Specifier Q&A / Precast Planetarium / Precast Goes Corporate

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ON THE COVER:
Around the Globe: At the center of the new, 250,000-square-foot Patricia and Philip Frost Museum of Science in Miami, Fla., is an impressive, 87-foot diameter planetarium dome. Learn more about the design and production of the precast concrete "peels" that made the structure possible on page 16.

Photo courtesy of Gate Precast.

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NPCA
Precast Solutions
1320 City Center Dr., Suite 200
Carmel, IN 46032
(800) 366-7731
(317) 571-9500 (International)
E-mail: npca@precast.org

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WHAT’S INSIDE

Photo courtesy of Gate Precast

Precast Concrete Reinforcement: An Ever-Evolving Technology

The many different reinforcing technologies available offer plenty of options for precast concrete manufacturers and designers.

By Angus Stocking

With its amazing compressive strength, concrete has a history in large-scale construction going back to ancient times – the Romans even used forms in a manner that resembles modern precast manufacturing. Today, researchers continue to study Roman concrete to determine how structures built thousands of years ago have performed so well while withstanding the test of time.

But the Romans never learned to reinforce concrete to compensate for its relatively low tensile strength. Today, there are four major ways to reinforce concrete: rebar, welded wire fabric, prestressing/post-tensioning and fiber. These technologies allow the impressive and versatile uses of concrete we associate with modernity.

REBAR

The use of steel rods is mankind's oldest technology for reinforcing concrete, going back to the 15th century. But the first use in construction wasn't until 1853, when François Coignet used the material in a four-story home in Paris.

Embedding steel bars into concrete increases the material's tensile strength, allowing cured concrete to be used in applications like precast beams and deck plates. This works well not only because of steel's inherent tensile strength, but because steel and modern concrete have very similar coefficients of expansion. As temperature changes cause the two materials to expand and contract, they remain at the same size relative to each other and undue stress and cracking is avoided.

For effective steel reinforcement in any application, the size or area, strength and precise placement of bars must all be carefully considered. Fortunately, this is a well-studied area, and precast manufacturers have access to comprehensive specifications and well-developed codes and tools when designing new elements.[1]

Two additional conditions must be in place for effective reinforcement: good bonding and corrosion protection.

Bonding means reinforcing steel must adhere to concrete so it does not shift or slide independently. This was a difficult problem until modern times. A relatively simple innovation, deformed steel bars (usually ribbed) increase friction between steel and concrete. These were not commonly used until the early 1900s. Bonding and splicing techniques are well understood today, and designers and detailers have good tools for predicting the performance of various bonding schemes.


NPCA File Photo

The gridded nature of welded wire reinforcement provides it with excellent bonding characteristics.

Corrosion remains a challenge for steel-reinforced concrete structures. The problem is straightforward – rust occupies a volume 2 1/2 times greater than the steel it oxidizes. When this expansion happens inside concrete, it is extremely destructive.

Concrete provides some corrosion protection on its own, but water intrusion combined with minimal concrete coverage may eventually lead to corrosion. Various techniques are used to prevent corrosion, including coatings, deeper placement of reinforcing members and less permeable concrete. In some applications, notably seaside structures and bridge decks – which have to deal with salty air, de-icing salts and flexure cracking – epoxy-coated, galvanized or stainless steel rebar is used.

In recent years, use of fiber-reinforced polymer rebar for precast structures has increased, especially in aggressive environments like those mentioned above. Because FRP rebar is manufactured from composite materials, it is corrosion-resistant, resulting in increased service life and enhanced durability.

FRP is lightweight but typically exhibits higher tensile strength than traditional steel. This makes it useful in a variety of applications, including bridge decks, caissons, seawalls and more. Still, the increased costs associated with the material have limited even more widespread adoption.

Because rebar is the oldest known concrete reinforcing technology, the design knowledge and skill needed to use it is readily available and the infrastructure of production and distribution is widespread. Consequently, rebar is relatively inexpensive when compared to other reinforcement techniques. And from a technical perspective, simple steel bars are often the most effective structural reinforcement available.

But there are downsides. Rebar is a heavy material compared to modern alternatives, which makes construction and fabrication potentially more labor intensive. The weight itself can be a limiting factor in large precast structures as well. And there are limits to rebar's structural supporting capacities, which is why the ambitions of modern builders and architects sometimes dictate alternative reinforcement technologies.

WELDED WIRE

Welded wire reinforcement arose as a direct response to the perceived shortcomings of rebar. The material, which looks a bit like steel fencing, "is produced from a series of longitudinal and transverse high-strength steel wires, resistance welded at all intersections."[2] The resulting steel lattice is stronger, by weight, than simple bars for the same reasons lightweight wood trusses

Due to the elastic nature of the reinforcing steel, prestressing and post-tensioning are considered "active" reinforcement.

are stronger than heavy beams. Welded wire's design strength is typically compared to grade 60 reinforcing bars. However, actual steel tensile strength is certified to greater standards and can be used to reduce original design steel areas (and hence weight) when permitted by specification.

The gridded nature of the material provides welded wire excellent bonding characteristics with concrete. In addition to the welded wire nodes, there are many surfaces – in multiple orientations – for concrete to grab onto. For additional bond, welded wire can be produced with deformed wire rather than traditional smooth wire.

Because it's already fabricated into large sheets to meet the required steel design, welded wire is easier for precast production staff to place and secure than rebar, where each bar must be individually placed and tied. This can lead to reduced labor and time savings and may also limit pinch and strain injuries.

"Precasters have been early adopters of welded wire innovations," said Todd Hawkinson, a consultant to the Wire Reinforcement Institute. "Really, welded wire is more of a shop technique than a construction site technique. Forming the cages and other shapes needed requires the kinds of tools and space found in precast plants."

Welded wire is more suitable for thin-walled precast structures like utility vaults and concrete pipe because it relies on thin wires at close spacing rather than larger diameter rebar at greater spacing.[3] Additional advantages include better crack control and improved weldability because welded wire is typically made from low carbon, cold-drawn steel.

Compared to rebar, the chief disadvantage of welded wire for precast manufacturers is added expense, including greater initial investments in equipment. In most reinforcement applications, welded wire fabric must be formed into cylinders, cages, boxy stirrups and other specialized shapes to suit particular needs. The hydraulic benders and cutters needed to work with sheets of material can be expensive.

Another disadvantage of welded wire arises from its lightness. The material has to be precisely positioned, but is more easily displaced during concrete pours, making it difficult to place and secure.

Still, there are many reasons welded wire is so widely used in precast manufacturing – it's strong, versatile and easy to work with. Comprehensive specifications and good design tools are available, including many from WRI.

PRESTRESSING/POST-TENSIONING

Imagine a row of 20 concrete blocks aligned end to end. To join them, you run a piece of rebar through the voids, fill it with concrete and leave it to cure. If lifted from the end, the blocks would function as a single mass, but would sag under their collective weight. Now imagine the same scenario, but replace the bar with high-strength steel tendons placed between abutments on each end and stretched to 70-to-80% of ultimate strength. Now place the concrete in the void and allow it to cure before releasing the tension on the cables. In this scenario, the concrete's compressive strength is used to aid tensile strength.

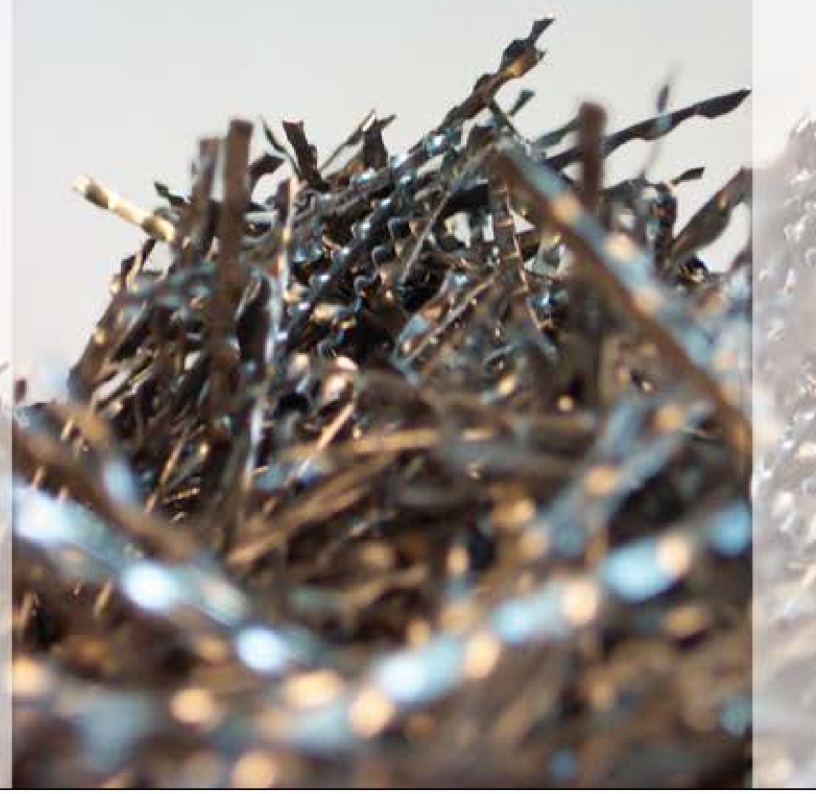
That's the idea behind post-tensioned concrete reinforcement – concrete's inherent compressive strength is used to increase tensile strength. Post-tensioning tendons (multi-ply cables) are set in slabs or other members and allowed to overlap forms. The tendons are sleeved and/or greased so that they don't bond with poured concrete. After the concrete has sufficiently cured, the tendons are stretched tight with hydraulic jacks and wedged in place to maintain their tight grip. In some applications, cementitious grouts are then used to fill voids around the tendon, bonding it to the new concrete. Depending on the precast product, post-tensioning can occur at the plant prior to shipment or on the job site.

Prestressing is subtly different. Tendons are still used, but solid anchors apply tension (stress) prior to pours. After curing, the tendons bond with the new concrete and can be cut away from anchors. On most construction sites, prestressing is not practical because sufficiently strong and stable anchor points are not available. It's more common in precast manufacturing plants, where anchor points can be built in place. Both prestressing and post-tensioning are sometimes referred to as "active" reinforcement due to the stretched, elastic nature of the reinforcing steel.

The advantage is greater initial strength leading to reduced deflections with thinner concrete sections. Concrete beams reinforced with post-tensioning or prestressing can be designed to span longer distances than beams reinforced with other methods because they can generally be thinner and lighter. Additionally, the more slender beams provide extra clearance space and may be more aesthetically satisfying for context-sensitive designs. Slabs reinforced with active methods have been known to exhibit fewer and smaller cracks. In ambitious projects, active reinforcement can be used to make structural elements with complex curves and other difficult geometry.

Disadvantages arise from the relative complexity of active reinforcement production and installation practices. Reinforcing elements remain under high stress for the duration of the project, meaning ordinary causes of failure – like corrosion – can have dramatic effects.

Even with these difficulties, prestressed and post-tensioned reinforcement remains vital in modern construction and precast manufacturing. Simply put, it can make the seemingly impossible, possible.



NPCA File Photo

FIBER

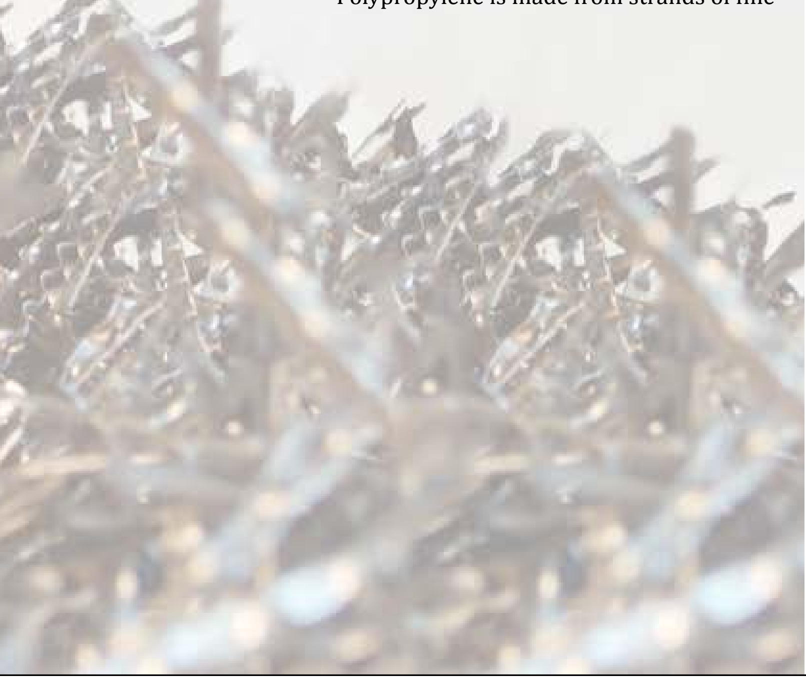
Properly speaking, fiber reinforcement is not a new technology. The Romans sometimes used horse hair to make concrete less likely to crack. That's the same basic idea underlying fiber reinforcement – fibrous material is used to increase concrete's tensile strength.

Historically, fiber has been used in the precast concrete industry to enhance durability, but not as a true replacement for traditional reinforcement. But in recent years, researchers have focused heavily on developing design methods to allow for the use of fiber as primary structural reinforcement. The establishment of ASTM C1765, "Standard Specification for Steel Fiber Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe," in 2013, and the forthcoming ASTM C1818, "Specification for Rigid Synthetic Fiber Reinforced Concrete Culvert, Storm Drain and Sewer Pipe" has helped lay the groundwork for the use of various fiber types as a reinforcement option in the future.

Although fibers encompass a wide variety of materials – including nylon, cellulose and many more – the most common types currently used in the precast industry are steel, polypropylene and fiberglass.

Generally made from carbon or stainless steel, steel fibers work to prevent cracking in concrete products. Manufacturers have developed varying geometries for steel fibers, which anchor into the concrete in different ways depending on their shape. While the most common application for steel fibers is floor slab construction, use has expanded in recent years to include other precast products such as tanks.[4]

Polypropylene fibers are part of a wider category of synthetic fibers which provide many of the same advantages to precast products as steel alternatives. Polypropylene is made from strands of fine monofilament. Typically, polypropylene fibers possess the same physical characteristics as steel and are also used to prevent cracks and enhance durability. Applications for polypropylene have widened to include septic tanks, burial vaults and additional precast structures.



Glass fibers differ from the aforementioned types in that they are most commonly used for architectural applications. When glass fibers are added to a concrete mix, decorative elements and cladding systems can be manufactured as thin as 1/2 inch with minimal weight, reducing loading and providing excellent thermal properties. The material also boasts some of the same characteristics as other fiber reinforcement types, increasing tensile strength and making the concrete resistant to cracking.

Despite the advantages fiber can offer precast products, some issues still need to be addressed before it can become an even more effective reinforcement technology. Sizes and shapes of fibers vary, making it difficult to determine which type is the optimal choice for a specific project, especially in the absence of a more complete set of standards. Additionally, more work needs to be done to ensure fibers are evenly distributed throughout precast structures in a manner that can be replicated and relied upon from mix to mix.

Compared to rebar or welded wire, fiber reinforcement is not a mature industry. It's more like the still-evolving software sector, which means new equipment and workflows can be made suddenly obsolete. Even so, fiber reinforcement's versatility guarantees it a place in modern precasting, and research and innovation continues to open up exciting possibilities.

EVER-EVOLVING

For a technology that is the foundation of modern civilization, concrete reinforcement has a surprisingly short history. Most of the important developments occurred in the 20th century or are happening now. For those who make a living forming concrete, this means significant change is still happening and the future offers exciting possibilities. PS

Angus Stocking is a licensed land surveyor who has been writing about infrastructure since 2002.

Endnotes

1 precast.org/2012/10/why-rebar-spacing-is-crucial/

2 Bending Welded Wire Reinforcement for Reinforced Concrete, Wire Reinforcement Institute

3 Welded Wire Reinforcement for Circular Concrete Pipe, Wire Reinforcement Institute

4 precast.org/2014/12/precast-concrete-tank/

Precast Happen

Photo courtesy of Dalmaray Concrete Products

Large-scale precast concrete manure storage systems have provided an effective and efficient solution for farmers.

By Kirk Stelsel

Dalmaray Concrete Products' precast solution eliminated sloped walls and reduced the overall site footprint.

What do fresh produce and precast concrete have in common? More than you might think.

Everyone enjoys fruits and vegetables from farmers' markets or grocery stores, but few give much thought to the process by which such products are grown. In addition to the sweat equity of the farmer, it typically requires some extra nutrients. In some cases, the manure used for this purpose is stored in precast concrete structures.

PRECAST IN THE DAIRY CAPITAL

Wisconsin and dairy products are inextricably linked based on both volume and public perception. Over the years, dairy farms have continued to increase in size. With that comes the need for more infrastructure. In 2013, Dalmaray Concrete Products in Janesville, Wis., saw an opportunity in this growth and began working on approval for a new product for manure storage.

Using its standard T panels – which the company manufactures for bunker and silage storage as well as salt and commodity storage buildings – Dalmaray engineered a manure storage system. With the bunker and silage markets becoming increasingly competitive and increasing farm sizes driving demand for large-scale manure storage solutions, the move made sense.

During the approval process, the Dalmaray team got a lead on a job for a farmer that was evaluating an alternative solution.

"I found out about this job about a year and a half ago," said Aaron Ausen, vice president of Dalmaray. "We were approached about this when it was a cast-in-place project and we were asked about using precast. Once we got it approved, we approached the


Photo courtesy of Dalmaray Concrete Products

The pit can hold **2.3 million gallons of manure** and from the top of the panels measures 247 feet long by 132 feet wide.

farmer about using precast and he was onboard with it because of the cost savings."

Along the way, Ausen and his team worked closely with Norm Tadt, senior conservation specialist at the Rock County Land Conservation Department. Tadt was the link between the farmer and the precaster and has seen the advantages precast provides with manure storage pits from a previous job. Among the top advantages, according to Tadt, are the elimination of sloped walls, the accompanying reduction of the overall footprint and the time savings.

"The nice thing with the straight walls is the appearance – it's neat and tidy," Tadt said. "Precast versus poured-in-place, our largest poured-in-place wall that we have available to us is a 10-foot wall. This gave the farmer the opportunity to go to 12 1/2 feet.

"You get more storage in the footprint by going to that depth. You also have to have some extra capacity for a large rain."

The pit can hold 2.3 million gallons of manure and from the top of the panels measures 247 feet long by 132 feet wide. Using T panels, Dalmaray reduced the amount of concrete needed by changing the plans from a 10-inch thick wall down to 6 inches at the thinnest point. There are 148 pieces of precast, including standard wall pieces and corner pieces.

The panels include grade 80 structural steel mesh in combination with traditional rebar. This hybrid approach allowed the precaster to reduce the diameter and spacing of the bar to prevent blockage, pockets or imperfections in the walls. Dalmaray also used a mix design it has seen great results from in recent projects.

"We have a new hybrid SCC mix that has a higher flow and makes the product look a lot nicer," Ausen said. "It uses an old-school mix technique – a Type A water reducer – and combines it with an SCC admix. It gives us a real nice, cohesive mixture that allows us to get a 28-inch-plus spread.

"There are very few bug holes or other discrepancies on the product. It's a 6,500-psi mix and has been really nice for us."

Dalmaray installed the panels and has worked closely with the state conservation engineer on the project. Tadt has been pleased with the results and sees the precast concrete method as a growing trend in the county.

"I foresee that we'll see more as time goes on," he said. "I think what they're looking at is a time savings versus poured-in-place. On some sites, it's difficult to get the concrete pumped to all the corners. The other thing precast gives you is quality control.

"When it's poured-in-place, trying to get that steel placement and all those types of things exactly where they're supposed to be can be difficult."

SUPERIOR SLURRY STORAGE IN CANADA

Further to the north, Eagle Builders, a precast concrete manufacturer in Blackfalds, Alberta, recently worked on a project for a dairy producer with a similar need, albeit with a unique twist. For this manure storage project, ground conditions dictated that an in-ground solution was not an option, so the only choice was an above-ground slurry storage.

By selecting precast concrete over steel, the slurry storage structure will benefit from a longer life span.

Photo courtesy of Eagle Builders


Photo courtesy of Eagle Builders

Eagle Builders had worked with the customer previously on a welding shop and a poultry barn. Because of the success of those projects, Eagle Builders was chosen for both the new dairy facility and the waste storage structure.

"This is the first precast waste containment structure we've ever done," said Werner Brouwer, project manager for Eagle Builders. "We designed and quoted a precast slurry storage for them and compared it to a steel one. The precast option was cost effective.

"Steel was their first choice because that was the only option until we created a precast option."

According to Eagle Builders, the customer is already noticing rusting issues with their existing steel slurry storage and is looking to precast for a longer life span.

The completed project is 200 feet in diameter and has a 3 million gallon capacity. It is comprised of 56 pieces of precast concrete that are 10 feet wide and 20 feet high. Production was completed in just two days. Eagle Builders has been pleased with the results of the project, as has the customer.

"We are on our third building with Eagle Builders and they have been able to innovate solutions on each build," said the customer, Beiseker Colony. "So making the choice on a precast containment structure versus steel was obvious due to price and longevity."

WHAT CAN PRECAST DO FOR YOU?

The manufacturers that make up the precast concrete industry continually innovate custom solutions to meet the needs of a wide range of customers. Many precasters find themselves altering a standard product line or creating and obtaining approval for an entirely new line on a regular basis. To learn more about what precast concrete can do for you, contact your local precaster by visiting precast.org/find. PS

Kirk Stelsel is NPCA's director of communication and marketing.

Sphere of Influence

Architects employ precast concrete for Miami museum's dome planetarium and building façade to make a bold design statement.

By Shari Held

Photo courtesy of Grimshaw Architects


PHILLIP FROST MUSEUM OF SCIENCE

Each of the dome's precast panels consists of 5,000-psi, post-tensioned concrete.

From the very beginning, it was destined to be a one-of-a-kind, world class project. Miami's ambitious $300 million Patricia and Philip Frost Museum of Science epitomizes quality and an exacting level of complexity – from its 500,000-gallon, martini-glass shaped seawater tank to its full dome 3-D planetarium and striking geometrical-patterned façade.

It's no wonder the 250,000-square-foot museum, slated to open in summer 2016, is garnering international attention.

The main objective of the museum board was to make the structure's architecture part of the exhibition.

"The way in which the systems are developed and the façade is engineered is all part of their mission to make the invisible, visible," said Aaron Vaden-Youmans, senior architect for Grimshaw Architects.

They also wanted the planetarium to express its function, resulting in its spherical shape. Stark white precast concrete was used for both the planetarium's dome and the Bar Building's geometrical-patterned façade, which was inspired by simple shapes found in nature. The precast components allow the museum to achieve a stunning visual appeal.

AN OPTIMAL SOLUTION

Precast wasn't the first choice for the planetarium dome. The bottom half of the sphere is cast-in-place concrete and designers originally considered a total cast-in-place planetarium as well as a steel-frame dome.

However, serious concerns about the finish quality on the upper half of a cast-in-place sphere led Grimshaw to abandon that option. And the thickness of the cladding needed to acoustically seal a steel-framed dome was nearly equal to the cost of a precast dome. There would also be the added cost of the steel frame.

Grimshaw awarded the contract to Gate Precast Concrete for the precast planetarium dome and decorative exterior wall panels. There were many reasons why precast was the perfect solution for the dome.

"Precast is precise, is made in a controlled environment, can be very high strength and can have an outstanding architectural surface that doesn't require additional finishing and painting," said Dr. Maher Tadros, professor of civil engineering at the University of Nebraska. Tadros is working for Gate as a consultant on the project. "It's also fire-resistant, hurricane-resistant and tornado-resistant. But it requires very intense engineering and planning," he said.

Photo courtesy of Gate Precast

Precast domes are quite rare for that reason – especially when they boast an 87-foot-diameter outer shell.

“To our knowledge, our dome is the only one that has ever gone to the equator portion of a sphere,” said Bryant Luke, vice president of operations for Gate.

PLANNING AND PRODUCTION

“The big challenge on the dome was to make it self-supporting,” Luke said. “To give it an architectural look while it was actually a structural component.”

MIDAS engineering software and Revit drafting software assisted with the engineering.

The 32 precast pieces that make up the dome, dubbed “orange peels,” are 58 feet long and weigh approximately 60,000 pounds each. To achieve a sphere shape once the dome was erected, each peel features a length-wide radius plus a curve in the width of the panel. The base of each peel is 10 feet, tapering to 2 feet at the top.

Each of the panels are conventionally reinforced, consisting of 5,000-psi, post-tensioned concrete.

The 32 precast pieces that make up the dome, dubbed “orange peels,” are **58 feet long** and **weigh approximately 60,000 pounds** each.

SAFETY FIRST

Until all of the peels were in place, the dome couldn’t be self-supporting, so Gate designed and installed a shoring tower to support the dome while under construction.

“From a safety perspective, the engineering of the shoring tower was critical,” said Andy Allen, project director for Skanska, the general contractor on the project. “We had to be absolutely certain that the pieces stayed where they were placed.”

Skanska supplied an on-site superintendent whose sole responsibility was to manage that process. The company also placed additional safety engineers on site during the entire operation. The shoring tower was inspected daily to ensure its integrity since it also served as a work platform for erectors and welders.

The precast façade on the museum's Bar Building boasts a variety of subtle variations to create a unique design aesthetic.

Photo courtesy of Gate Precast

The daily pre-task planning was elaborate.

"Any time there was the slightest thing that would cause us to deviate from that plan, everybody would stop to re-discuss and re-plan what needed to be done next," Allen said.

LOGISTICS AND INSTALLATION

To safely transport the peels from Gate's Kissimmee, Fla., manufacturing facility to Miami, Gate fabricated six specialty frames to securely hold the peels on a flatbed truck. The peels were delivered to a staging area a few blocks from the site, then transported to the site individually as needed.

Space on the job site was limited. A public road to the art museum covered 50% of the access and the Bar Building covered the other 50%. And the bottom half of the planetarium was already in place.

That meant the 550-ton superlift crane had to remain stationary throughout the installation as it hoisted each peel more than 80 feet in the air to assume its place. The challenge at this point was to find the optimal position for the crane and for peel delivery with minimal disruption to the roadway.

"Once we got the plan in place, it was simply a matter of implementing it," Allen said.

First to be placed were the two pieces that compose the approximately 30-foot-diameter cap of the dome. These pieces were temporarily welded to the shoring tower. Then came the meticulous task of attaching each individual peel to the capstone, moving clockwise and alternating one peel with its opposite to achieve counterbalance.

To speed the process, the peels were installed during the day and welded into position at night.

"Getting that flow down right was critical to getting everything assembled correctly," Allen said.

FABULOUS FAÇADE

The dome may have been the most challenging precast structure on the project, but the decorative façade on the north, west and south sides of the Bar Building brought its own set of challenges. It's the first thing people see, whether approaching the museum from the causeway or via air en route to Miami International Airport, so it had to be visually appealing.

But the complexity of the systems within the museum meant less money could be allocated for it. "The original concept was a modular façade that could achieve an economy of aesthetic by repeating but subtly changing," Vaden-Youmans said.

Grimshaw first considered using large terra cotta forms, then glass-fiber reinforced concrete. But precast prevailed.

"It became clear over the process of designing and value engineering that precast was both affordable and could create a visually complex and compelling façade," Vaden-Youmans said, adding that precast is self-finishing, eliminating the need for a rain screen.

A DOSE OF INGENUITY

The challenge Gate faced was how to make the project "production friendly." Grimshaw's original plan called for many variations of molds to produce the wall panels. The patterns on the panels needed to be random, but there were restrictions on where repeats could occur. And since the panels were going to serve as the backdrop for the museum's light show, the joints and reliefs needed to create appropriate shadows.

Photo courtesy of Gate Precast

Achieving the finished look took a generous dose of ingenuity.

"We couldn't do the entire exterior in 4-foot-by-4-foot sections," Luke said. "Nor could we make a custom-built mold for every single panel. One would have taken too long and the other would have been too expensive."

In the end, Gate accomplished the look and made it practical to produce by using 16 4-foot-square shapes.

The façade consists of 10 1/2-inch-thick modular precast panels each weighing about 25 tons and ranging in size from 8-to-12 feet wide to 30-to-48 feet tall. Nearly every panel is unique and is comprised of a combination of 4-foot-square sections, each featuring a different geometrical design element. The middle of each section is either concave, convex or flat to provide further variation.


Photo courtesy of Grimshaw Architects

"It became clear over the process of designing and value engineering that precast was both **affordable** and could **create a visually complex and compelling façade**."

– Aaron Vaden-Youmans, *senior architect, Grimshaw Architects*

Gate used computer numerical control milling to create the forms for the panels.

"We figured out a way to modify those 4-foot-square sections inside the mold to get five or six different variants from just one mold," Luke said. "It was a very complicated process."

Thanks to extensive planning and rehearsal, the installation of the panels was straightforward, although there was limited space and tight constraints.

"Gate did a great job with their quality control efforts to make sure they got a very uniform and consistent appearance in the precast concrete," Allen said.

The result is stunning.

"The way the shadows play on the subtle concave and convex modules achieves a strong aesthetic form that's beautiful, but also subtle," Vaden-Youmans said.

TOP MARKS

All of the project players are ready to take on another precast dome now that they've got the experience.

Vaden-Youmans, who hadn't worked extensively with precast prior to this project, was impressed with precast's capabilities and the fact that there were so few hiccups along the way.

"I would certainly seek to use it again based on this experience," he said.

If Vaden-Youmans has one word of advice for precasters, it's to get out and give presentations to architectural firms.

"A lot of what they are doing and are capable of doing is not well-known in the profession," he said.

And those capabilities change daily.

"Precast has existed for 60 years or so, but in reality it's still a baby being formed," Tadros said. "With precast concrete, the sky's the limit." PS

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

Specifier Q&A

This month, Precast Solutions magazine sits down with Dan Hahn of HDR Architecture to discuss his involvement with precast concrete products and projects.

Baxter Arena, a multi-sport facility located at the University of Nebraska at Omaha, made use of structural precast concrete in its design.

Name: Daniel E. Hahn
Title: Senior Vice President; Director of Architectural Engineering Services
Company: HDR Architecture
Professional Designations: P.E., S.E., LEED AP

(Above) HDR Architecture's decision to employ precast concrete wall panels and stairs for the River's Edge office complex in Iowa saved the project significant time and money.

(Right) Precast seating risers – supported by structural steel raker beams – form the seating bowl of Baxter Arena.

Q: What is your field of focus and what particular products do you specialize in?

A: I am a structural engineer doing primarily building design. The structures I have worked on include medical facilities, advanced laboratories, higher education buildings and research labs, concert and performing arts venues, stadiums, arenas, museums and a variety of other smaller industrial projects. I have used all the primary building materials in my designs, but primarily work with reinforced concrete, steel, masonry and precast.

Q: What are the benefits of using precast concrete products?

A: Precast concrete is used when unique, repetitive components are needed that are durable and consistent with high strength and a long-spanning capability. Our use of precast primarily centers on the exterior skins of buildings, but we have used it in a variety of ways to create high-quality, architecturally finished structural components. The speed of erection and consistent quality makes our contractors suggest precast on many applications where we would traditionally use cast-in-place design.

Q: What are some unique or interesting projects on which you specified precast concrete?

A: Two recent projects used precast in ways that are examples of the characteristics described above: Baxter Arena, the recently opened hockey, basketball and community ice arena for the University of Nebraska at Omaha, and the River's Edge office building complex for Noddle Development on the Missouri River in Council Bluffs, Iowa. The precast products used for these two buildings are primarily structural components within a basic structural steel framework.

The arena project used precast seating risers supported by structural steel raker beams to form the seating bowl. Precast was used to form all the walls, access stairs and barriers in addition to the U-shaped risers. Precast products allowed a larger column grid spacing and variability on riser height by simply adjusting the dap at the supported ends. It also provided integral architectural-grade finished surfaces without adding other coatings, keeping costs down.

The River's Edge project uses precast concrete wall panels and stairs to form the lateral load-resisting elements of the primary structure. Originally proposed as cast-in-place concrete, initial cost estimates indicated that precast could save significant time and money in the construction of the shear walls. And since precast was on the job, the stairs themselves could be built from concrete rather than steel pan. Precast stair risers gave the building a much more durable and high-quality product for stairs.

Q: How have you seen precast concrete evolve? How do you see it continuing to impact your work?

A: We continue to find new and innovative ways to use precast in our building design. Precast products also continue to develop new architectural finishes for use in exterior building applications. The quality of the production and the reliability of the engineering make precast a great choice when repetitive but uniquely formed pieces are needed.

For more information on HDR Architecture and the company's wide variety of projects employing precast concrete products, visit hdrinc.com. PS

"The **speed of erection** and **consistent quality** makes our contractors suggest precast on many applications where we would traditionally use cast-in-place design."

Precast Goes Co

Precast concrete products decrease construction time, increase safety for two high-profile corporate projects.

By Mark Crawford

The advantages of precast concrete in today's construction environment are seemingly endless. Because it is manufactured in a controlled environment, precast concrete has superior quality, strength, durability and consistency. Being able to cast multiple components from the same mold saves time and money. Precast provides more creative finishes that add to the aesthetics of a project. It also requires less labor to manufacture and install, keeping construction costs down. In fact, precast can speed up project completion time by weeks or months, allowing a site to be up and running faster.

Two recent corporate projects – a Volkswagen dealership in London, England, and an IKEA store in St. Louis, Mo. – made use of precast components to vastly improve operational efficiencies and the overall quality of the structures.

MASSIVE RCP FOR IKEA

St. Louis, Mo.-based Fred Weber Reinforced Concrete Products (formerly BeCo Concrete Products) recently delivered a nearly 300-piece Class III reinforced concrete pipe package for a new 380,000-square-foot, multi-story IKEA store in St. Louis's Cortex Innovation District. The project, completed in summer 2014, consisted of 1,080 feet of 144-inch-diameter combined sewer sections and 1,192 feet of 66-inch-diameter storm sewer sections. The massive, 144-inch RCP is the largest-diameter pipe Fred Weber has ever manufactured.

"As president of the company, my role was to talk to the bidding contractors pre-bid to get a good handle on the specifications for the material being supplied so that I could competitively quote

Photo courtesy of Fred Weber Reinforced Concrete Products

orporate

exactly what was needed," said Joe Barlow, president of Fred Weber. "I also wanted to get a feel for the contractor's expectations concerning the project schedule for both manufacturing and shipping, as the size and weight of this 144-inch RCP would dictate a lot how we would approach the work."

The project required some expertise and construction savvy – not just to deal with the size of the project and tight timeline, but to fabricate the 16 bend sections required to get from Point A to Point B. Barlow said the connected pieces possessed a snake-like appearance.

To expedite the production of the bends, Fred Weber engineers implemented a non-traditional method of fabrication. The standard approach of laying the product down and fabricating one side, then waiting for it to cure before rolling the product over and completing the opposite side, would be time consuming and complicated by transportation challenges. Instead, they opted to fabricate the bend in the standing position, from the top, just below the lifting pins.

"With the pipe in this position, we were able to complete the fabrication process in a time span that was two days shorter and safer than our traditional method, because we were able to work around the full diameter of the pipe," Barlow said.

Engineers also manufactured three lifting points in the 144-inch RCP to make handling easier. The pipe was hauled standing up because of the size.

From both the manufacturing and shipping perspectives, the most challenging part of the project was the aggressive schedule. Other than a few bumps in the beginning, the project went according to plan and was delivered on time.

"All our personnel on the job, from the operations manager to the clean-up crew, performed flawlessly, making the project a great success," Barlow said.

DAS PRECAST

In West London, contractors quickly erected a new structural frame for a Volkswagen dealership in 2014. The 165,500-square-foot sales and service center is four stories tall and includes a large repair workshop, three-story showroom and a 78,110-square-foot

A wide of variety of precast concrete components – including columns, wall panels, beams and more – made the new Volkswagen dealership in West London possible.

Photo courtesy of PCE Ltd.

parking garage. Longcross Construction, the project's general contractor, worked closely with specialist contractor PCE Ltd., the company responsible for the design and construction of the facility.

With the exception of the steel deltabeams – which enable the slim-floor construction that supports the hollowcore flooring in the car showroom areas – and some limited cast-in-place concrete, everything was precast. Precast components consist of columns, wall panels, beams, lift and stair boxes, stair flights and flooring units for the multi-story parking garage.

Precast modular boxes form the frame of the car park area, which helped reduce construction time and improve job safety. A special modular box system was designed for the three precast cores, moving away from the conventional flat-pack system and speeding up the construction process. It also includes a precast column and beam frame using the PCE contiframe concept, in which the column and beam connection are made at the position of zero-bending moment.

PCE's "GT" flooring consists of reinforced 16-inch-thick prestressed concrete units that can be cast up to 7.7 feet wide and more than 50 feet in length, incorporating solid, lightweight void formers that reduce the overall weight. By minimizing structural depth, the GT flooring solution "does not require any on-site structural topping compared to the other long-span precast concrete systems used in the U.K.," said Nickie Brown, managing director of PCE Ltd. "This results in a structural weight saving of approximately 3.85 tons per car parking space."

Brown also noted that carefully controlled factory conditions assured high-quality surfaces for all of the pieces involved.

Overall, the project includes about 1,500 precast concrete components, some weighing almost 20 tons. They were manufactured at six different off-site precast concrete facilities.

"Our choice of precast hybrid construction, combined with just-in-time delivery methods, enabled an overall frame erection time of 18 weeks, saving 14 weeks against a conventional in-situ structure," Brown said. "Precast also provided high-class factory formed finishes, required fewer construction workers and reduced vehicle deliveries, creating less on-site congestion.

"The use of precast provided the customer with an engineered solution that met its cost constraints with a dramatically shorter erection time scale."

COMPANY MATERIAL

For corporate projects, owners require a building material that can save construction time on site while remaining durable and pleasing to the eye. Precast concrete products accomplish all of this and more, enabling owners to quickly and efficiently complete projects of any size or scope for any company or business. PS

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