stairway in Stone34 was built with precast stair treads. "A dark charcoal color was used with a smooth form finish, except that the front of the tread had a sandblasted nosing pattern for both visual and tactile difference at the tread nose," said Kevin Jewell, project manager for precast manufacturer Olympian Precast.

The lighter exterior precast consisted of white cement, a blend of two sands and pigment. Charcoal panels used Type-III gray cement with black pigment. Both precast colors were acid etch finished. Jewell noted that Skanska was initially concerned about the environmental impacts of acid etching.

"I explained that all of our etching work is done in a contained



area, with the acid and residue collected and pumped to a treatment tank," he said. "The liquid is treated to pH neutral and then released to sanitary sewer. All this work is done under a permit from the Washington State Department of Ecology. After review, Skanska agreed that acid etch was the best finish for the project."

Mrozek added that working closely with the precaster led to success.

"We worked collaboratively with Olympian Precast to achieve a solution that provided the desired aesthetic, longevity and technical resolution required for the project," he said.



Almost all the concrete materials - including the aggregates, gray cement, reinforcing steel and most miscellaneous iron connections - were mined or processed within 300 miles of the construction site, which helped with the LEED scoring. Reinforcing Nucor steel is certified as 99.4% recycled content, with a mix of 82.5% post-consumer and 16.9% pre-consumer, post-industrial.

LEEDING THE WAY

Stone34's success will go a long way toward convincing skeptical developers that this kind of sustainable LEED project, with its extra community commitments, can be a win/win for the developer, builder, tenants and local residents. It can also be profitable - in December 2014, Skanska sold the complex for \$70 million. Precast concrete components are an essential part of the building design that contribute to its energy efficiency, cost efficiency and good looks.

Stone34 was named Office Development of the Year by the Washington Chapter of the Commercial Real Estate Development Association in 2014. This recognition reflects the growing interest in developing flexible green design standards to meet or exceed LEED and community standards for sustainable design, and that these goals are achievable and deliver important benefits to both the community and the environment. PS

Mark Crawford is a Madison, Wis.-based freelance writer who specializes in science, technology and manufacturing.

A Sunny Path Ahead

Innovative solar roadway projects in the U.S. and abroad use precast concrete to convert the sun's rays into reusable energy.

By Claude Goguen, P.E., LEED AP





Solar technology isn't new. Evidence suggests humans used magnifying glass in the 7th century B.C. to create fire from the sun's rays. In 1767, noted Swiss physicist and adventurer Horace-Bénédict de Sassure invented a solar oven using a wellinsulated box with three layers of glass to trap thermal radiation. Another milestone occurred in 1954, when scientists at Bell Labs developed the silicon photovoltaic cell, the first solar cell capable of converting the sun's energy into enough power to run common electrical equipment. Today, you can simply walk into your local hardware store and buy a residential solar power system.

Looking ahead, great potential remains for groundbreaking solar power technologies. And with the help of precast concrete, inventors are paving new roads to success.

SOLAR ROADS IN THE U.S.

Imagine a parking lot that's roughly the size of South Carolina. That's what you'd get if you combined the roughly 30,000 square miles of roads, parking lots, driveways, playgrounds, bike paths and sidewalks in the contiguous U.S. Scott Brusaw, an electrical engineer and Marine Corps veteran, hopes to take that surface area and use it to convert the sun's rays into energy. Solar Roadways, a technology he and his wife Julie developed together, will power this process.

As a child, Scott envisioned the creation of an "electric road." Throughout his career, which included everything from a stint in the oil exploration industry to research and development work, he continued to refine his idea. Today, Scott and Julie function as co-founders of their ambitious project, which has garnered much attention from a variety of major media outlets.

The technology consists of hexagonal structural pavement panels protected by textured glass. An integrated circuit controls each unit, which also contains LED lighting for road lines and signage. Panels convert solar radiation to electricity and can be mounted in new or existing roadways. The Brusaws have received support from many parties, including the Federal Highway Administration, which has funded two study phases of the Solar Roadways system.

In Phase 1, FHWA confirmed the functionality of the system's electronics. The Brusaws built a prototype crosswalk panel that included load cells for detecting weight on its surface. When weight is present, data is sent to the solar panel, which then displays instructions for approaching motorists to slow down using LED lights. This process demonstrated the ability of the road panels to communicate with one another.

For Phase 2, Solar Roadways installed a 36-foot-long, 12-footwide prototype outside its facility in Sandpoint, Idaho. The parking



Construction workers install precast concrete solar panels for the 230-foot-long SolaRoad bike path in the Netherlands.

lot was slanted at a 3% grade to simulate a roadway and was fully functional with solar cells, LED lighting with added colors, heating elements and textured glass. The glass surface was sent to engineers to test for loading, traction and impact resistance. According to Scott, the glass exceeded all expectations, with tests revealing that it could support the weight of a 250,000-pound truck.

In this phase, the panels were placed in a concrete foundation. A concrete stormwater basin and utility corridor were also added to the side of the parking lot. In the real world, the basin would be used to collect stormwater runoff and direct it to appropriate treatment systems. The utility corridors would route cables for electricity generated from the solar cells and could also be used by other utilities. The parking lot is roughly equal to a 3,600-watt solar array.

AN IDEAL MATERIAL

For the prototype used in Phase 2 of the FHWA study, Scott used cast-in-place concrete. But he sees many benefits in using precast in the future.

"Precast concrete would be ideal for this system," he said. "The conduits could be pre-installed during manufacturing. Also, we had to drill the concrete to be able to install 396 bolts for the Phase 2 prototype. Precast panels could have those anchors pre-installed."

Precast panels could also quickly and easily be delivered to the installation site. Then, the solar panels would bolt into them, completing the connection.

The Brusaws' vision is for Solar Roadways to first take root in smaller projects, including driveways, bike paths and sidewalks. From there, parking lots and residential roads would follow, with the ultimate conversion being the nation's highways. To get to that point, Solar Roadways must next conduct large-scale tests in parking lots or other surfaces that would not impede traffic. The Brusaws are also experimenting with piezoelectric elements and thermocouplers for their next design. Both of these devices can produce energy around the clock.

The Brusaws may be dreamers, but they're not the only ones. Across the Atlantic, another company is exploring a similar technology and has progressed to larger-scale field testing.

SOLAROAD

Just a few miles outside of Amsterdam in the town of Krommenie, a 230-foot-long by 11.5-foot-wide bike path dubbed "SolaRoad" is attracting international attention. Constructed in October 2014, the path represents an important project exploring the use of road surface to collect solar radiation and convert it to electricity. Precast concrete panels with a translucent top layer of



The SolaRoad bike path in the Netherlands consists of precast concrete panels with a translucent top layer of tempered glass.

tempered glass are used. Crystalline silicon solar cells are located under this glass.

In 2009, Netherlands-based organization TNO came up with the vision for the path and later formed a public-private consortium with other outfits - including the North Holland government, Ooms Civiel and Imtech - to bring the vision to reality. Like Solar Roadways, the ultimate goal is to have large parts of the road surface in the Netherlands act as a solar panel. The generated electricity could then be used for street lighting, traffic systems, households and electric vehicles.

Sten de Wit, spokesperson for SolaRoad, believes that - with time - the system could have a significant positive impact.

"This could be a breakthrough in the field of sustainable energy supply," he said. "In particular if the road concept will develop into a system with which the generated electricity is transported to the vehicles driving on the road. Subsequently, a big step towards an energy-neutral mobility system will be possible."

SolaRoad is being developed in stages. After a feasibility study, a first prototype was created in 2010 and has been tested extensively in the laboratory. The results raised questions and revealed some points for improvement, but were so promising that in 2011 it was decided to further develop the system. This is what led to the bicycle path in Krommenie.

Throughout the course of the project, alternative options have been examined for both the solar cells and the glass. Researchers are looking for the best skid-resistant coating to use on the glass to provide adequate braking traction. The glass was also tested for fatigue and loading.

SolaRoad has exceeded expectations since it first opened to the public. In the first six months, the bike path had already generated 3,000 kilowatt-hours, enough energy to provide a single-person household with electricity for a full year.



Bicyclists traverse SolaRoad, which has exceeded energy generation expectations since opening in late 2014.

Stan Klerks, SolaRoad lead engineer, said that using precast concrete panels contributed to the success of this project. "We learned it's possible to integrate things in precast concrete elements," he said. "The panels were simple to install and had conduits already integrated for cabling."

SolaRoad already has plans to extend the prototype next year to 330 feet in length, which would produce enough electricity to power three houses. As the system continues to evolve, one main area of focus will be refining the technology to lower costs, making SolaRoad available for larger-scale projects.

THE NATURAL CHOICE

Precast concrete played a role in solar power generation long before the development of Solar Roadways and SolaRoad. Footings and piers are widely used to provide a stable support system for solar modules. Precast has also been integral in the sustainable construction and repair of roadway systems. With its many advantages and sustainable benefits, precast concrete is the natural choice for any roadway solar system project.

For more questions on precast applications such as this or any other sustainable project, please contact Claude Goguen, NPCA's director of sustainability and technical education, at (317) 571-9500 or by emailing cgoguen@precast.org. PS

Claude Goguen, P.E., LEED AP, is NPCA's director of sustainability and technical education.

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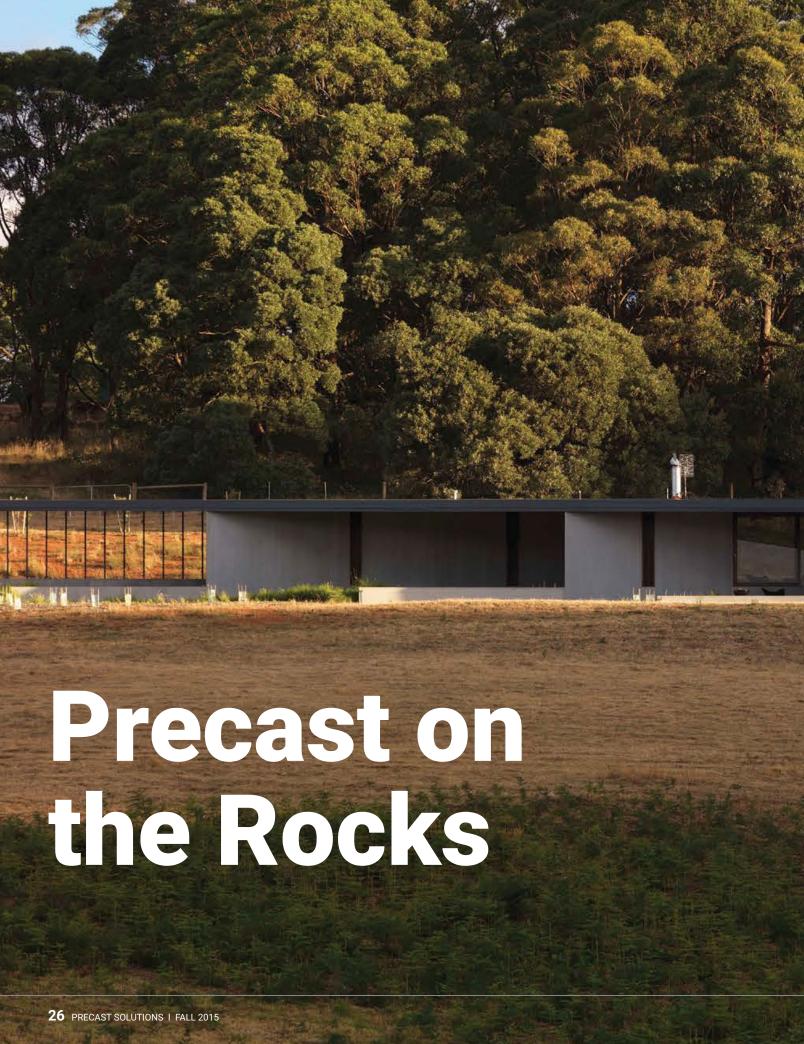
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Thermal insulated concrete sandwich panels keep the home's temperature consistent despite extreme fluctuations in the area.

Hanging Rock, located in the Macedon Ranges of scenic Victoria near the southern tip of Australia, has a rather checkered past. The massive volcanic boulder, suspended between two other rocks, was once the site of Aboriginal tribal gatherings. But the Aborigines refused to climb the 350-foot lava blister because they feared malevolent spirits inhabited the area. In the '70s, Hanging Rock was immortalized by Picnic at Hanging Rock, a haunting movie in which several schoolgirls and a teacher mysteriously disappear. The eerily beautiful landscape seems to inspire that kind of mystique.

But recently, the picturesque location served as an inspiration for something different - the award-winning House at Hanging Rock. The home, in which precast concrete played a starring role, earned Australia's most prestigious residential architectural prize, the 2014 Robin Boyd Award, and the 2015 Australian Institute of Architects Victorian State Harold Desbrowe-Annear Award for Residential Architecture.

Kerstin Thompson Architects designed the House at Hanging Rock for European artist Tatiana Henderson and her husband.

The couple, who were actively involved in the design process from the beginning, had several criteria for their new abode. The exterior had to merge into the landscape while providing them with shelter and protection from the elements, including extreme fluctuations of temperatures and dangerous brushfires. And the interior needed to convey a feeling of intimacy in contrast with the spectacular, vast expanses of the surrounding area.

A CONCRETE SOLUTION

The owners requested a "brutalist use of materials" and felt constructing the home from concrete would mesh well with their concept. In addition to its aesthetically pleasing qualities, concrete is known for its adaptability, low maintenance and durability.

That fit right in with Thompson's philosophy of designing buildings that enhance the natural surroundings rather than alter the site to accommodate construction. The House at Hanging Rock, set amidst a stark and dramatic landscape, holds its own without being obtrusive and taking away from the natural beauty of the area



Kerstin Thompson Architects specified precast concrete for the House at Hanging Rock due to its cost-effectiveness, durability and thermal efficiencies.

"The House at Hanging Rock epitomizes the clarity of KTA's planning and interest in a direct and reduced material palette in which the structure actually forms the finished surface," said architect Kerstin Thompson. "Much of the house's intriguing character comes from the use of concrete thermapanels for the primary wall expressed inside and out. More broadly, the project demonstrates the intrinsic relationship between construction, material, parti and landscape in the making of this distinctive dwelling."

PRACTICAL AND COST-EFFECTIVE PRECAST

Thermomass insulated concrete sandwich panels from Composite Global Solutions were used for the walls of the home. Thompson had used Thermomass panels in an earlier industrial project for the Templestowe Fire Station, but this was her first foray into using them for the residential market. The precast panels met the design specifications for a concrete finish on both the exterior and interior walls. Using precast also helped keep the cost of constructing a concrete home in check.

"It was a more cost-effective way to achieve a concrete building than in-situ," Thompson said. "And precast offered more quality control than in-situ, since it was produced within a controlled factory setting. This helped with managing client expectations around the finish."

Another advantage Thermomass precast concrete sandwich panels brought to the project was excellent thermal efficiencies. Thermomass panels can handle extreme temperature fluctuations over a 24-hour period, something common in that part of Australia.

During the daylight hours, the insulation protects the home against sharp rises in external temperatures. Any heat entering the home through the windows and doors is cooled by the interior layer, which acts as a heat sink for the building, lowering ambient temperatures.

"As the external temperature drops towards evening and throughout the night, the interior leaf of the concrete panel, that has gradually risen in temperature during sunlight hours, keeps the internal temperature pleasant," said Fredrik Carlstrom,



Construction of the home was completed in just under two years.

marketing manager for Composite Global Solutions in Toorak, Victoria. "As such, the peaks and troughs of diurnal temperature fluctuations have been vastly diminished, resulting in a much smoother temperature variation."

By placing the insulation toward the outside of the sandwich panel and having the bulk of the internal mass on the inside of the structure, diurnal swings are reduced without the need for additional non-passive cooling.

FIVE STEPS TO SUCCESS

Manufacturing the insulated precast concrete sandwich panels is a five-step process, and timing is critical. First, the exterior layer of concrete is poured into a form with reinforcement that's been treated with a bond-release agent. Immediately after the exterior layer is set - within 15 to 20 minutes to ensure the concrete mix is still plastic - pre-drilled, extruded polystyrene insulation is placed over the concrete. Next, special concrete-compatible, fibercomposite connectors are inserted through the pre-drilled holes in the insulation. A single connector is strong enough to carry up to 2,500 pounds of concrete. Then, the form is vibrated to create a 5-to-7-inch slump around the notches in each connector. For the finishing touch, another layer of reinforcement is laid and the interior layer is poured on top.

Sandwiching the insulation between the two layers of concrete doesn't just help moderate indoor temperature fluctuations - it greatly reduces energy consumption as well. R-values range from R-10 to R-50, which is significantly better than concrete alone.

Thermomass concrete panels also meet the strict bushfire attack level requirement for the area. No one in Victoria has forgotten 2009's "Black Saturday," during which 400 individual bushfires broke out, leaving 173 dead and 414 injured. Global warming is making the area hotter and drier and the threat of bushfires is an ever-present challenge to builders.

"By its very nature, concrete is non-combustible," Carlstrom said. "And since the insulation is never exposed to naked flame, being sandwiched between two layers of concrete, the whole system is deemed to satisfy the fire ratings of the area."

On-site construction on the 2,583-square-foot home, built by Project Precast Panels, took place from July 2011 to April 2013.

CONCRETE WALLS LET THE SCENERY TAKE TOP BILLING

Thompson's design called for three parallel levels or terraces, each in an east-west orientation that followed the slope of the hill they're nestled against. The generous overhang on the tapered roof, which creates a shadow serving as a buffer between the home and the outdoors, helps the home blend seamlessly with the rugged terrain.

According to Thompson, the multiple levels help define the interior space, creating distinct areas within the home. Each level has its own function: the lower level houses the guest room and studio, the upper level contains the master suite and study, and the middle level accommodates the main living areas.

"The widest of the three terraces houses the central living



The House at Hanging Rock has won several awards, including Australia's most prestigious residential architectural prize, the Robin Boyd Award.

zone and overlaps with the outer two terraces, creating a series of interconnected living spaces that are experienced as one larger space," Thompson said.

The middle level is also where the three terraces flow together, providing spectacular views. Incorporating that rugged scenery into the interior of the home was crucial to the owners. Its rough-textured precast walls and concrete floors provide a rustic backdrop that puts the spotlight on the scenery. The parallel concrete walls also create natural longitudinal "viewing corridors." But Thompson expanded upon that concept by "pulling apart" selected panels to create lateral views that capture the scenes from all three levels in the main living space.

"The formal arrangement of the house frames the desirable views - distant ones of Hanging Rock and closer ones of bushland," Thompson said. "There are also incidental diagonal views across the various levels and spaces. Although a 2.4 module is used for all wall panels without windows, the spatial outcome is decidedly un-modular and dynamic."

A FITTING ABODE

The House at Hanging Rock has been described as everything from "sophisticated and elegant" to "tough," but architects and those in the industry appear to be fascinated by it. A big part of its allure is the innovative use of precast concrete panels that form the interior and exterior of the home.

"We have been delighted by the success of the project, particularly the peer recognition we have received for the quality of the architecture," Thompson said. "It is appreciated when what we, in our office, have judged to be a good building is endorsed as such by others. But most rewarding is the clients' enjoyment of it: the rightness of the fit between their lives and the flow and feel of the house." PS

Shari Held is an Indianapolis, Ind.-based freelance writer who has covered the construction industry for more than 10 years.

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