Photo: Rasmus Hjortshoj.

1200 INTREPID

LOCATION
Philadelphia, Pa.

PROJECT TYPE
Speculative office building

SIZE
94,000 square feet

COST
$18.8 million

DESIGNER
Bjarke Ingels Group, New York, N.Y.

OWNER
Liberty Property/Synterra L.P., Philadelphia, Pa.

STRUCTURAL ENGINEER
Environetics Design Inc., Philadelphia, Pa.

CONTRACTOR
Turner Construction, Philadelphia, Pa.

PCI-CERTIFIED PRECASTER
High Concrete Group LLC, Denver, Pa.

PRECAST COMPONENTS
421 architectural panels, typically 15 feet tall by 5 feet wide by 12 inches thick (for east façade panels) or 8 inches thick (for other three sides)

PRECAST CONCRETE CREATES 'SHOCK WAVE'

BIG's iconic precast façade of the Intrepid office building features cantilevered curves facilitated by the precaster who worked out details in advance as a design-assist partner

— Craig A. Shutt

As you approach the structure, the façade comes to life, rippling and curving as the colors dance around the building, responding to the sun and the clouds. The "shock wave" that appears to have hit the façade from the circular park in front generates a sense of wonder and awe at 1200 Intrepid at the Navy Yard in Philadelphia, Pa., a building with a unique response to its specific location.

"The building definitely addresses the site," says Kai-Uwe Bergmann, principal at Bjarke Ingels Group (BIG). "In many cases, architects design big, boxy buildings that could be placed anywhere and don't connect directly to the site. You would really be hard-pressed to place this building anywhere else other than where it is, due to how it connects. We like to think about a building beyond its borders and look at how it interacts with its neighbors and the open spaces around."

The 94,000-square-foot, four-story building is located at the Navy Yard's Corporate Center in Philadelphia, a master-planned development within the Navy Yard encompassing approximately 1.35 million square feet. The center offers state-of-the-art, sustainable facilities to various tenants and also creates build-to-suit office space. The properties are owned by joint venture Liberty Property/Synterra LP. During the past 11 years, the partners have developed 10 properties in the center, investing $233 million. The Navy Yard also has developed four buildings with an additional investment of $67 million.

'The "shock wave" of the public space spreads like rings in the water, invading the footprint of the building to create a generous urban canopy at the entrance.'

"The Navy Yard is undergoing a major transformation from its military background to an office park and neighborhood," Bergmann explains. "Our commission involved creating a speculative office building, for which no tenants were committed. Part of our job was to create a reason for tenants to want to be here." But that had to be accomplished on a budget under $200 per square foot. "Designing speculative office space with the constraint of a stringent budget was the key challenge," Bergmann says.

"Our design for 1200 Intrepid has been shaped by the combination of Robert Stern's urban master plan of rectangular city blocks and James Corner's iconic circular park," explains founder Bjarke Ingels. The master plan laid out a circular park in front of the building, with roads on either side leading to the entry. BIG suggested curving the roads around the park to emphasize its shape. "That then created the idea in my head of curving the building to fit the space on a grand level," explains Ingels.

PUBLIC 'SHOCK WAVE'

"The 'shock wave' of the public space spreads like rings in the water, invading the footprint of the building to create a generous urban canopy at the entrance," explains Ingels. "The resultant double-curved façade echoes the complex yet rational geometries of maritime architecture. Inside, the elevator lobby forms an actual periscope, allowing people to admire the mothballed ships at the adjacent docks."

The master plan called for a rectilinear design overall, so the building flattens out on the top floor. "The impetus for the curve of the façade came from the curve of the park and the roads in front of it," Bergmann says. "But we also wanted to be truthful to the master plan as well as to the site plan." The exact shape of the "shock wave" curve was inspired by the curved bow of the battleships docked a few blocks away.

The park, Bergmann notes, offers "a beautiful amenity for the Navy Yard, and it takes the site from being an ordinary office park to being something special. It helps to create the feel of a neighborhood that you can hang out in. We wanted to have a building suited to that environment."

INFLUENTIAL CURVES
The curve of the building's façade was influenced by curve of the ships docked in the Navy Yard. Photo: Rasmus Hjortshoj.

The goal was to connect the people with their environment. "The sidewalk starts to become a part of the building," he relates. "You can almost see the front of the façade as the result of a 'shock wave' that comes off the circular park and creates a double-curved impact on the façade at the entrance to the building."

PRECAST CONCRETE EXPERTISE

To achieve this concept, Bergmann turned to architectural precast concrete panels, a material BIG uses frequently, especially in its homeland, Denmark. "We are a Danish company, and in Denmark, precast concrete is the predominant building material," he says. "We use it for structural elements, decorations and fascia, and façade pieces of all kinds."

He estimates that 80% to 90% of Danish projects include precast concrete. Danish architects often arrive at that solution due to the long, cold winters. "Designers have realized in the past 60 or 70 years that precast concrete can be cast indoors, all year round, under very favorable conditions, which also gets more of the work off-site." Previously, firms relied on masonry for many projects. "But now precast concrete has been found to be a much better option."

DOCK VIEWS
The atrium of the building features an angled mirror that reflects views of the nearby Navy Yard. Photo: Rasmus Hjortshoj.

BIG arrived in the United States in 2010 and received the commission for this project in 2012. "We came very quickly to the idea that precast concrete would be a great way to achieve our goals.", says Bergmann.

Precast concrete's plasticity played a key role in that decision. "It has an industrial feel, but if you have a deft touch, it allows the design to flow smoothly," he notes. "We see precast concrete as providing an opportunity for creativity."

That creativity was encouraged by his early interest in various material capabilities and his questioning of how they could be pushed further. "I started my career actually working as a carpenter, stone mason, and glassblower, to learn and respect the trades that I as an architect would work with," he says. "I saw a certain inventiveness in those materials, the same inventiveness I remembered from playing with LEGO blocks as a child. You have certain specific pieces, and you use the creativity of a child to create any kind of shape you want."

Bergmann retained that inventiveness as he began using these materials in his architectural designs. "That is what is most exciting," he says. "When you design with precast concrete, you have certain shapes you work with, but then the architect can unleash his creativity with those shapes. We can take that limited pallet of shapes and sizes and create almost any shape or feel that we want."

BIG has done other designs with curving, geometric designs in precast concrete, he notes, including the 40th Precinct Police Station in the Bronx, N.Y. But Intrepid offers the most dramatically flowing shape, which required significant cantilevering and structural-load analysis. "We've done other designs using these cantilevered concepts that push and pull at the envelope," he says. "It's all about addressing the site in the best way and then accomplishing that with the material."

'When you design with precast concrete, you have certain shapes you work with, but then the architect can unleash his creativity with those shapes.'

REFLECTED SHOCK
The building was designed to address its site, with the curving roads in front of it representing a "shock wave" that impacts the façade. Photo: Rasmus Hjortshoj.

This cutaway shows how the office space adapts to the curving façade. Photo: Bjarke Ingels Group.

DESIGN ASSIST PROVIDED

To accomplish that, Turner Construction collaborated with the precaster, High Concrete Group, on a design-assist basis early in the design process. "We have had 15 years' experience working with precasters, and we know the dos and don'ts," he says. "High came onto the project with the general contractor, after we had completed the design concept and were working on construction documents. But even at the shop-drawing level, we were still refining the design, so they had input into how to create efficiencies by adapting the design to fit how they could accomplish things best."

The adaptations at the design stage factored in every detail possible, including how panels could be transported to the site and what design techniques could be used on the panels to protect their chamfered edges from damage during handling. "Those are important pieces to consider as early as possible to ensure they are accounted for."

Was High shocked by the concept of the "shock wave?" "High's team reacted the way most people do when they are asked to use their brains and see potential for growth as a person and a professional," Bergmann says. "They saw it as a wonderful experience. It's true that not everyone would enjoy that idea so much, but High's team jumped on it as a chance to show off their skills and products."

TIGHT CORNERS
Only the front façade curves, creating challenges in matching its design to the three flat sides. Photo: High Concrete Group.

High's team recognized the significant challenges and were intrigued by how they could be met. "We were brought onto the project after its aesthetic design was decided," says David Bosch, design team leader at High. "But structurally, it was all ours, with the provision that we weren't allowed to transmit gravity loads to the steel frame. That made for an interesting project to erect and to ensure against a progressive collapse."

Most of their attention focused on the curved east façade, adds Matt Krebs, High project manager. "Three elevations were cut and dried, but we realized the cantilevered and sloped elevation had a lot of issues involving joint spacing and alignment to ensure the panels would meet up smoothly and could work with each other across the façade. The key challenge was how to orient the panels so they could achieve the look but still ensure they would close themselves together tightly at each connection."

BIG came to High's team and said, "Here's what we want to do," Krebs relates. In return, High's engineers said, "Here's where we think there will be problems with that." "We had a lot of iterations back and forth with BIG to achieve their goals and maintain efficient constructability of the design."

BIM ADDED ADVANTAGES

Designing with Building Information Modeling (BIM) aided the process of working through the details. "It wasn't universally used then, but we have now transitioned and use it on every project," says Bergmann. "It's not a proprietary system, it's part of any CAD system, and it aids the process a great deal. We think most companies will have to transition to using it to be able to live up to the new designs that are being created."

'The key challenge was ensuring that the curving precast concrete panels could align properly.'

General contractor Turner Construction was a part of that program. "We were involved from the bidding process on, and we worked with the BIM designs," says Bill Swanson, project executive. "The key challenge was ensuring that the curving precast concrete panels could align properly, and the 3D model allowed us to see how to make that happen."

"High's company policy today states that every design will be created with BIM," says Krebs. They also are encouraging the outside engineers they work with to make the transition. "There are big advantages

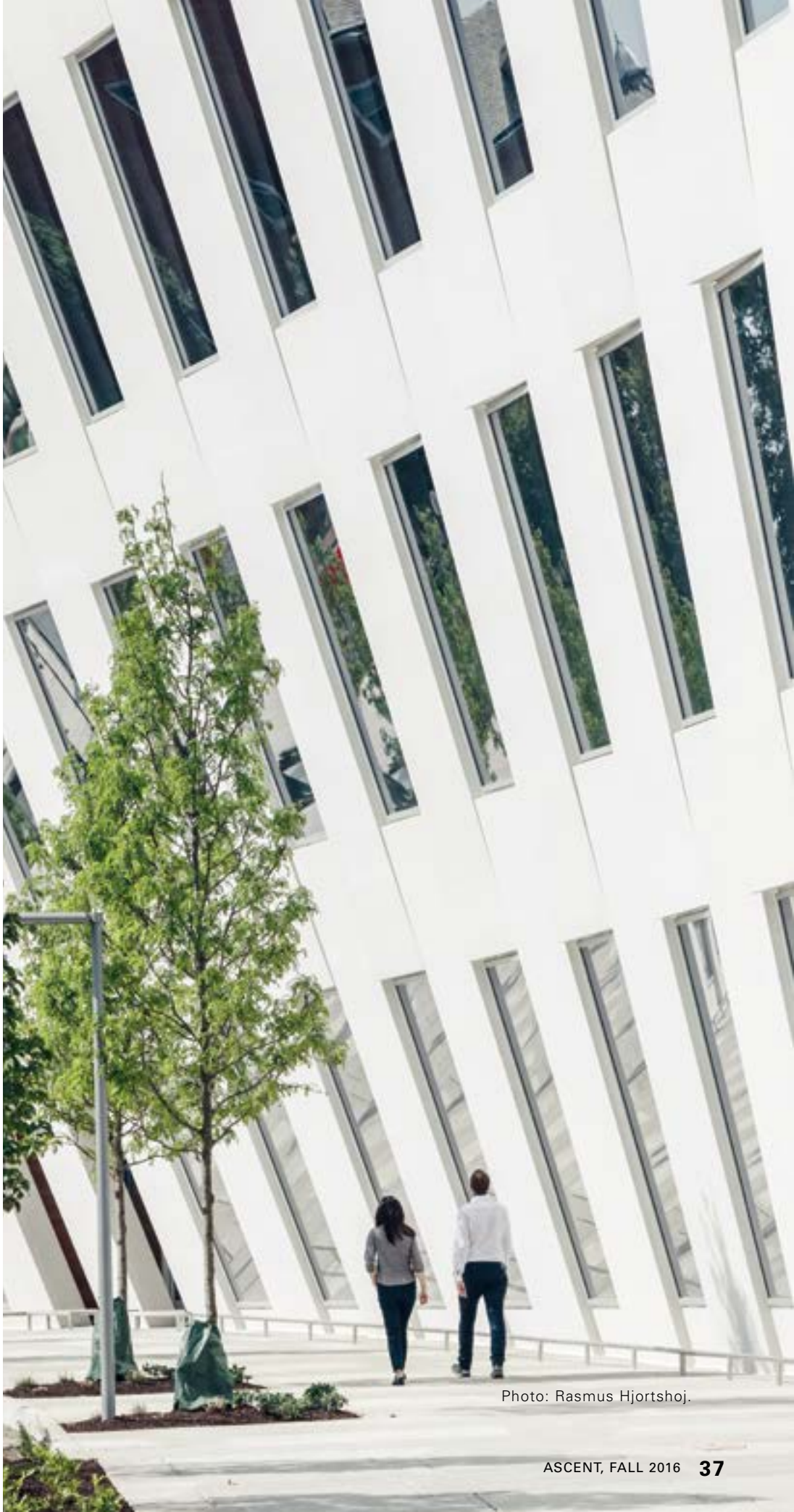

Photo: Rasmus Hjortshoj.

HOOK 'EM
Hook attachments at the top and bottom of the panels allowed them to be placed into the exact location for connection. Photo: High Concrete Group.

REACHING THE SUMMIT
Shorter, square panels were used to finish off the alternating pattern of panels at the roofline. Photo: High Concrete Group.

that come from using 3D modeling," he says. "It gives us advantages in visualizing and anticipating loads and connections. I really don't think we could have done this project with two-dimensional models."

There can be a steep learning curve to using it thoroughly, he notes. "But we learned it and now we use it on every project." It especially helped to work out the lateral connections that were critical to the design of the curves. "They were fairly typical, but they had to be slightly modified in each case to adjust to the curve."

'It really makes it feel as if the wall moves as you walk toward and along it.'

Casting the panels for the east façade proved especially challenging, as each had its own curve and slant with different chamfers on the edges. "The lack of repetition was an unlikely situation for a precaster, as repetition is our bread and butter," notes Krebs. However, the other three sides had enough economy in their shapes to make it effective. "Three sides of this building were a piece of cake," says Swanson. "They could be cast like a cookie cutter. But the east side required more attention."

The panels are typically rectangular in shape (before twists and curves), measuring 15 feet tall and 5 feet wide, with four panels forming the outline of each similarly rectangular window. The windows alternate up the façade, leaving the panels to zig-zag around them as they loom over visitors. "Each of the pieces is faceted and is very different," Bergmann explains. "It really makes it feel as if the wall moves as you walk toward and along it, while the glass reflects the sky's changes as the clouds and color change during the day. It makes it feel alive in that moment, which will be different from the next time."

LOADS FLOW TO GROUND

An additional challenge came from the requirement that, as the panels cantilevered and swerved around the windows, their loads had to bear to the ground rather than load onto the steel framing behind them. "The steel-strut system was designed to hold them in place but not to bear their load," Bergmann explains. "That was necessary to allow them to flow properly. It required extra thinking, but it also made it a lot of fun."

The panels were designed to appear to be 11 inches thick, but the backs were partially hollowed out, reducing their thickness to 4.5 inches at the face to minimize the weight. The panels' backsides feature thick metal bars, about 4 inches wide by 14 to 16 inches long and 1.5 inches thick, which tie each panel to the adjacent ones. The loads then transfer back and forth as they flow to the ground. "It's not that unusual of a concept, but the cantilever puts more stress on the panels than is typical," Swanson says. "It ensures all the stress stays in the panel."

"There was more load than we had anticipated initially, but it wasn't difficult to control," Krebs says. The panels feature overdesigned shear bars and thicker bearing plates than is typical. "They're really not that unusual."

Precast concrete sandwich insulated panels were considered, Bergmann notes, but their thickness and interior insulation would have limited the curvatures that could have been achieved. Instead, the panels were sprayed with insulating foam after erection. The panels have only a 4-inch structural framing that allows them to appear thinner at window penetrations when inside the building. All of the panels received a light sandblast finish.

SPOT WELDING
The precaster and erector spot-welded the connection plates onto the steel frame by referring to BIM drawings so they were in place before panels were erected. Photo: High Concrete Group.

"The windows serve as gaps in the panels," Bergmann explains. The walls protrude slightly beyond the windows, he notes, creating a little shade with their thickness. "The precast wall serves as a rainscreen and shading device. We wanted to ensure we could provide large window openings so from inside the rooms didn't feel like Swiss cheese. But we also wanted a sweeping façade. When you are there, you're surprised by the size of the panels, but you're also surprised by the size of the windows."

CUSTOM TOUCH
Each panel on the curved façade required a personal, customized fit to ensure it fit perfectly into its assigned spot. Photo: High Concrete Group.

SITE OFFERED EASY ACCESS

The site offered easy access with room for staging, Swanson says. "The Navy Yard worked with us well to close streets as quickly as possible for the time needed, and we used that time efficiently." Three sides of the building provided easy access for cranes, while the fourth side abutted a road.

The erection process moved smoothly, at least once all of the details of how to erect the panels on the east façade were worked out. The steel frame was erected first, and then the precaster and erector laid out their weld points, referring to drawings of the actual panels that would be erected in each position and using high-reachers to then spot-weld the plates prior to any erection.

"We spent 1½ months working with the erector to plan out the locations of the welding points," Krebs says. Adds Swanson, "The connection points for the entire building were laid out for real, rather than by referring to drawings and putting in weld points, which is not the typical approach. But they wanted to avoid any risks of mistakes in the drawings from transferring to the frame and requiring adjustments during the erection process."

Each panel on the east side required a personal, customized fit. Hook attachments were embedded in each panel at the top and bottom. Once the panel was hovering in its approximate placement location, a come-along was used from behind to pull

FINISHING TOUCHES
The close attention to detail throughout the project—which met budget and schedule—resulted in a building with a dramatic sense of movement. Photo: High Concrete Group.

the bottom into position so it could be welded in place, then the top was attached.

"The orientation for each panel changed, so there was no constant to work from," Bosch says. "The location of the panels was accomplished by assigning points at the corners of each panel in the model and transferring those digitally via a file to the building. This was the only way to locate them with accuracy." Adds Krebs, "There was a lot of theory-based work, but it worked out perfectly."

In fact the erection went faster than anticipated. "Those panels really flew up there," says Swanson. "It was all about getting the engineering and the 3D modeling complete and correct. Once it was done and approved, the actual erection just went." Bergmann was pleased to see that no field adjustments were needed as the panels went up.

LEED GOLD CERTIFICATION

The project was targeted to achieve LEED Gold certification, and the precast concrete panels helped reach that goal. They enhanced energy efficiency with their dense mass and provided a variety of manufacturing benefits. These included local manufacture using local materials, use of recycled and recyclable content, and reduction of construction waste.

As a final touch relating to the Navy Yard's pedigree, the roof of the building's lobby features a "periscope" that emphasizes the building's location near the river. "The coolest and most beautiful part of this center is that it is only a few blocks away from the ships at rest," Bergmann explains. To take advantage of this, an angled mirror that reflects the ships at dock to those who look up was screwed into the substrate on a supporting frame along the roof inside the lobby atrium.

Such amenities add to the dramatic sense of movement and wonder evoked by the façade as visitors approach. "The panelized façade is unique, but it still managed to hold to budget," Bergmann stresses. "It shows that you don't have to dumb things down to hit your budget. You can think intelligently about what you want to do and work closely with the team members to do the work efficiently."

Krebs agrees. "This was by far the most unusual façade we've ever produced. It became more and more impressive to us as we erected the panels and saw it taking shape and fit together perfectly. It was definitely exciting to watch it go up. It's still very impressive for us to see it, even after it's done, and we know exactly how it's loaded."

BIG will continue to create impressive designs using precast concrete, Bergmann says. It's currently completing several projects with the material. They include the Faroe Islands Education Center near Tórshavn, Faroe Islands, which combines a high school, technical school, and business school, as well as the "Hualien residences" in Taiwan, a 1,000-square-meter show home for a residential development that emphasizes the surrounding nature. Projects in the United States. also are on the drawing boards.

"Precast concrete is our go-to product," Bergmann says. "We are working on projects in eight states now, and we will be using precast concrete whenever possible."