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Photo courtesy of Ben Tanner, Populous.

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Bridge that ever Sleeps

To meet strict project requirements and drastically reduce impact on traffic, the New York City Department of Transportation turns to waterproof precast concrete paving slabs.

By Peter Smith, P.E. and Evan Gurley



THE BROOKLYN BRIDGE, designed by John Roebling, has been a symbol of American ingenuity since it opened in 1883.¹ When it opened, the bridge provided passage for horses and buggies, elevated trains, bicycles and pedestrians. Over time, it evolved to also carry trolleys and cars.

By 1954, major renovations of the inner and outer trusses eliminated the elevated train structures and the roadways on each side were widened from two lanes to three, a configuration that remains today. Ramps to intersecting roadways were also added to provide access to and from the bridge.

In terms of complexity and technological innovation, the suspension spans and approaches on both ends are some of the most remarkable components of the Brooklyn Bridge. The 1,525-ft Manhattan approach includes two conventional structures and two arch structures and the 2,100-ft Brooklyn approach includes five conventional structures and three arch structures over the streets below.

AN INNOVATIVE UPGRADE

In the late 1990s, it became apparent the asphalted concrete pavement on the approaches needed to be replaced. Measures also needed to be taken to protect the masonry arch block structures below. Design consultant Weidlinger Associates Inc., a subcontractor to New York City-based URS Corp., was faced with many daunting challenges. The work could not impede the flow of more than 105,000 vehicles, 2,661 commuter bicycles and thousands of pedestrians per day and had to be done with equipment that would not damage the 127-year-old arches and arch block structures below. Work also had to be completed in strict accordance with the city's noise abatement requirements and with minimal pollution. But perhaps the most difficult challenge was that the new pavement had to be impervious to water, which would prevent damage to the classic masonry structures below.

WAI continued the Brooklyn Bridge tradition of ingenious design by developing a waterproof pavement consisting of precast pavement slabs fabricated off site in a controlled environment. Precasting the slabs off site helped to satisfy the specified noise and air pollution requirements. The slabs were manufactured to exacting specifications, allowing them to fit the complex geometry between the existing bridges.

Precast pavement was chosen primarily because it can be placed overnight, allowing the road to reopen to traffic the next morning. The system was made waterproof by sandwiching it between two membranes. The first membrane was sprayed on the graded concrete fill below, while the second was sprayed directly on top of the precast slabs, creating a "belt and suspenders" waterproofing system. Water collected by each membrane is directed to specially-designed drainage systems.



GETTING TO WORK

Work on the precast approaches began in 2010 when general contractor Skanska Koch Inc. partnered with Ferreira Construction Co. Inc. to install the precast pavement slabs as part of the New York City Department of Transportation's \$508 million Brooklyn Bridge rehabilitation project. Project surveyors 50 States Engineering Co. performed a 3-D laser scan and a conventional total station survey to gather correct existing data and proceed with ramp and slab construction.

Using a master file developed by Skanska Koch, project precaster The Fort Miller Co. Inc. developed shop drawings for each of the approximately 950 mark-numbered slabs on the project. Because of the many skewed bridge abutments, existing underground vaults, new catch basins and water valves, and changes in cross slope – especially adjacent intersecting access ramps – the majority of the slabs were unique in plan-view dimensions, thickness and surface planarity.

Slab installation began in July 2011. Ferreira, an experienced precast pavement installer, had a six-hour overnight window to work. Each night, Skanska Koch rerouted traffic to one side of the bridge and the nearby Manhattan Bridge to provide Ferreira with access to all three lanes of either the Brooklyn- or Manhattan-bound roadways. This complex, almost instantaneous modification of traffic flow required careful and expert coordination.



Figure 1: Cross sections of original and new waterproof pavement.

PLACEMENT AND INSTALLATION

The installation process consisted of removing the existing AC pavement, milling the cinder concrete fill below the pavement to the correct elevation and cross slope, installing a waterproof membrane on top of the cinder fill, and placing bedding material and the new precast slabs on top. Application of the upper waterproof membrane and final AC overlay was delayed until all of the precast slabs were in place.

Because the entire process could not be completed in one night, Ferreira developed an innovative removable and replaceable roadway system consisting of top-textured steel plates supported by variable-depth timbers. This provided a smooth ride over the working area during daylight hours.

The subgrade preparation work was the most uncertain of all because of the many unexpected obstacles encountered, including steel columns and framing steel from the old railroad structure, reinforcing bars and underground cavities. While the designer made every effort to locate such items, many had not been recorded correctly – if recorded at all – during the original construction.

When unexpected obstacles were encountered, milling ceased until an acceptable solution could be determined. The time required to resolve these issues and to complete the subgrade process varied widely from area to area, sometimes taking more than three nights.

Once the subbase surface was fully prepared, the next step involved installing the waterproofing membrane on the cinder concrete surface. After the surface was thoroughly cleaned, workers applied an 80-mil layer of polyurea waterproofing membrane. To meet application specs, the moisture content of the cinder concrete surface had to fall between 5-10% and the air temperature had to be at least 5 degrees above the dew point. These exacting conditions added limitations to the times work could be done.

The precast slabs were typically placed within one or two nights of the waterproof membrane installation. Once the temporary roadway was removed, the bedding material was placed, compacted and graded to a surface accuracy of approximately 1/8 in. in accordance with the approved Super-Slab installation procedure. The slabs were placed directly on this surface, each to their specified location using a vertical right angle laser.

FINAL STEPS

On a typical installation cycle, Ferreira installed 12-14 slabs, each approximately 10 ft wide by 12 ft long, although many slabs were much larger. Many slabs were skewed or otherwise speciallyshaped to fit between bridges and other structures. While the majority of the slabs were 9-in. thick, other slabs varied from 8-12 in. depending on the location. Some of the perimeter and bridge approach slabs were haunched or otherwise specially-shaped to accommodate adjoining structures. For areas where few or no steel obstacles were encountered during the removal process, Ferreira placed 16-18 slabs per cycle. Grouting of the slabs typically occurred following slab placement. The complete cycle of pavement removal, milling, waterproofing and placement of slabs varied between 5-10 nights, so slabs were not placed every night. During the occasional full or partial weekend closures, all of the previously-described operations were performed consecutively so that many more slabs could be placed.

Traffic had to be maintained on the newly-placed precast slabs until all the slabs on each approach were completed. To accomplish this, temporary AC ramps (transitions) were placed between bridge joint assemblies at finish grade and the precast slabs at 2 in. below. Traffic used this pavement arrangement of precast slabs and ramps for months until all of the slabs on one side of the bridge were completed.

After all the precast slabs were in place, the top waterproofing membrane material was installed over a period of approximately two weeks. The precast slabs were first cleaned by shot-blasting, followed by an application of concrete primer and a subsequent application of two coats of waterproof membrane material. The top coat of membrane received a broadcast coating of aggregate material to provide a skid-resistant surface until the final AC overlay was installed a few days later. The temporary AC ramps were removed just prior to installation of the AC overlay in those areas. Overall, the crisp, clean finished pavement surface belies the sophistication of the waterproof pavement structure lying below it.

FLEXIBLE, POWERFUL PRECAST

The final result is impressive. The project team was able to install the waterproof pavement under the tires of New York City traffic without negatively impacting everyday users of the bridge.

Precast pavement has frequently been viewed as standard, flat slabs to be used in all locations, and designers have counted on casting non-standard pavement sections in place and grinding away the tops of slabs until they conform to required nonplanar surfaces. This project proves that non-standard precast panels, uniquely shaped in cross section, plan-view and surface planarity, can be routinely designed, fabricated and installed on very complex and heavily traveled projects in a manner that the traveling public is not significantly inconvenienced. That is what precast concrete pavement is all about. **PS**

Peter Smith, P.E., is the vice president of market development and product engineering for The Fort Miller Co. Inc.

Evan Gurley is a technical services engineer with NPCA.

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(Endnotes)

http://memory.loc.gov/ammem/today/jun12.html







Top – A view of Manhattan from the completed Brooklyn approach.

Bottom – **Figure 2:** Plan view of both approaches.

Form Factor

Custom forms provide the perfect solution for two water projects employing precast concrete on a micro and macro scale.

By Mark Crawford and Mason Nichols

FOR MOST PRECAST CONCRETE PRODUCERS, manufacturing custom products is commonplace and crucial to success. When a project calls for a unique piece of precast, coordinated collaboration between the form manufacturer and precaster takes center stage. Here, two water projects showcase just how important solid teamwork – coupled with the right form – can be. The Water Bottle Specs: Finished Height: 181 in. Diameter: 94 in. at largest point Wall Thickness: 9.5 in. at bulges; 6.75 in. on straight walls Weight: 20,000 lbs

Capacity: 500-gallon auto fill storage tank Filtration: Eight stages, including reverse osmosis and UV light





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Marks Metal Technology and Rockway Precast worked closely together to manufacture the unique water bottle form.

MASSIVE WATER BOTTLE

In 2011, Dapper Development, a commercial real estate development firm and owner of The Water Bottle, built its first water-filling station in Las Vegas to provide residents with filtered municipal water. Using precast concrete top and base pieces, the 15-ft-tall and roughly 8-ft-wide station is manufactured to look like a giant five-gallon water container. Inside, an eight-stage filtering process dispenses clean water to customers.

Originally, the construction team used a wood-fiberglass strip form to build the structure, a solution which flexed and became increasingly out of spec the more it was used. After the construction of a few more stations, the form had to be thrown away. With the increasing popularity of its stations and the desire to expand in Nevada and Arizona, Dapper Development decided to create a more reliable steel form.

After a year of rejection from various formwork companies, Dapper Development contacted Marks Metal Technology in Clackamas, Oregon, at the suggestion of Rockway Precast, a precast concrete producer in North Las Vegas, Nevada.

"When the original inquiry came in to provide a quote for a form that would produce a giant concrete water bottle, my initial reaction was to say that it wasn't possible," said Steve Tuttle, manager of Marks Metal's precast forms division. "I remember even talking about it at an upcoming projects meeting and

forbidding anyone on the team from even thinking about it."

However, Tuttle was reluctant to let go of the challenge. He spent some time over the following weekend trying to design the form using standard metal-forming techniques. He rejected all the ideas he came up with because he was uncertain they could maintain the consistent shape necessary for producing a flawless concrete surface.

"Then, just when I was ready to give up, it hit me," Tuttle said. "I realized this could not be just a single form. We would be able to efficiently produce this form if we created it as if it were a series of machined joint rings, stacked one on top of the other."

Tuttle also realized it would be highly challenging to turn the concept into a buildable product. With key input from Rockway Precast and Joseph Randall, Marks Metal's 3-D form engineer, Tuttle and his team assembled an engineered set of shop drawings for manufacturing the form.

"A lot of discussion went into designing a round form with all the angles that were needed to make it look exactly like a water bottle," said Greg Taylor, operations manager for Rockway Precast. "We suggested window and door blockouts, made from steel, to ensure consistent quality for every bottle produced."

The inside of the form was polished to provide the smooth concrete surface that the customer required, and Rockway Precast made sure to use the right mix design to achieve the desired results.





"Being an architectural piece of concrete, a lot of work also went into making a specialized mix design to create a visually pleasing finish," Taylor said.

Pleased with the final product, Dapper Development is eager to start building an additional 15-20 stations in the Las Vegas and Arizona markets.

"It required a very different way of thinking to come up with this design," said Christopher Donohue, director of facilities for Dapper Development. "With the help of Rockway Precast and Marks Metal, we are now ready for large-scale production of our water bottle stations."

According to Taylor, bringing in other experts at the start of the project and letting them share their expertise and knowledge to help get everything right during the design stage played a pivotal role.

"Take your time and communicate thoroughly," advised Taylor. "From starting design all the way through delivery of the finished product, communication is vital for a successful project."

A CLEAN WATER FIRST

Standing high above neighborhoods across North America, water towers often serve as landmarks, signifying the local culture of cities and towns. But beyond aesthetics, these towers serve an important function that is often taken for granted – the storage and



Hamilton Form Co. partnered with Stubbe's Precast to manufacture a unique precast concrete water tower pedestal.



delivery of clean water to residents.

For members of the Wasauksing First Nation, a community of aboriginals inhabiting the 19,000-acre Parry Island on the eastern shore of Lake Huron in Canada, clean water is anything but taken for granted. For a decade, the community – which consists of more than 1,000 band members – was living under a boil-water advisory.¹ But thanks to support from the federal government, the Wasauksing reserve secured funding for a water treatment system including the construction of a 120-ft-tall water tower.

While the tower's base consists of cast-in-place concrete, the pedestal – which provides support for the reservoir tank – is manufactured from 16 conical precast concrete panels. For many water towers, a welded steel platform and tank are used; however, the Wasauksing tower combines a precast concrete pedestal with an enamel tank, making it the first of its kind. This pairing allows for minimal maintenance over the lifetime of the project and enhances the overall appearance of the tower.

Each panel is approximately 7 ft wide by 6 ft tall. In order to create the conical shape required for the pedestal, supplier Hamilton Form Co. manufactured a form with a curved base. Additionally, a raised insert within the form helps create the relief panel which can be seen on the face of the product. According to Bill Daily, president of Hamilton Form, going with a precast concrete solution resulted in many project benefits.



"If they would have had to cast the pedestal in place, the formwork would have had to extend all the way to the ground," he said. "Using this method, the sections were precast, shipped to the site, put up with a crane and it was done. They saved time and a considerable amount of money by using precast concrete."

Bill Stubbe, sales consultant with Stubbe's Precast of Harley, Ontario, agreed.

"The contractor was looking to reduce the cost of building the water tower and felt that this would save an awful lot of work with the framing," he said.

Although Stubbe's Precast already had a product drawing of the pieces they needed to cast, Daily said he prefers getting involved in a unique project as early as possible to solve potential issues before they arise.

By selecting precast concrete for the pedestal, project owners were able to save considerable time and money.

"When the precaster gets involved in some of these unique jobs, that's the time to get the form manufacturer involved," he said. "That's when the form provider may see something that can help the precaster out."

SYNERGY

Manufacturing unique, high-quality precast concrete products requires exceptional coordination between the project's form supplier and precaster. With the right balance of innovation and collaboration, infinite possibilities are created, making the seemingly impossible, possible.

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

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¹ http://ese.dgtlpub.com/2013/2013-12-31/pdf/new_treatment_system_ brings_clean_water_and_opportunities_to_wasauksing_first_nation.pdf

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ver Play

When it comes to modern-day stadium and arena projects, precast concrete is the undisputed MVP.

By Mason Nichols

IN APPROX



Levi's Stadium used precast concrete to help achieve LEED Gold certification.

A GOLD STANDARD: LEVI'S STADIUM

Precaster: Clark Pacific **Products:** Treads, Risers, Vomitory Walls

General Contractor: Turner/Devcon JV Architect: HNTB

Engineer: Magnusson Klemencic Associates

Seats: 68,000-75,000

Each year, the Super Bowl ranks among the most-viewed television programs in the U.S. In 2014, Super Bowl XLVIII set the all-time record for the most-watched television event in U.S. history, drawing more than 111 million viewers.¹ To capitalize on the excitement the Super Bowl offers, NFL team owners are in constant competition for a chance to host the big game.

Recognizing an opportunity to secure Super Bowl 50, owners of the San Francisco 49ers were in a need of a building material for Levi's Stadium that could meet a tight project timeline. Jack Hill, project executive for the 49ers, said precast concrete was essential for keeping the work on schedule.

"One advantage of using precast involved the timing," he said. "We could fabricate the seating treads and risers off site so that when the steel frame was put up, we had the ability to complete the frame. That saved us considerable time versus castin-place."

The use of precast also helped the many different



WITH THE SECONDS TICKING AWAY, a quiet anticipation begins to build. Just 15 minutes ago, the team you'd ardently followed all season held a surefire ticket into the playoffs. But after a roaring comeback by the opposition, a deficit has dampened your spirits. As doubt begins to creep in, your team's star player suddenly comes through. A deafening roar is all you need to hear. The game has been won. Hope has been restored.

Scenes like this develop every day at sports stadiums and arenas across the world. The drama is real, and while fans may experience an array of emotions ranging from downtrodden to jubilant, one constant is the experience a well-designed and well-built stadium provides. One of the building materials that take unique designs from concept to reality is precast concrete.



trade workers operating on site function efficiently as a unit, preventing potential project hiccups. Thomas Ketron, marketing director for precast manufacturer Clark Pacific, noted the importance of synergy between the groups.

"Clark Pacific worked closely with the general contractor to really create this dance that was super-efficient in the constructability," he said. "That really helped nail the schedule."

Matt Engelking, project manager for Clark Pacific, agreed.

"There was a lot of coordination just with the precast alone," he said. "Even with on-site materials, if this would have been a cast-inplace structure, you'd have a lot of formwork. Precast really was the only solution."

Clark Pacific's products and close proximity to the job site helped Levi's Stadium become the first LEED Gold certified stadium in the NFL. The result is an aesthetically pleasing, durable solution which will host a variety of sporting events in the Bay Area for many decades.

A MULTI-FACETED FACILITY: AMWAY CENTER

Precaster: Gate Precast Co.
Products: Insulated Wall Panels, Flat Slabs, Columns, Beams, Risers
General Contractor: Turner/Hunt JV
Architect: Populous/HOK
Engineer: Walter P Moore
Seats: 16,400-20,000+

The Amway Center's iconic spire is hard to miss towering over the intersection of Interstate 4 and State Road 408 in Orlando, Florida. The arena's façade, constructed of 256 pieces of 10-in. insulated precast concrete panels, is just as captivating. According to Randy Dvorak, senior principal for stadium architect Populous, architectural precast concrete's durability played a significant role in its selection for the project.

"Precast will probably outlast the design desirability of the building," he said. "We say a building will provide at least a 50year life. If the precast is maintained – cleaned and sealed when necessary – we think it will outlast that."

Bruce Bartscher, senior project manager for Gate Precast Co. in Kissimmee, Florida, stressed architectural precast's rapid erection as another important factor.

"For a lot of projects, the speed in which you can start buildout and begin your interior work or finishes is important," he said. "Once we finished the installation process of making all the connections, we were able to quickly move forward."

Many different events are held inside the Amway Center. The building serves as the permanent home of the NBA's Orlando Magic, but also hosts arena football, minor league hockey, concerts and more. All events are made possible by the use of structural precast concrete products including flat slabs and risers.

For Tom Newton, vice president of operations for Gate's Jacksonville, Florida, location, using structural precast components meant saving time and money.

"With regards to schedule, if they had to form and pour all of those risers, they would have been out there forever," he said. "And by going with prestressed, we were able to have longer spans, which resulted in less column and beam framing and a lower construction cost."

Newton sees the Amway Center as a fitting complement to the rest of the city skyline. "It was fun to work on," he said. "The city of Orlando has an awesome coliseum there."



A WELL-COORDINATED EFFORT: PPL CENTER

Precaster: Bethlehem Precast Inc. Products: Flat Slabs, Rakers, Walls and Beams General Contractor: Alvin H. Butz Jr. Architect: Sink Combs Dethlefs Engineer: Martin/Martin Inc. Seats: 8,500-10,000+

More than a decade ago, initial discussions to bring a minor league hockey team to Allentown, Pennsylvania, began. Although the idea was championed by then Mayor Bill Heydt, the city was never able to secure the funding necessary to jumpstart the project, leaving plans in limbo. But in 2009, the tide finally turned after a state senator helped create the Neighborhood Improvement Zone tax district, which would eventually be used to help pay for the arena.²

Enter precast concrete, which enabled the highly anticipated PPL Center to meet the demands of a tight schedule while providing a top-notch experience for fans.

"Precast concrete is always the best option because we are able to prestress and post-tension items, which allows for longer spans," said Tom Engelman, president of Bethlehem Precast Inc. in Pennsylvania. "This reduces the amount of superstructure and provides better views in the stadium."

The company, which manufactured approximately 1,000 pieces of structural precast for the arena, provided a slew of products, including bleacher elements, walls and 48,000-lb rakers. While producing the pieces required for the project was straightforward, Engelman noted one of the biggest challenges was coordinating with the many other trades involved.

"There were probably 6-8 months of work with the other trades, including the steel guys, the railing guys and the seating guys," he said. "We had to ensure that our elements could take the loading and structural necessities of their parts of the contract."

Thankfully, precast concrete works well in conjunction with other products, allowing for such coordination efforts to run smoothly. "You put your pieces up, and within a day or two of finishing any welding and other things that need to be done, the precast's ready," Engelman said. "It can be used by other trades without any issues."

Though originally conceived as a hockey arena, the PPL Center has already hosted concerts, a professional bull riding competition and more since first opening to the public in September 2014.



A COMPLETE PRECAST SOLUTION: FIRST TENNESSEE PARK

Precaster: Sherman-Dixie Concrete Industries Inc. **Products:** Reinforced Concrete Pipe, Curb Inlets, Vaults, Manholes

General Contractor: Sunrise Contracting **Architect:** Populous/Hastings Architecture

Associates Engineer: Walter P Moore Seats: 8,500-10,000

The smell of fresh popcorn. The sight of a lush, green playing surface. The sound of a bat sending a ball deep into the air and over the right field wall. Attending a baseball game floods the senses with the myriad sights and sounds that make America's pastime such a unique experience. But what fans don't typically see are the underground infrastructure systems that make each game possible. That's where precast concrete comes into play.

Seeking a move from their original stadium built in 1978, the Nashville Sounds, a minor league affiliate of the MLB's Oakland Athletics, gained approval for the construction of First Tennessee Park. Before the components making up the stadium seating could be placed, many underground pieces, including reinforced concrete pipe, curb inlets and vaults had to be installed.

Mike Kusch, director of technical marketing for project precaster Sherman-Dixie Concrete Industries Inc., said precast concrete was chosen for the infrastructure portion of the work due to its strength and extended service life.

"Precast concrete is a low-maintenance, highly durable, buryit-and-forget-it type of product that will last a minimum of 100 years," he said. "Around a stadium site, pipe is something you want to put in only one time and never have to go back."



Core Components

Walls, beams, risers and exterior panels are integral in the construction of sports arenas. However, it is the underlying infrastructure pieces, including reinforced concrete pipe, vaults and more that lay the foundation for a stadium's success. Precast concrete products can be specified for every step in the construction process, marrying underground and above-ground elements in the creation of stadiums that are as visually appealing as they are functional.



Although not manufactured by Sherman-Dixie, the stadium will also include precast products in the seating areas. According to Justin Barton, P.E., S.E. and principal for Walter P Moore, using precast for these components is crucial to meeting project deadlines.

"We had a very aggressive design and construction schedule," he said. "I think the precast concrete will help in terms of being able to make the project ready for opening day."

Beyond speed of erection, Barton also said using precast helps boost the quality of installation. "By manufacturing the precast in a plant, you're able to have tighter tolerances that you might not get if the product was just cast in the field," Barton said.

The Sounds will play their first game at the new facility when the season begins in mid-April 2015.

A SIZEABLE UPGRADE: KYLE FIELD

Precaster: Heldenfels Enterprises Inc.Products: Columns, Beams, Rakers, Risers, Vomitory Walls, Stairs

General Contractor: Manhattan/Vaughn JV

Architect: Populous

Engineer: Walter P Moore

Seats: 82,500 (Before Renovations), 102,500

(After Renovations)

Over the past several years, the college football program at Texas A&M University has exploded in popularity. In a 2013 poll, the Aggies supplanted the University of Texas as the football program fans most identify with in the state.³ Now, thanks to a renovation project currently underway, Kyle Field will become the stadium with the largest seating capacity in the entire Southeastern Conference when work is completed later this year.⁴

According to Gil Heldenfels, vice president and general manager of the building systems division at Heldenfels Enterprises Inc., the project is taking place between the team's football seasons, which run from August to December each year. Due to the limited time available for construction teams to work, the renovation schedule is very aggressive.

"The university decided to go with a precast and steel structure for speed," he said. "The lower deck – all the way around – is going to be all precast, including columns, beams, raker beams, risers, vomitory walls and stairs."

Heldenfels added that the first phase, which was completed before the start of the 2014 season, contained more than 1,500 precast concrete pieces. On-site teams demoed the lower east side stands and rebuilt them. The south end of the stadium was also enclosed by adding a new seating complex with precast components in the area. In phase two, Heldenfels Enterprises will provide an additional 773 pieces of precast. Teams will demo the west side and rebuild it, completely closing in the stadium.

In addition to the major structural work, another producer – Enterprise Precast Concrete – will manufacture architectural cladding that will wrap around the exterior of the stadium. Heldenfels believes the work will give Kyle Field a bold new look.

"For the most part, before it was just an exposed structure with some metal panels," he said. "The precast is going to really dress up the stadium."



MOST VALUABLE PRECAST

With modern-day stadiums and arenas growing ever-larger and project schedules continuing to tighten, engineers and architects are in need of a construction material that is just as clutch as a last-second winning play. Precast concrete's strength, durability and speed have consistently come through, enabling the completion of some the world's most awe-inspiring sports complexes. PS

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

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Rain Go?

Precast concrete filtration planters provide an effective, long-term solution for stormwater runoff.

By Claude Goguen, P.E., LEED AP



returning to underground aquifers or surface waters. The planters act as temporary storage for runoff water, helping minimize discharge rates. A percentage of water captured also provides irrigation for the vegetation in the planters, further contributing to the overall reduction in the volume of stormwater runoff.

Versatile and efficient, filtration planters can be installed in almost any urban space. In addition to slowing down and soaking in stormwater, they enhance the aesthetics of any area.

The ability of the soil to absorb the water will dictate the size and type of planters. Some are bottomless, allowing

water to filter through. Others have a bottom, serving as treatment and retention of runoff water before discharge into the sewer system.

Filtration planters can be constructed from a variety of building materials, but factors in the decision should include:

- Is it durable?
- Can it withstand loads, especially near areas with traffic?
- Can it be installed quickly?
- Can it be installed in any climate?

Precast concrete meets all of the above criteria, making it the material of choice for many authorities throughout North America. Specifiers have found precast to be a strong, reliable material that allows planters to be installed quickly and easily.

Thanks to precast's versatility, planters can be manufactured modularly or as an entire unit. Additionally, units can be produced in any size or shape with any texture, finish or color.

A RESILIENT, TIME-SAVING SOLUTION IN WEST VIRGINIA

A small city with a population of just under 5,000 residents, Ranson, West Virginia, was awarded federal funding from the U.S. Department of Transportation's TIGER II Planning Grant Program as part of the "Green Corridor Revitalization" project. The project consists of improvements to a 1.5-mile stretch of Fairfax Boulevard, a two-lane road providing residential access and parking. The \$9.4 million job combines a two-lane, median-divided boulevard with on-street parking, new sidewalks, street trees, a wide center landscaped median with contemporary Chesapeake Bay stormwater approaches, LED lighting and street furniture. With an expected completion date of late 2015, the project scope includes the implementation of cost-effective and sustainable stormwater management techniques.

The project includes the installation of flow-through precast concrete filtration planters along the western edge of the

AS HENRY WADSWORTH LONGFELLOW ONCE SAID, "Into each life, some rain must fall." This is especially true for Little Port Walter on Baranof Island in southeast Alaska, where average precipitation amounts to 237 in. per year. Longfellow's words aren't so true in Death Valley, California, where not a single drop of rain has fallen in three years.

Where you live, you're probably somewhere between these extremes. Regardless, the process of stormwater runoff remains the same. When rain falls on undeveloped areas, water is absorbed and filtered by plants and soil. However, when rain falls on streets, parking lots, roofs and other hardscapes, water does not soak into the ground. Instead, it carries pollutants through collection systems to nearby bodies of water.

With many cities still operating on combined sewer systems, overflows during heavy rains – otherwise known as combined sewer overflows – can release millions of gallons of raw sewage into lakes and rivers. Higher flows can also cause erosion and flooding.

For these reasons, management of stormwater runoff continues to be a major challenge for cities across North America. Precast concrete plays a role in all of the solutions currently implemented, including larger collection and retention systems and green infrastructure.

Green infrastructure uses soils, vegetation and other processes to mimic nature by soaking up and storing water and creating healthier environments. A wide range of green infrastructure elements can be implemented, such as permeable pavements, green roofs and increasingly popular filtration planters.

WHAT IS A FILTRATION PLANTER?

Filtration planters are shallow, vegetated basins also referred to as bioretention cells that collect and absorb stormwater runoff. They mimic natural hydrology by infiltrating and evapotranspiring runoff water. Through a variety of physical, biological and chemical processes, pollutants are removed from the stormwater before



Figure 1: Elements of a filtration planter.

southbound lane along Fairfax Boulevard. Mark Wilhelms, vice president of architectural sales for panel supplier Midwest Block & Brick Inc., said the project originally called for a cast-in-place structure.

"The concern was controlling the quality of the casting of the product," he said. "Going with a precast option gave officials assurance that quality would be closely monitored in a controlled environment and the structure would be done right."

Due to residual soil conditions and underlying karst geology,¹ each planter is retrofitted with a geo-membrane liner to prevent concentrated infiltration points at the installation site. To accommodate large stormwater events that would otherwise wash out the planter, perforated underdrains and an overflow inlet are installed. Overflow water can then be transported to a separate collection cistern, another planter or be connected directly into the city's main stormwater system.

Concrete Products Group provided the precast concrete planters, which are manufactured using the Freno System. Developed by architects at HOK, Freno consists of a segmental planter wall and curbing system. The modular aspect of the system will allow the filtration planters to expand and contract in size and shape based on block-by-block conditions and stormwater capture needs along Fairfax Boulevard.

According to Kevin Johnson, project manager for Jefferson Contracting, the Freno System proved to be an effective alternative to traditional cast-in-place walls.

"With this large streetscape project being constructed in phases over more than a year, we've been able to get the precast stormwater structures installed quickly in a variety of weather conditions and not lose any time waiting for concrete to cure and forms to be removed," he said.

The capital cost to implement a modular system is roughly the same as a custom cast-in-place concrete system. However, using precast concrete allows for simple construction inspection requirements. Additionally, a typical precast structure can be built in a day versus a week for a cast-in place concrete system.

In addition, the modular system can be removed and reused. If Fairfax Boulevard is redesigned to support additional adjacent redevelopment, the units can be reconfigured to accommodate

changes to size and shape, based on localized needs. The modular system can also be repaired with replacement units if accidental damage occurs.

PITTER-PATTER

Hearing the pitter-patter of rain on the roof is soothing for some. Most of us don't give much thought to the path raindrops take or what they accumulate on the way. The good news is, landscape architects, urban planners and designers are thinking about it and coming up with innovative ways to manage stormwater runoff while adding beautiful elements to the area. Precast concrete is manufactured from local and recycled materials and is installed quickly, minimizing impact during construction. It also has an exceptional life cycle, making it a sustainable choice for stormwater management.

To locate precast manufacturers in your area, please visit precast.org/find.

For questions on this or other precast concrete solutions, please contact Claude Goguen at cgoguen@precast.org or at 800-366-7731. **PS**

Claude Goguen, P.E., LEED AP, is NPCA's director of Sustainability and Technical Education.

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Page 24-25 - Midwest Block & Brick Inc.

Page 26 – Midwest Block & Brick Inc.

Page 27 – Figure created by Kayla Hanson, NPCA technical engineer. Foliage courtesy of © Rohitha Wijerathne | Dreamstime.com

(Endnotes)

¹ Karst is a "landscape formed from the dissolution of soluble rocks including limestone, dolomite and gypsum." Learn more at http://www.esi.utexas.edu/outreach/caves/karst.php

Revival: Preserving an Iconic Style

Speed Fab-Crete manufactures precast concrete wall panels that highlight a Texas town's Mission Revival-style.

JOURDANTON POLICE-COURT

By Sara Geer

Editor's Note: Earlier this year, NPCA held its second-annual Reader's Choice Cover Contest for Precast Inc. magazine. Highlighted here is this year's winner, Speed Fab-Crete, and the company's city complex project. To view all of the 2014 entries, please visit precast.org/cc2014.



Precaster: Speed Fab-Crete **Project:** Mission Revival City Complex **Location:** Jourdanton, Texas

FEW TEXAS COURTHOUSES exhibit the full range of architectural features associated with Mission Revival-style as well as the City of Jourdanton's. As one of a small number of surviving examples in the state, city officials wanted to extend this rich style – stucco walls, low-pitched roofs with projecting wide eaves and clay roof tiles – into the construction design for a new city complex.

To accomplish the task, the city hired Callahan & Freeman Architects, based in Fort Worth, Texas, to plan and design the new facility. The architects juggled a number of tasks when designing the building – which houses the city council chambers, city courts and the Jourdanton Police Department – to satisfy the needs of the city while making the best use of the space.

Due to expansive soil conditions on site, the old city complex structure was built on a suspended slab system. With funding levels dictating a tight budget and the suspended slab system remaining the best option, precast concrete emerged as the construction material of choice.

With the optimal building material selected, all that remained was finding a precast concrete producer to manufacture the wall panels for the project. Having worked on more than 300 successful projects together, Callahan & Freeman Architects turned to Speed Fab-Crete of Kennedale, Texas. "Speed Fab-Crete and Callahan & Freeman Architects are actually co-located in the same building," said Randy Landers, director of business development for Speed Fab-Crete. "Through our close relationship and co-location, we had some knowledge of the project. This led to heightened interest in the project, resulting in our selection through a competitive sealed proposal process."

The building's exterior is primarily composed of structural precast wall panels. Landers said precast concrete lends itself perfectly to the local Mission Revival architecture as it can easily mirror stucco or adobe.

Carl Hall, co-owner, vice president and manager of plant manufacturing operations for Speed Fab-Crete, explained the majority of the wall panels were cast in a face-up orientation and given a textured sponge finish. Beginning in January 2013, the precaster poured about six pieces per day to meet the December project deadline. All pieces were manufactured using a mix design that included 1,800 lbs of 1 in. crushed limestone, 1,277 lbs of fine aggregate, 564 lbs of type III Portland cement, and Eucon Air 40 and SPC admixtures.

"All the architectural features such as reveals and water tables were then formed on the top face of the panels," Hall said. "The frustum arch used to create the curved beveled bands above the barrel arch entries were the only items that required some very exact mold work."

The sizes manufactured varied, but all panels were within the limitations of an A-frame trailer, including panels as large as 12 ft by 28 ft. Most panels were shipped, loaded on their side and later rotated into the correct position on the job site. The combination of precast and – in selected areas – applied stone masonry veneer resulted in an attractive solution requiring minimal maintenance.

In addition to functioning as the general contractor and manufacturing the precast walls, Speed Fab-Crete also fabricated and installed the structural steel roof system and assisted the city with additional services, including the installation of security systems, audio/visual systems and furnishings.

"We actively seek out projects where we can combine our precast concrete expertise with our structural steel fabrication capabilities," Landers said. "This enables us to supply and erect/ install all the major structural components in a project in a seamless process."

By using so many items manufactured and installed by Speed Fab-Crete, the company controlled costs and kept the project on schedule. The City of Jourdanton moved into the facility and began operations in early 2014 and held a formal ribbon-cutting dedication to show their pride in the complex.

"The city is pleased with the building and the entire team is quite proud of the project," Landers said. City Manager Daniel Nick wrote the company a reference letter, stating he's confident "Speed Fab-Crete will provide the same level of service, communication, quality and value to future projects with these same outstanding results." **PS**

Sara Geer is the managing editor of Precast Inc. magazine and is NPCA's internal communication and web manager.

Photo Credit: Jason Roberts, Jason Roberts & Associates Inc.



Precast Concrete: A Shore Thing for Coastal Protection

In the Laboratory of the Labor

Precast concrete products provide the flexibility and durability necessary to mitigate shoreline erosion and protect marine life.

By Shari Held





NOW YOU SEE IT ... NOW YOU DON'T.

It's one thing if you're talking about a great magic trick, but quite another if you're talking about your beachfront home. In recent years, the winds and waves of Hurricane Katrina (2005), Hurricane Ike (2008) and Superstorm Sandy (2012) have reclaimed miles of our beaches and shorelines and demolished everything in their path. But anything that produces significant wave action, including high-speed boats and poorly planned construction projects, takes its toll.

Besides loss of property, large wave activity disturbs the natural reef habitat of marine life, reducing their numbers and disrupting the balance of the ecosystem. Increasingly, homeowners, municipalities and government officials are actively searching for ways to protect their shorelines. And that's good news for precasters.

PROVIDING A SUPERIOR SOLUTION

High-strength precast concrete is the perfect solution for protecting marine life and halting shoreline erosion. That realization has generated increased interest and acceptance of artificial reef barriers created from precast concrete, such as Wave Attenuation Devices[®], Reef Balls[™] and Beach Prisms[™].

One big advantage precast enjoys is that it's environmentally friendly, unlike the surplus armored vehicles, old steel barges,

trawlers and tugboats that are sometimes used to create artificial reefs.

"The problem with those materials is that they pollute, and that's not good for the marine life," said Tom Montalbine, president of Roman Stone Construction Co., based in Bay Shore, New York. "The equipment has to be cleaned to make sure it doesn't contain any toxic materials, and cleaning costs aren't cheap."

Precast concrete artificial barriers are specifically designed to provide protection for marine life, attract living organisms and diffuse waves. Additionally, when a source of sand is available, they can actually help rebuild shorelines.

Plum Point in Calvert County, Maryland, provides one example. After losing 150 ft of shoreline during a four-day storm, Beach Prisms were installed. Within three months, Plum Point had not only regained the 150 ft, but an additional 100 ft as well. "Other solutions like riprap or Armour Stone only preserve the status quo," said Jay McKenna, regional sales manager for Smith-Midland Corp. in Midland, Virginia, which manufactures and installs Beach Prisms.

Precast concrete is much easier to install and less expensive than riprap or Armour Stone. It's also more cost-effective than pumping in replacement sand. When Texas lost 100 million cubic yards of sand to Hurricane Ike, the replacement cost at the time was \$2.5 billion in sand alone.¹ In addition, precast concrete reef



barriers are portable and strong, manufactured at a minimum of 5,000 psi and with a life expectancy of 100-plus years.

WAVE ATTENUATION DEVICES

Living Shoreline Solutions Inc., based in Dade City, Florida, is a licensed dealer of Artificial Reefs & Coastal Restoration Inc.'s patented Wave Attenuation Device. The pyramid-shaped WAD is designed to be roughly 12-18 in. taller than the mean high tide at the deployment site, with triangular openings along each side that dissipate wave action and trap any available sand deposits.

Living Shoreline Solutions installed 800 ft of WADs, weighing 8,100 lbs each, on the western end of Bird Island in Tampa Bay. The project was so successful that the Audubon Society requested the company wrap the entire island in WADs.

"We don't guarantee sand deposits," said Thomas Brown, CEO of Living Shoreline Solutions. "What we guarantee is that we're going to give customers 90-95% wave attenuation." WADs aren't guaranteed to hold up to Category 5 hurricanes, either, but Brown noted he's never seen a WAD move, even in those conditions.

Each project begins with research specific to the locale, such as the 20-, 50- and 100-year storm events, water depth and bottom conditions. Steel molds are then designed and manufactured at the Dade City location. Corrugated steel on the outside produces increased wave attenuation. Instead of steel rebar, the concrete is reinforced with fiber mesh.

New Iberia, Louisiana's Shark Island was one of the company's more challenging projects. Coastal wetlands and spoil islands, which are created by dredging along a waterway, are Louisiana's last line of defense when major storms roll in. Over the past 25 years, the state's coastline has been losing wetlands at the rate of more than 16 miles per year – the equivalent of losing a football field of coastline every hour.²

Shark Island's muddy, unstable bottom conditions necessitated the creation of a special mold – a two-piece unit with a 2.5-ft base that could distribute the weight of a WAD so it would sink no more than 3 ft. The 156 WADs were 9.5 ft tall and weighed 13,500 lbs each.

Another challenge was determining how many WADs could safely be placed on the barge at one time. With a water level depth of less than 4 ft, getting grounded was a real possibility. But deployment proved to be a breeze.

"We found we could take a 13,500-lb unit off the barge, put it in the water, set it and go back for another one in close to 3 1/2 minutes," Brown said.

According to Brown, the biggest competition for WADs comes from riprap, but the cost per linear foot of WADs is, in general, half that of riprap or boulders.



REEF BALLS

The Department of Environmental Conservation Marine Artificial Reef Program manages 11 artificial reefs in New York to promote the growth of fish and other aquatic animals, restore oyster beds and improve water quality.³

A few years ago, the DEC approached Roman Stone Construction Co. about supplying Reef Balls for Fisherman's Reef, located on the Great South Bay off Long Island. While Reef Balls help stop erosion by diffusing waves, the focus of this project was to create a favorable habitat for fish and marine life.

Designed by the Reef Ball Development Group, Reef Balls come in 10 sizes and 20 styles⁴ to accommodate different functions and conditions and are designed with most of the weight at the bottom for optimum stability. The manufacturing process involves pouring pH-neutral precast into fiberglass molds with a Polyform buoy in the center, which can later be used as a flotation device. Sand-filled paper bags, placed on the bottom of the mold, make that surface uneven and suitable for lobster holes.

The customized holes and voids, which provide shelter for marine life, are created by using inflated balls that are deflated after the curing process is complete.

"The concrete picks up this texture and it makes a good surface to promote marine life growth," Montalbine said.

Smaller Reef Balls can be towed to the site and the flotation device deflated, while larger ones are often deployed by barge and crane. The Fisherman's Reef project called for 100 pallet-sized (4 ft wide by 2.9 ft tall) Reef Balls, each weighing approximately 1,500 lbs.

A strong tidal current and a tide that was slack for a period of only 30 minutes at a time made deployment at Fisherman's Reef very challenging. Fortunately, the local Army National Guard volunteered to drop the Reef Balls in Fisherman's Reef as a training exercise. It took three helicopters only one day to deploy all 100.

BEACH PRISMS

A Beach Prism consists of a series of triangles constructed from sulfate-resistant concrete reinforced with rebar. Prisms are designed with a parabolic curve that dissipates wave energy and deposits any sand held in suspension on the shore. A typical unit is 4 ft high, 4 ft wide and 10 ft long and weighs 9,000-plus lbs, but units can be larger.

Easi-Set Worldwide, based in Midland, Virginia, licenses the latest generation of Beach Prisms to established precasters. Easi-Set helps manufacturers obtain permits – prisms are permitted on a case-by-case basis – by providing engineering expertise as well as studies and examples of other permits.

Moffette Tharpe, managing director for Easi-Set Worldwide, estimates there have been about 30 installations since 2009, mostly in the Chesapeake Bay area. "Progress has been rather slow because of the time it takes to get installations approved," Tharpe said, "not because of their performance."

Smith-Midland's Ocean Gate, New Jersey, project was several years in the making. Borough officials and the New Jersey Department of Environmental Protection had discussed using Beach Prisms to stop erosion, but it hadn't been approved when Superstorm Sandy hit. Sandy destroyed Ocean Gate's beautiful boardwalk, one of the borough's top attractions. The cost to rebuild the boardwalk was approximately \$8 million.⁵

"Now, they started getting serious about getting protection," McKenna said.

The NJDEP agreed to an experimental installation of 35 prisms



for the first phase that were subject to evaluation before approval would be given for the remaining two phases. Because fish-spawning season begins Jan. 1, the job had to be completed before Dec. 31, 2013.

The prisms were precast in the main plant and trucked to Ocean Gate. All went well until it got mired in the sand. Then it was back to the barge and crane. Beach Prisms are quick and easy to install, and the first phase of the project was completed Dec. 18.

The Beach Prisms received the "Good Housekeeping Seal of Approval" from the NJDEP in October, and Smith-Midland immediately received a second order for five additional prisms.

"It's not considered experimental anymore," McKenna said. "We expect to do a lot of business in New Jersey next year." **PS**

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

Photo Credits:

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