

Precast Concrete Optimizes, Industrial Buildings' Functionality

Warehouses, data centers, distribution centers, manufacturing facilities, and other industrial buildings benefit from precast concrete structural and enclosure systems

— Craig A. Shutt

Industrial facilities of all types need to handle a high level of activity, ranging from delivery vehicles, data-processing servers, manufacturing equipment, and offices. They require durable, flexible spaces that maximize efficiency inside, while providing a pleasing appearance outside that allows them to fit into the neighborhood or project the proper image. High-performance precast concrete structural systems and enclosure systems can help meet these and other challenges for spaces that are specialized, high-intensity, and demanding.

Precast concrete provides a variety of benefits that owners, architects, engineers, and contractors can tap into.

Multiple Benefits

Precast concrete provides a variety of benefits that owners, architects, engineers, and contractors can tap into when designing these facilities. Among its advantages for these facilities are:

- **Creating open interiors.** Hollow-core units and double tees create long spans, allowing column-free areas for installing or rearranging equipment to meet evolving needs.
- **Supporting heavy loads.** Precast concrete is a structural material, and can be used as the structural system for the project. Double tees or hollow-core roofs can typically support the weight of suspended mechanical equipment and exterior panels can carry the structural load of the roof system.
- **Resist high wind and impact loads.** Precast systems can be designed to resist extremely high-wind loads and their resultant uplift or impact forces. This resistance can allow a structure to be

operational after a catastrophic weather event; protecting lives, equipment, and operations.

- **Meeting local seismic requirements.** Precast systems using proven connection technology can be used in all seismic zones.
- **Installing efficient delivery bays.** Precast panels can be cast in 12-foot widths or wider to allow dock door openings to be cast into one panel, enabling faster construction.
- **Minimizing energy requirements.** Insulated sandwich wall panels offer an energy-efficient enclosure that aids in reducing heating and cooling costs through continuous insulation and the thermal mass of the concrete.
- **Allowing for expansion.** Precast concrete components can be disassembled, and relocated or combined with new precast components to enable easy expansion of facilities.
- **Reducing congestion and safety concerns at the site.** Precast concrete components can be brought to the site as needed for that day's erection, minimizing staging areas on-site and overall site impact.
- **Accelerated construction.** A structural or total-precast concrete system speeds construction, minimizes the number of component pieces by combining structural and architectural attributes into a single piece, and offers single-source responsibility with the precast manufacturer. Component casting often begins before or while the site work is being completed. This allows for erection to begin once the site is prepared.
- **Providing aesthetic control.** Architectural precast concrete panels use colors, textures, reveals, finishes, formliners or thin-brick insets to create any needed design style, from historic to contemporary.
- **Finishing interiors faster** by providing a clean, durable, low-maintenance interior wall with an attractive finish on insulated panels.

The following examples show some of the ways that owners, architects, engineers, and contractors are using high-performance precast concrete components to achieve



their goals in a cost-effective manner.

SuperMax Healthcare Inc. Distribution Center

Executives at the SuperMax Distribution Center in Aurora, Ill., which serves as the healthcare product manufacturer's North American distribution headquarters, needed a functional facility that also projected a welcoming appearance for visitors. They also wanted a highly energy-efficient structure that would minimize long-term energy costs. To achieve these goals, designers specified architectural precast concrete insulated wall panels, which helped the building achieve LEED Gold certification.

"We used precast concrete panels because of the fast construction they could provide in erecting the building's enclosure and ensuring an economical cost," says Rod Zamparo, project manager for ARCO/Murray, the design-build firm on the project. The panels also allowed the designers to create an attractive façade that helped minimize the scale of the 90,170-square-foot

The 90,170-square-foot SuperMax Distribution Center in Aurora, Ill., features insulated precast concrete panels that helped the facility achieve a Gold LEED rating. Photos: ATMI Precast.

PROJECT SPOTLIGHT

SuperMax Healthcare Inc. Distribution Center

Location: Aurora, Ill.

Project Type: Distribution center

Size: 90,170 square feet

Designer: ARCO/Murray, Downers Grove, Ill.

Owner: Supermax Healthcare Inc., Aurora, Ill.

Structural Engineer: Structural Resources Inc., Naperville, Ill.

Contractor: ARCO/Murray, Downers Grove, Ill.

PCI-Certified Precaster: ATMI Precast, Aurora, Ill.

Precast Components: 49,166 square feet of architectural wall panels, typically 42 feet tall and 12 feet wide.



building. "This was their headquarters, so they wanted it to project a strong image without interfering with the building's main function as the key distribution center."

The 9½-inch-thick insulated precast concrete panels, which were erected using temporary braces and then connected to the steel-roof diaphragm steel frame, consist of a 3-inch interior wythe of concrete, 3 inches of expanded polystyrene insulation, and a 3½-inch-thick exterior concrete wythe. The exterior concrete wythe was fabricated slightly thicker to accommodate a variety of vertical recesses and reveals. These recesses create the illusion of window openings and break up the horizontal nature of the long, low structure. Additional horizontal reveals were cast into other panels to align with joints.

The panels also support the roof load around the perimeter of the structure eliminating the need for a redundant steel frame. To create composite action, galvanized wire trusses were used to connect the wythes, with the insulation running end-to-end in the panels. Solid-concrete segments were provided at the top, to create a base for roof joists, and at the bottom to set onto the footings.

Door Frames Cast into Panels

Overhead doors frames for truck deliveries were cast into one side of the building to allow quick access. The doors were grouped into sets of four, with each 9-foot-wide door cast within one 12-foot-wide panel, making installation move smoothly. Two additional 10-foot, drive-through doors were created using a precast concrete hanger panel above the drive-in doors.

On the parallel wall, three access doors were provided, each cast within one panel to ensure fast installation. Knockouts were provided adjacent to several of these doors so they could be converted into delivery doors for trucks at a future date if needed.

Tall panels, which look like wide columns, were erected at the corners and halfway along each half of the façade, breaking up the mass and adding vertical elements into the design. These panels had five horizontal reveals cast into them,

giving the appearance of large stones. Once the panels were erected, the columns were painted a dark gray, while the rest of the panels were painted white.

The most challenging part of the project focused on the expansive curtain wall at the building's entry. The 42-foot-tall wall, comprising an 8-foot glass entryway topped by a 34-foot green and black checkered aluminum band, required close attention to connection detail, says Mike Walsh, vice president of business development at ATMI Precast, the precaster.

"The details of the supporting members for the curtain wall had to have high strengths to provide the necessary support," he says. "It was an engineering and fabrication challenge. Basically, we were replacing a structural wall with structural glass, and we needed to provide the necessary support in the precast concrete."

A monument sign was provided at the entry in the form of a standalone identification wall, created from two "bookends" of precast concrete flanking a stone sign featuring the company's logo and name on a white background. The precast concrete bookends consist of two pieces each, a taller column that connects to the sign and a lower wall that provides a sloping appearance to the structure. The pieces were cast with reveals to mimic the look of the end columns on the building behind them, and they too were painted gray. They were set onto trench footings and welded into place.

It only took five days to erect all 49,166 square feet of precast concrete panels. The panels, typically 42 feet tall and 12 feet wide, were erected in a vertical position. A two-hour fire caulking was applied around the main doors, with other joints receiving a traditional caulking and grouting. Although the site backs up to easements for the nearby highway, its position didn't restrict the erection, Zamparo says. "Everything went smoothly, with no site restrictions to constrain us."

The insulated precast concrete panels aided in achieving the LEED Gold certification by using recycled and local materials in their fabrication, helping to control construction

Fast construction capability to meet a tight deadline, combined with thermal efficiency and design flexibility, led designers to specify insulated precast concrete architectural panels to clad the 72,000-square-foot Macy's Parade Studio in Moonachie, N.J. Photos: J & R Slaw Inc.



waste, aiding with energy efficiency through the continuous insulation and concrete's thermal mass, and manufacturing near the site, saving transportation energy costs.

'The entire project moved very quickly and allowed us to complete the project on time and on budget.'

"The precaster's proximity to the site was very close, which helped make the project move smoothly and added some LEED points," says Zamparo. "The entire project moved very quickly and allowed us to complete the project on time and on budget."

Macy's Studio

Due to the growth of Macy's famous Thanksgiving Day parade, executives decided they needed to provide more room for its Parade Stu-



PROJECT SPOTLIGHT

Macy's Studio

Location: Moonachie, N.J.

Project Type: Warehouse

Size: 72,000 square feet

Designer: Russo Development, Carlstadt, N.J.

Owner: Russo Development, Carlstadt, N.J.

Structural Engineer: Russo Development, Carlstadt, N.J.

Contractor: Russo Development, Carlstadt, N.J.

PCI-Certified Precaster: J. & R. Slaw Inc., Lehigh, Pa.

Precast Specialty Engineer: Civilsmith Engineering, State College, Pa.

Precast Components: 136 insulated sandwich wall panels with embedded thin brick, encompassing 44,783 square feet. The 3-3-3.5-inch panels feature an interior layer of XPF insulation.

dio, where the floats are created and stored. The new space in Moonachie, N.J., provides 72,000 square feet of space, which is more than twice the size of the original building in Hoboken, N.J. It also offers 46-foot-tall ceilings, providing more flexibility in designing and building the floats. Precast concrete architectural panels not only helped create this tall space effortlessly, but it provided an aesthetically pleasing look on a tight schedule and a thermally efficient envelope.

'Precast concrete was the perfect fit for this building.'

The front and side elevations feature 50-foot-tall precast concrete insulated sandwich wall panels finished with two contrasting shades of thin brick. A custom pigmented concrete color was chosen to be used as the "mortar joints" that coordinates with both colors of brick. This approach reduced the amount of labor needed to create the look of hand-laid brick while providing a more durable, monolithic

insulated wall that requires less long-term maintenance.

The rear elevation uses similar insulated precast concrete walls but with an integral color and sand-blasted finish. Deeply tinted glass used throughout the building complements the brick colors and adds to the contemporary appearance.

"Precast concrete was the perfect fit for this building, as the tenants were on a tight schedule for occupancy," says Dave Thomas, project manager for J.R. Slaw Inc., the precast concrete manufacturer. The parade float designers and construction crews had to occupy the space by October or else remain in the original facility until the next June. "This would have resulted in delays and lost revenues for the services they provide." The worst-case scenario would have caused the parade to be cancelled due to lack of space to create the floats.

The precast concrete panels were cast and erected quickly and kept to their schedule. The 136 panels, encompassing 44,783 square feet, were cast in two months and erected in a little more than a month. The quick erection of the enclosure allowed

crews inside to install the equipment for designing and constructing floats early in the construction process. The entire facility was completed by August, two months ahead of the final deadline.

The insulated panels, which provided an R-15 thermal rating, consisted of a 3-inch interior wythe of concrete, 3 inches of extruded polystyrene (XPS) insulation, and a 3.5-inch exterior wythe of concrete. The additional thickness helped in creating reveals and other architectural features that added visual interest to the building's large face. The panels were designed as structurally composite and provided continuous insulation. They also were prestressed at the manufacturing facility to aid in providing stability for their unusual height. The large size of the pieces also helped erect the building quickly, reducing the piece count.

"The project moved very smoothly from casting through delivery and erection," reports Robert Slaw, president. "The structure is not only functional, but it's thermally efficient and very attractive." Completed under the schedule restrictions and on budget, Macy's officials were pleased with

the result, which allowed the parade to go on uninterrupted and Santa to arrive right on time.

'The structure is not only functional, but it's thermally efficient and very attractive.'

WMATA Bus Depot

In replacing the existing Washington Metropolitan Area Transit Authority (WMATA) bus garage in Washington, D.C., designers wanted to create a state-of-the-art complex that facilitated bus and crew movements and provided space to maintain the fleet efficiently. Helping to achieve these goals—and obtain LEED Silver certification—were precast concrete structural components and architectural precast concrete panels embedded with thin brick, which also produced a strong aesthetic statement.

The project was awarded to general contractor Hensel Phelps, which had prior construction experience with WMATA and with bus-main-



tenance facilities, according to Michael Barker, project manager. The contractor worked with SYSTRA Consulting, the architectural firm, to create three distinct buildings on the campus: an 88,000-square-foot, one-story parking garage featuring a total-precast concrete structural system, along with a 90,000-square-foot maintenance/administration building with 27 service bays to service the station's 250 buses, and a three-lane, diesel-fuel building. All three were clad with architectural panels with similar design elements to blend the facilities together.

All three buildings were clad with architectural panels to blend the facilities together.

The architectural panels for the buildings, which were connected to a steel framing system, consist of insulated sandwich wall panels embedded with architectural thin brick

to create a traditional and attractive aesthetic statement. Structural components used to construct the parking structure consisted of double tees, columns, exterior columns with thin brick, column covers, shear walls, beams, L-beams, and inverted T-beams.

"The brick was chosen to meet the district's Architectural Review Standards Board requirements," explains Jason Reynolds, project manager for The Shockey Precast Group, which fabricated the components. "Finding a brick that met those needs as well as those of the client wasn't difficult."

The insulated wall panels, consisting of two, 3-inch wythes of concrete sandwiching 3 inches of polyisocyanurate insulation, not only provided high energy efficiency, but also allowed the interior face to serve as the interior wall of the buildings. The interior surface of these panels were cast with a trowel finish that was painted once the panels were erected. "It was a little higher-grade trowel finish than would typically be given to the panels, but it allowed the buildings to avoid having to do more interior finishing," Reynolds explains.

Flow Creates Challenges

Movement among the buildings for both bus traffic and pedestrians was aided by several design elements. A pedestrian bridge connecting the parking structure to the administrative building allows safe and easy flow between the two out of the path of the buses moving through the grounds.

Designers specified AASHTO bridge girders to span the 200-foot distance, which were supplied by Northeast Prestressed Products in Cressona, Pa. The firm supplied the beams as a subcontractor to Shockey, which erected them along with the other precast components. The beams were finished with flat slabs, with spandrels hung off the sides of the beams with the same embedded brick as the other walls, creating a unified appearance. The beams ensured that no additional supports had to be added near the building's entry, creating a cleaner façade at the main entrance, according to Barker.

Another challenge occurred with bus-traffic flow through the parking structure, which followed one of the short sides of the rectangular, one-





Selecting a brick to provide the desired aesthetic for the WMATA campus wasn't difficult, but the choice had to meet the district's Architectural Review Standards Board's requirements.

PROJECT SPOTLIGHT

WMATA Southeast Bus Depot

Location: Washington, D.C.

Project Type: Bus depot, parking structure, offices

Size: 88,000-square-foot parking structure, 90,000-square-foot maintenance/administration building, and three-lane diesel-fuel building

Designer: SYSTRA USA, Philadelphia, Pa.

Owner: Washington Metropolitan Area Transit Authority, Washington, D.C.

Structural Engineer: Klein & Hoffman Inc., Philadelphia, Pa.

Contractor: Hensel Phelps Construction Co., Chantilly, Va.

PCI-Certified Precaster (structural and architectural precast and erection): The Shockey Precast Group, Winchester, Va.

PCI-Certified Precaster (AASHTO girders): North East Prestressed Products LLC, Cressona, Pa.

Precast Components: 338 structural pieces, including double tees, columns, exterior columns with thin brick, column covers, shear walls, beams, L-beams, and inverted T-beams; 123 architectural panels with embedded thin brick and column covers; four 100-foot AASHTO bridge girders.



Three separate buildings, including a one-story parking structure built with a total-precast concrete structural system, created a state-of-the-art bus facility for the Washington Metropolitan Area Transit Authority in Washington, D.C. The three facilities were clad with architectural precast concrete panels embedded with thin brick to create a consistent and attractive appearance. Photos: Shockey Precast Group.

story structure. "Traditionally, it's been feasible to design open, one-level parking structures in low-seismic design areas like this by cantilevering columns from the foundation," explains Matt Cooper, engineering manager at Shockey. For this project, two design conditions led to creating moment frames in the structure.

"The clearance between the slab-on-grade and the bottom of the framed level needed to allow the buses to travel through, increasing clearance beyond what would normally be used for standard passenger vehicles," he says. "In addition, introducing shear walls would obstruct desired visibility for users and limit bus access. The moment connections allowed the structure to be designed within allowable drift limitations stipulated by the code and project requirements."

Moment frames were introduced by splicing the precast concrete columns to the foundations with Type II grouted couplers, creating moment resistance at the base. At the elevated level of the garage, inverted T-beams with protruding reinforcement were installed on top of columns that also had protruding reinforcement. A designed void between the components' interfaces was left after erection, and the voided region was filled with cast-in-place concrete to create the moment connection.

"It was an atypical design for a precast concrete parking structure, but this type of project had unique conditions that had to be met," says Reynolds. "The moment connections provided the best approach to meeting all of the needs in a concise and efficient manner."

The project, located on a 16-acre brownfield site, achieved a Silver LEED rating. Features that helped meet that goal included a white EPD roofing membrane, water-reclamation washing stations with snow-removal capabilities, and the precast concrete components. The latter generated points for local manufacture and use of local and recycled materials as well as for energy efficiency due to the insulated panels' high R-value.

The site, in a congested part of southwest Washington, D.C., required restricted delivery times and additional coordination. Bringing the bridge girders into the downtown area especially needed close communication, as nighttime deliveries were required for these superloads. "We

needed to coordinate all of the deliveries with the city's review board and obtain special permitting from state agencies," Reynolds notes.

"The project had some unique aspects, but the precast concrete design was able to meet all of the challenges and provide an efficient and aesthetically pleasing design," he says. "Close communication among the team made it move smoothly."

Indeed, the project proved so effective that contractor Hensel Phelps received a 2012 Contractor Award from the Associated General Contractors of Washington, D.C., for its work on the project.

Washington & Lee Data Center

Data centers often require tight scheduling to ensure their operations are online when they're needed. In the case of the Washington & Lee University Data Center in Lexington, Va., scheduling also was critical to be sure the funds remained available to build the project.

The 4,500-square-foot Tier II+ data center was part of a federal stimulus program to construct 134 miles of fiber to bring broadband services to west central Virginia. The project, a public-private partnership, included allocated space for use by Rockbridge County, the university, and other groups. "The timeframe for building the project had to be met, as other projects were occurring at the same time, and the funds had to be used by a set time or they wouldn't be available," explains Chris Meier, project manager for Hoch Associates, the architectural firm on the project.

Load-bearing architectural precast concrete insulated sandwich wall panels were specified for the building enclosure, with precast concrete hollow-core slab used for roofing, with cast-in-place slabs used for flooring. The panels feature multiple finishes as well as embedded thin brick, with 4 inches of insulation sandwiched between two 4-inch wythes of precast concrete. Gate Precast Company fabricated the components.

"Data-center projects are more complicated than many other types, because they have a lot of critical functions and infrastructure that has to be built inside," says Meier. "Those functions add some design elements that have to be included—and the



The 4,500-square-foot Tier II+ data center at Washington & Lee University required a tight schedule to ensure funding remained available for the project. Load-bearing architectural precast concrete insulated sandwich wall panels and hollow-core slab helped to meet a variety of challenges in completing the project. Top Photo: Hoch Associates. Others: Gate Precast Co.

PROJECT SPOTLIGHT

Washington & Lee Data Center

Location: Lexington, Va.

Project Type: Data center

Size: 4,500 square feet

Cost: \$2.5 million

Designer/Structural Engineer: Hoch Associates, Indianapolis, Ind.

Owner: Rockbridge County, Va.

Contractor: South End Construction, Roanoke, Va.

PCI-Certified Precaster: Gate Precast Co., Oxford, N.C.

Precast Components: 24 pieces encompassing 5,500 square feet of architectural wall panels, 40 pieces encompassing 4,100 square feet of 10-inch hollow-core slab.



functions can't be interrupted for any reason. So the building envelope has to provide flexible interior space and a hardened, protective shell to provide high-level protection."

'It was an extraordinarily challenging building.'

"It was an extraordinarily challenging building," agrees Mike Howdyshell, project manager at the time for the general contractor, South End Construction. "There was so much electronic-data equipment required, with a lot of high-speed servers and mechanical and electrical equipment to support it. Those made the construction very complex. What made it easy was the precast concrete. The precaster did a great job of casting just what we needed and erecting it so we could put the roof on right away. It freed us up to focus on the hard stuff inside."

Designed following LEED-certification standards, the facility has approximately 2,400 square feet of raised-floor data-processing space. Cabinets and racks for use by Washington & Lee University comprise about 25% of this space, while the remainder is dedicated to co-location services by other groups. Offices, conference rooms, and support functions take up about 2,000 square feet and are located at the front of the building in a rectangular front space that creates the building's face for the public.

To accommodate the 2-foot raised floors, the panels were cast taller than would be typical and were erected in a vertical position, Meier says. "Integrating the insulation into the panels ensured the installation could be completed quickly while providing strong thermal efficiency."

HVAC Challenges

Considerable attention went into locating the HVAC and mechanical equipment and ensuring the precast concrete components could accommodate the heavy-duty needs. "Data-center projects are mostly about power and cooling," says Meier. "The data equipment generates a huge amount of heat, so we need to be sure that the HVAC equipment can

maintain the specified temperatures.

A key requirement was to minimize roof penetrations to avoid any possibility for roof failures that could cause leaks. Condensers and other HVAC equipment were placed outside adjacent to the building, with wall penetrations in the precast concrete panels where needed. "All of the penetrations we needed were blocked out in advance and coordinated at the plant to avoid any field adjustments," says Howdyshell. "A few vents were placed in the roof, but otherwise everything came in from the walls or from underneath."

The panels' embedded thin brick was accented with wide corner pieces and columns using a bright white cement, along with a decorative cornice on the top. "The brick was chosen to match the brick used elsewhere on the Washington & Lee campus," Meier says. "It's a historic campus so the new building had to blend in despite its size and functions. Aesthetics were very important in the considerations of the design."

The design creates a picture-frame effect around the brick on the front office portion of the building, with the columns leading the eye up to the cornice, which was painted in a dark clay color. Additional buff-colored framing around each window and buff-colored lintels were finished with a light sandblast. Some of the panels featured three different finishes plus the decorative cornice work. The remaining building, housing the equipment, was recessed behind the front portion to diminish its size. It features gray concrete with decorative reveals.

The erection process was accelerated with the aid of Hoch Associate's on-staff engineers, who created the precast concrete engineering drawings as the design progressed, along with all shop drawings, plant tickets, and erection plans. "At bid time, we had all of the precast concrete drawings prepared so we could skip the traditional shop-drawing phase, which sped up construction even more," Meier says.

The building was tucked into a corner of the campus with woods surrounding it, but its location didn't restrict the erection, which proceeded with no problems and caused no disruptions to the campus, he notes. The building enclosure—precast concrete panels and hollow-core slab were erected in only two weeks.

The data center and the precast concrete panels, along with the electrical and mechanical systems, were designed to allow for a future expansion of the building. "The precast concrete walls would remain in place, but we designed the rebar layout so it can be cut out and additional panels added on." The preparations also required adding support to the traditional slab-on-grade foundations to accommodate additional dead load in the future. "When they're ready to expand, the precast concrete can be saw-cut and added onto seamlessly," Howdyshell says.

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LEED concepts were incorporated into the project, but it was not submitted for certification. Some of the sustainable design concepts used were a cool roof, enhanced commissioning to ensure mechanical and electrical systems were highly efficient, alternative-transportation accommodations, water-use reductions, enhanced indoor-air-quality construction methods, light-pollution controls, and water-reduced landscaping.

Precast concrete contributed to achieving sustainable goals by providing a highly efficient thermal enclosure, using local and recycled products, manufacturing its products nearby and helping to control construction waste.

The project provided an attractive building that fits into the campus aesthetic while providing a highly efficient and functional structure. "The team worked very well together to meet all of the challenges on a tight schedule and within our budget," says Howdyshell.

These projects show a versatility of precast concrete systems in meeting the challenges of industrial buildings of all types. Their special needs play to precast concrete's strengths, creating cost-effective, quickly constructed, durable, and aesthetically pleasing structures. **A**