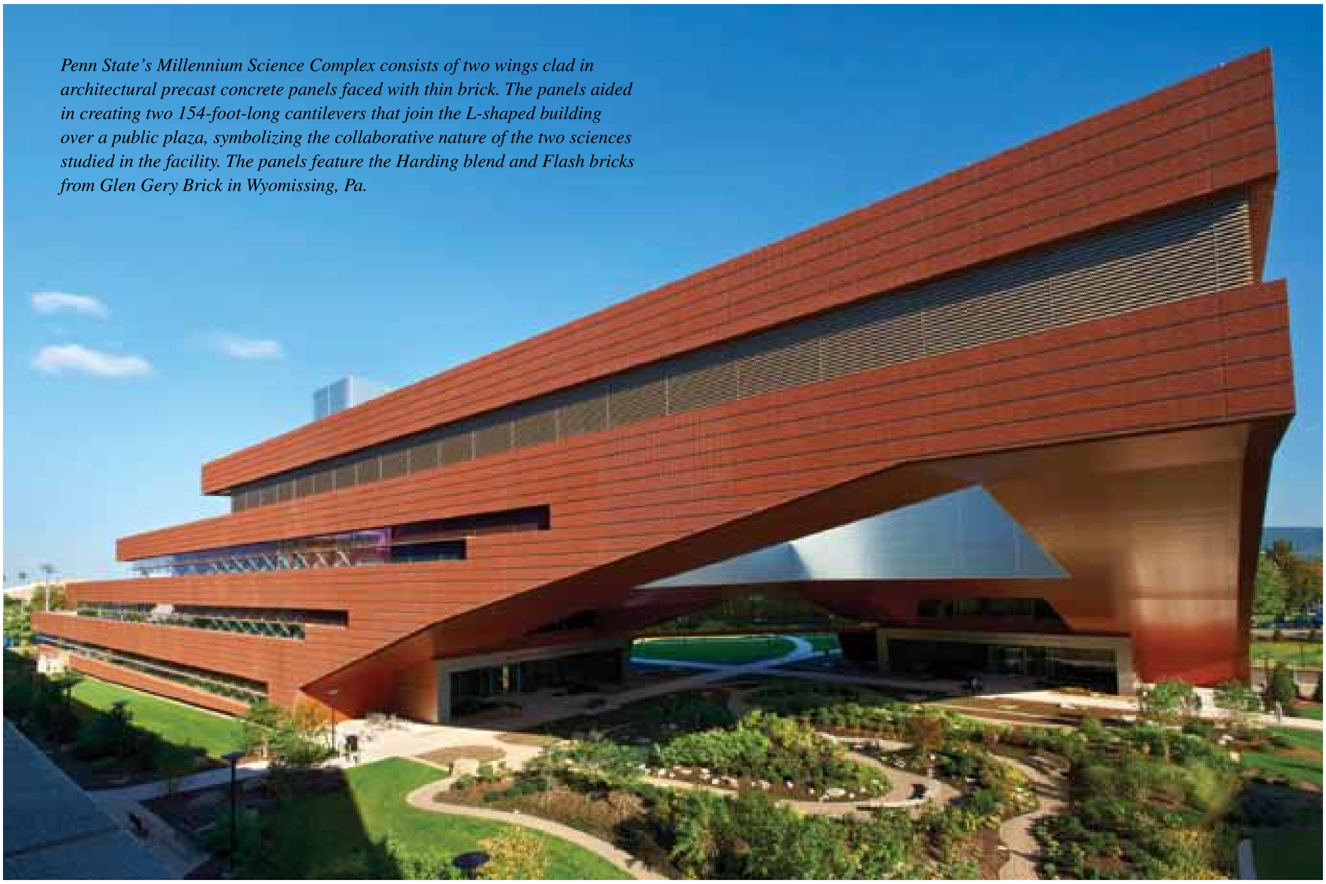
Precast and Innovation Combine To Meet Schools' Variety of Needs

Structural and architectural precast concrete components help colleges and universities meet the diversity of requirements of their users while ensuring a complementary look for the campus

— Craig A. Shutt

Universities operate as their own small cities, with diverse programmatic needs for their variety of users in a range of building types. These include classrooms, offices, residential units, parking structures, community-gathering facilities, recreational centers, theaters, stadiums, and even highly specialized laboratories. Meeting the requirements for these buildings—some of which may combine two or more functions—creates challenges. Their design and construction can become even more daunting when the new buildings must fit seamlessly into an existing campus aesthetic, be constructed without disrupting activities around them, and be ready for the new semester when students arrive back at school.

Many administrators, designers, and contractors are finding that precast concrete components can help them achieve their goals in a cost-efficient way. Total precast concrete structural solutions offer a variety of benefits in speed of construction, quality control, elimination of site congestion, sound and vibration control, fire resistance, and other areas. Architectural precast concrete panels offer many of these benefits, as well



Penn State's Millennium Science Complex consists of two wings clad in architectural precast concrete panels faced with thin brick. The panels aided in creating two 154-foot-long cantilevers that join the L-shaped building over a public plaza, symbolizing the collaborative nature of the two sciences studied in the facility. The panels feature the Harding blend and Flash bricks from Glen Gery Brick in Wyomissing, Pa.

as the plasticity to blend with any existing aesthetic style, from historic to contemporary. Precast concrete also contributes to an energy efficient envelope system, which has become increasingly important, especially as sustainable design requirements continue to increase.

The material's use is growing as well because developers familiar with precast concrete's benefits from other projects are becoming involved in more higher education projects as states encourage public-private partnerships.

The following examples show some of the ways universities are taking advantage of precast concrete's many benefits to achieve multiple goals with a range of building types.

PSU Science Center – Cantilevers Join Science Departments

The Millennium Science Complex is located on the campus of Penn State University in University Park, Pa. It consists of two wings, one for the Huck Institute of the Life Sciences and one for the Material Research Institute, both containing specialized laboratories and research facilities. The multiple opportunities for the two sciences to collaborate on projects are epitomized by the two 154-foot-long cantilevers from each wing of the structure that join the L-shaped building over a public plaza. Enhancing this unique design is the use of precast concrete architectural panels embedded with brick on its facade.

"The goal was to create a facility that would provide an individual identity for both laboratory sciences while creating opportunities for collaboration by housing them in the same building," explains David Rolland, project director at RV Architects. "The architectural solution with the monumental conjoined cantilevers from each wing reinforces the promise of that collaboration."

Although the two wings have unique and separate programs, the building provides an opportunity to foster collaboration between these scientific endeavors. The programs were joined with a cantilevered connection, and the design team conferred with structural engineers about how the concept could successfully

PROJECT SPOTLIGHT

Penn State Millennium Science Center

Location: *University Park, Pa.*

Project Type: *Life sciences and Material sciences laboratories*

Size: *292,100 square feet*

Designer: *RV Architects, New York*

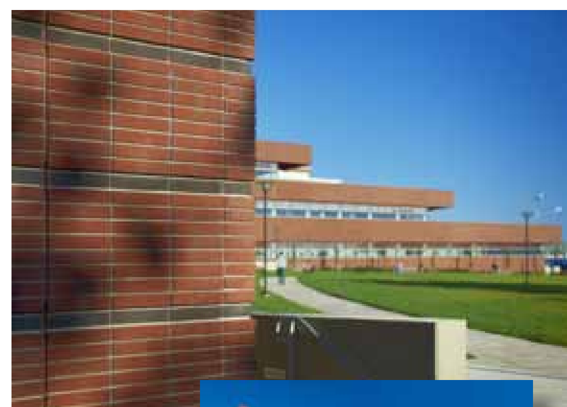
Owner: *Pennsylvania State University*

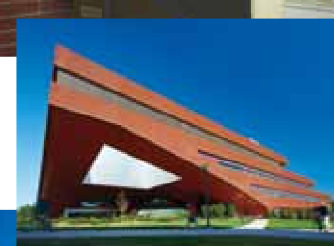
Structural Engineer: *Thornton Tomasetti Engineers, Newark, N.J.*

Construction Manager: *The Whiting-Turner Contracting Co., Allentown, Pa.*

PCI-Certified Precaster: *High Concrete Group LLC, Denver, Pa.*

Precast Components: *345 architectural spandrel panels embedded with brick.*





Photos courtesy of Nathan Cox

balance aesthetic, structural, and functional needs. The cantilever forms an open-air courtyard below and projects away from two roads that the wings front, stepping back until the upper level extends outward to join the other wing.

The cantilever was formed using steel trusses with precast concrete cladding panels that contained an embedded brick veneer. The panels are 22 feet long and vary in height from 8 to 12 feet. They not only provided the aesthetically pleasing and complementary look that was desired for the overall building but helped dampen the cantilever's potential vibrations by providing mass at the perimeter. High Concrete Group LLC provided the precast concrete components.

'The architectural solution with the monumental conjoined cantilevers from each wing reinforces the promise of collaboration.'

Precast Concrete Aids Dampening

"The mass of the concrete helps dampen the structure-borne vibration, which is critical for the building's specialized laboratories," Rowland explains. These spaces include clean rooms, electron-microscope labs, and vivariums where experiments could be affected by minute vibrations. Specialists studied the potential for vibration caused by the HVAC equipment located on the fourth level of the cantilever and determined that the concrete mass on the exterior precast panels would assist the steel frame and concrete shear to control the transmission of low-frequency vibration.

The bricks were selected to complement the "Penn State brick," used throughout the campus to create a coherent palette that can dominate the other brick colors that had been used over the years. The facades of the Millennium Science Complex consist of a mixture of deep reddish bricks with intermittent "flash" bricks distinguished by a charcoal-burnt hue resulting from a longer firing process. The design team segregated these bricks within the panels while retaining similar proportions for the bricks of mixed shades used elsewhere on campus.

The flash brick was used in a reveal pattern spaced every two feet up the height of the building, which emphasized the façade's scale and strengthened the horizontal lines of the building form as it steps up through four levels, Rolland explains. The stepping away of the building from the adjacent streets established a human scale with the streetscape and allowed five green-terraces to be built at various levels, keeping the sensitive laboratories furthest from the ground vibration caused by vehicular traffic.

The architect chose to use an approximately one-inch thick, thin-brick due to its preferred surface quality, which better reflected the local rusticated masonry of traditional structures. Rolland says, "The advantages offered by the precast concrete panelized construction were especially helpful in creating the cantilever. Many large pieces could be erected in a single day with a higher level of quality control, as opposed to trying to lay brick in a traditional method with scaffolding." This was particularly important due to the stack-bond pattern of Norman-style bricks, which accentuate the close tolerances at both the vertical and horizontal joints

"We made a number of trips to the precaster's plant to discuss the approaches to quality control," Rolland says. "High Concrete put a huge effort into ensuring the panels were tight on the tolerances, precise on the alignment, and cleaned of mortar slip."

The process required submission and revision of multiple small samples, the creation of a full-scale mock-up, and multiple factory reviews of panels before they were shipped to the project site, he says. "The contractor was challenged to produce a product that met our expectations. Through this process, he produced a product that we are all proud to have installed on this important research facility."

Precast Creates Window Depth

The precast concrete design also helped create a feeling of depth within the exterior enclosure by the use of C-shaped panels with returns around windows allowing the continuous horizontal glazing on each level to be recessed, with the precast panels serving as the spandrel and providing shading for the glazing. "The profile of the façade is a key reason we specified precast concrete panels for this application, as we could not have achieved that effect through traditional masonry construction."

Between each two levels of precast concrete panels, two lites of glass were split horizontally by an exterior shading device that controls solar heat gain and glare while adding an aesthetic feature. The lower vision lite wraps around the entire building, providing views to the exterior, while the upper lite is fritted and improves daylighting. A system of metal panels and storefront glazing encloses the building around the landscaped exterior courtyard.

The brick-faced panels consist of 6 inches of concrete supporting the brick, backed with 4 inches of rigid insulation and a vapor barrier. In total, 345 precast panels were fabricated, trucked to the site, and erected from a staging area near the building.

Construction was completed in two phases, with foundations and other site prep completed while precast concrete components were cast. Then the steel framework was erected and the precast panels were attached.

The most challenging portion of the work was erecting and linking the cantilevered wings at their apex. Cranes had to be placed on either side of the wings, with panels hung on the facades at the same rate so the trusses could deflect together simultaneously. In-place adjustment of the panels was considered and designed by the precast concrete contractor to allow tolerances to be met through the fine-tuning of panel alignment as the cantilever deflected.

The precast concrete panels contributed to the project's sustainable goals by enhancing energy efficiency with their thermal mass, being composed partially of recycled materials, and producing the materials within the region. Another key element in the complex's sustainability efforts is the use of extensive green roofs on both building wings. They serve as a storm-water control system, reduce energy loads due to their insulation value, extend the life of the roof, and filter pollutants and greenhouse gases. The project has applied for LEED Certification.

In addition, more than 90% of construction waste was diverted from disposal at a landfill and at least 10% of materials used in construction were from recycled content, including the precast concrete. Sustainably harvested wood was used, and 10% of the materials were regionally sourced, again including the precast concrete components.

University of New Mexico Parking – Offsets its Energy Use

As the University of New Mexico in Albuquerque has grown, surface parking lots have been sacrificed to allow new buildings to meet the variety of on-campus needs. As a result, the reduction in campus parking spaces was creating a major shortfall, requiring a quick solution. The Yale Parking Structure was recently constructed to add 797 spaces in a six-level design that was completed rapidly using a total precast concrete structural solution.

The 288,000-square-foot structure is located on the corner of a busy intersection of the campus and was designed with ease of access in mind for vehicles, pedestrians, and bicycles, explains Jarrod Cline, project architect at Dekker Perich Sabatini Architects.

The site created construction challenges, as would be expected on a campus requiring more parking to alleviate congestion. The site is surrounded by existing buildings on three sides, including two listed on the National Register of Historic Places. As a result, the design had to minimize impact on these structures while also paying homage to their traditional appearance. Construction was further complicated by a fall in topography of approximately 22 feet from one side of the site to the other and the school's desire to have the project ready to open for the new semester, which created a tight time frame.

The precast concrete structural system consists of double tees, load- and nonload-bearing spandrels, "lite" walls (shear walls with punched openings), beams, columns, stairs and landings, stair-wall panels, and grade beams. The system was selected for several reasons, Cline says. These included its ease of constructability and the high level of quality that could be provided. The capability for off-site fabrication aided this, both by control-

The new Yale Parking Structure on the University of New Mexico's campus lies adjacent to several buildings on the National Register of Historic Places, requiring the parking facility pay homage to that aesthetic while providing desperately needed parking space. A total precast concrete structural system helped it meet all of its aesthetic, functional, construction, and budget goals.

Photos courtesy of Dekker Perich Sabatini Architects

PROJECT SPOTLIGHT

University of New Mexico Yale Parking Structure

Location: *Albuquerque, N.M.*

Project Type: *Parking structure*

Size: *287,000 square feet*

Cost: *$13 million*

Designer/Engineer: *Dekker Perich Sabatini Architects, Albuquerque, N.M.*

Owner: *University of New Mexico, Albuquerque, N.M.*

Contractor: *McCarthy Building Companies, Tempe, Ariz.*

PCI-Certified Precaster: *Coreslab Structures (Albuquerque), Albuquerque, N.M.*

Precast Specialty Engineer: *Salmons P.C., Albuquerque, N.M.*

Erector: *Gibbons Erectors, Englewood, Colo.*

Precast Components: *Double tees, load- and nonload-bearing spandrels, lite walls, beams, columns, stairs and landings, stair-wall panels, and grade beams.*

ling the casting process and by minimizing congestion on the site during construction. Coreslab Structures (Albuquerque) Inc. supplied the precast concrete components.

The design features long-span construction, with a framing system of pre-topped double tees spanning 64 feet to beams, columns, and litewalls. "This design allowed parking spaces on each side of a center driving aisle, helping patrons feel more secure in the long-span areas because they're so open and well lit," he explains.

The structure's exterior was designed to fit into and respond to its surrounding context. "The predominant finish material in the area is tan-plaster stucco," Cline explains. To blend with context, the precast spandrel panels were designed with a tan integral color and a light sandblasted texture.

To highlight the pedestrian access points and frame the structure, corner stair towers were coated with a semi-transparent soy-based stain that was applied to the precast concrete panels once they were erected. "The reddish-orange color of the stair towers adds a new way-finding device on the campus and gives some life to the building," he notes. "It creates a dramatic contrast while also complementing the medical campus across the street."

To break up the horizontal nature of the parking structure between stair towers, vertical stainless-steel mesh panels were hung from the structure's face. "The mesh panels create the appearance of small, rectangular openings in the façade between them, breaking up the long, horizontal openings, helping it respond better to the adjacent buildings," Cline explains. At night, the lighting makes the mesh more transparent, bringing more visibility into the structure and creating a safer environment. The mesh panels were attached to the spandrel panels with a tension system, using brackets at each level to secure the mesh to the panel face.

The structure's east side deviates from the other three due to the adjacent chilled-water plant that discharges mist. To eliminate the concern of mist falling on cars, a wall with an oversized polycarbonate louver was installed. The louver also allows fresh air to move freely though the structure as well. A car fire that erupted shortly after the structure was completed gave an unintended test of the system, which dispersed the smoke smoothly.

Erection was complicated by a curfew placed on the precast deliveries by the city to avoid conflicts with rush-hour traffic, requiring all components to be delivered in early morning or mid-day. Foundations were poured in a scheduled order to allow the crane and delivery trucks to maneuver around the jobsite without interference.

> Precast concrete was selected for its ease of constructability and its high level of quality.

The components were delivered to the site in a specific order using just-in-time delivery to alleviate congestion. They were erected quickly, using a hydraulic crawler crane, which had limited maneuverability on the site. Close communication among contractor, precast plant, and erector ensured the fast-track schedule was met.

The construction process also was aided by the use of precast concrete stairs throughout the project, Cline notes. They were cast and erected as every level was built, speeding installation and allowing them to be used throughout the remainder of construction. The stairs were cantilevered in some areas, creating a "clean and modern look" that fit with the overall design statement, he says.

Incorporated into the design of the upper level of the structure is a steel canopy that not only provides shade but supports a 180-KW photovoltaic system consisting of 820 modules purchased from a local supplier. The installation offsets the energy demand load of the parking structure. The canopy's saw-tooth design allows for maximum solar orientation, while the clear span provided over the parking bays minimizes vehicle obstructions.

"The installation is very visual and provides an obvious indication of the commitment UNM is making to sustainability within their projects," Cline says. The array was provided as an additive alternate, and it was approved once it became apparent that the project was going to come in under budget (by about $800,000 under the construction estimate).

The structure's master plan also provided accommodations for growth, taking into account future development to the north with an academic/commercial building liner, and to the south, where provisions were made for expanding academic functions by replacing current low-density buildings.

LSU Basketball Arena – Precast that Cleans Itself

Designers for an addition onto the existing basketball practice facility at Louisiana State University in Baton Rouge faced a key challenge: The existing arena was a distinctive elliptical structure with no natural locations to create an addition without disrupting the building's flow. The design and construction also had to be completed in only 18 months to ensure it was ready for practices before the new season. To accomplish these goals, the designers used several precast concrete components, including architectural panels and stadium stair riser units.

"The real challenge was creating an addition to this iconic structure, which in no way lent itself to expansion," says Thomas Holden, principal at Holden Architects in Baton Rouge. The structure, built in the 1970s of cast-in-place concrete, features formidable architectural elements, especially protruding bent columns that extend to the roof to "grab" it as if it were a basketball. "We had to break that geometry with an addition that came off the rear of the building without breaking the symmetry."

To achieve this, the designers eliminated two massive pedestrian ramps and selected architectural precast concrete panels to clad the new rectangular facility, helping to convey the same mass and appearance as the original. "We use the same forms as the original design has to replicate that feel." Precast was chosen due to its cost efficiencies in casting the components, the speed with which it could be cast and erected to meet the schedule, and the aesthetics it could provide, he explains.

The rectangular addition features similar column bents that "grip" the roofline and uses the same coloring as the original building to blend with the structure. The 58,960-square-foot addition features two new practice courts for the men's and women's teams,

Photos courtesy of Holden Architects

Creating an addition to the iconic basketball practice facility at Louisiana State University was achieved by replacing large pedestrian ramps with a rectangular entrance in the same style as the existing facility. The addition was clad with architectural precast concrete panels and fronted by precast concrete stadium-stair components to create an efficient entry. The panels include TX Active, a self-cleaning photocatalytic titanium dioxide admixture from Essroc, to reduce long-term maintenance needs.

PROJECT SPOTLIGHT

Louisiana State University Basketball Practice Facility

Location: *Baton Rouge, La.*

Project Type: *Sports facility*

Size: *58,960 square feet*

Cost: *$15 million*

Designer: *Holden Architects, Baton Rouge, La.*

Owner: *LSU Athletic Department, Baton Rouge, La.*

Structural Engineer: *AST, Baton Rouge, La.*

Contractor: *Guy Hopkins Construction, Baton Rouge, La.*

PCI-Certified Precaster (stairs): *Gate Precast Co., Ashland City, Tenn.*

PCI-Certified Precaster (panels): *Gate Precast Co., Monroeville, Ala.*

Precast Specialty Engineer: *PTAC, Monroeville, Ala.*

Precast Components: *Architectural panels, column covers, and stairs.*

storage, restrooms, and a two-story entry lobby with display space for trophies. A grand staircase ascends to a multi-function/banquet room. Also included are locker rooms, viewing rooms, lounges, and meeting rooms.

Stairs Create Efficient Entry

The entry stairs feature precast concrete stadium-seating components, including raker beams and risers. "They required a fraction of the space occupied by the original ramps," Holden says. They also were quick to erect as the project was constructed.

The erection was complicated by the constricted site, due to the adjacent football stadium and the ongoing campus activities. The components were delivered on flat-bed trucks to a staging area on the other side of campus. They were then called to the site in sequential order, where the crane picked the pieces from the truck and erected them directly.

The precast concrete panels provided an additional benefit not available to the original. Due to the area's high level of humidity, north-facing walls often have mildew problems, creating black stains—and the original arena is no exception. To avoid that aesthetic problem and lower long-term maintenance needs, designers specified a self-cleaning photocatalytic titanium dioxide admixture, its first use on a university campus in the United States. The coating provides a bright-white color and, when exposed to UV rays, the titanium dioxide acts as a catalyst helping to break down organic compounds and allowing them to be easily washed from the surface by rain. This also helps prevent mildew from forming.

PROJECT SPOTLIGHT

Central Piedmont Community College Student Parking Structure

Location: *Charlotte, N.C.*

Project Type: *Parking structure (with office space)*

Size: *326,527 square feet*

Cost: *$16.2 million*

Designer: *Neighboring Concepts, Charlotte, N.C. in collaboration with ADW Architects, Charlotte, N.C.*

Structural Engineer: *Carl Walker Inc., Charlotte, N.C.*

Owner: *Central Piedmont Community College, Charlotte, N.C.*

Contractor: *Rodgers Builders, Charlotte, N.C.*

PCI-Certified Precaster: *Metromont USA, Charlotte, N.C.*

Precast Components: *Girders, double tees, inverted tee beams, columns, lite walls, shear walls, architectural spandrels, wall panels, flat slabs.*

Photos courtesy of Carl Walker Inc.

The new eight-level, 1,002-car parking structure at Central Piedmont Community College features a total-precast concrete structural solution. Two concrete pigments, one between bricks and one on larger portions, sometimes in the same panels, were used to achieve the appearance that the designers sought.

"The additive increased the cost of the precast panel fabrication, but university administrators readily accepted it because of the savings they will obtain in lower long-term maintenance costs," Holden explains. The building, completed in late 2010, has had no problems and is guaranteed by the admixture company against any mildew on its façade throughout its life.

The result is a facility that meets all of the programmatic needs while achieving the aesthetic goals. "We needed an upscale presentation with contemporary finishes that would endure and resist the impact of our adverse climate," he explains. In addition, the precast concrete approach cut more than 12 months from the estimated construction schedule for cast-in-place concrete and saved an estimated $500,000 in foundation costs.

Community College Parking – Blends in While Making a Statement

Located in the heart of Uptown Charlotte, N.C., Central Piedmont Community College was in dire need of additional student parking facilities. But to fit a new structure into a campus surrounded by an urban, historic environment required careful attention to aesthetics and construction approach.

To meet these needs, the new eight-level, 1,002-car facility features a total-precast concrete structural solution consisting of double tees, inverted tee beams, columns, shear walls, stairs, and architectural wall panels finished with embedded thin brick. Metromont USA in Charlotte., N.C., provided the precast concrete components.

Because of the relatively small area available, the structure was confined to two parking bays in width, says Joey Rowland, vice president at Carl Walker Inc. in Charlotte. "At two bays wide with 1000 spaces, the structure had to be eight tiers in height" he says. "The key challenge was to ensure the structure didn't 'read' as a tall project."

The parking structure had to make a strong, individual statement but also blend with its urban location.

At the same time, the project serves as a landmark for the campus, and its location adjacent to a Depression-era football stadium played a role in its design. "The parking structure serves as a 'bookend' for the college," explains Luis Tochiki, a partner at architectural firm Neighboring Concepts. "It had to make a strong, individual statement but also blends with its urban location and its brick and stone surroundings in the heart of the city."

Thin Brick Matches Nearby Campus Buildings

Most of the spandrels, typically eight inches thick and 6 feet 8 inches high, feature embedded thin brick that complements adjacent buildings in the area, says Tochiki. "We were fortunate to find a blend of colors and textures for our brick that matched the existing hand-laid bricks in other buildings."

The bricks are set into a form with a darker concrete mix securing them, simulating the look of mortar. In other portions of the panels, lighter colors were used and sandblasted, emulating a buff-colored limestone. "Combining the two mixes in one panel created a challenge for the precaster, but it was critical to use the darker mix between bricks," explains Rowland. "If there had been a buff-colored mix there, the contrast would have distorted the visual appearance of the bricks. But the precaster did it, and it looks very authentic."

In the buff-colored portions, various aggregates were combined in the appropriate proportions, and a light sandblasting was applied, to create the desired color and texture. "The coloring was a true collaboration from design through construction, and it worked perfectly," says Tochiki.

The structure is anchored by a tall stair tower on a key intersection that faces the campus. The tower is clad in brick-faced precast concrete panels and topped by a limestone-like bell-tower level. It features decorative Art Deco elements overlapping with the lower brick that reflect the adjacent stadium's design. Decorative limestone-colored accents frame openings that resemble windows, adding horizontal elements to the vertical columns of brick and disguising the intent of the structure.

The panels between columns were set back two feet four inches from the exterior face of the columns providing greater visual interest than a more typical eight-inch setback would have provided. Tochiki notes "The increased depth also helped break down the large scale of the building, allowing it to relate to the smaller structures around it."

Precast Offers Quality, Durability

Several factors contributed to the selection of the precast concrete structural system in addition to its ability to achieve the proper aesthetics. "Precast concrete has inherent quality and durability, due in part to the components being produced in a controlled environment," Rowland explains. "Durability is critical in every project we design, so we use every reasonable technique to ensure a durable and low-maintenance facility." To that end, the company specified an air entrained 0.40 water-cement ratio concrete, galvanized-steel connections, a penetrating sealer for the exposed top parking level and carbon fiber mesh added to the 3.5-inch flanges on the double tees instead of welded-wire fabric.

The pre-topped double tees are 60 feet long, with "lite" walls (shear walls with punched openings) spaced along the north-south length, which are 12 inches thick and 30 feet long, and along the east-west width 8 inches thick and 14 feet long. The structure rests on a 4-foot-thick reinforced-concrete mat foundation, which was used rather than driving piles, Rowland notes. The mat actually is shaped like a donut, with the center 20 feet of the structure not supported by the mat to eliminate some of the mass.

"It's unusual to use this approach, but the administration was concerned about potential impact to the historic stadium if piles were driven," Rowland says. "The benefit is that we don't have to worry about any settling." The mat foundation also provided a significant space in which to stage components, ensuring no other portions of the campus were disrupted during erection.

Two cranes were used to erect the components, which were completely set in place in about three months. The process was complicated by building the structure into a hill, due to a sloping site that has the first level of spaces underground at one end. "The erection process was flawless," Tochiki says.

The project features a variety of horticultural elements, including several planting beds, a rain garden, and a living green wall, which were designed in conjunction with the school's horticulture department, which will maintain them. The areas will serve as a hands-on learning tools for students while providing the neighborhood with greenery and an ever-changing amenity.

Turkey's SU-NAC – Precast Lattice Defines Structure

The use of precast concrete to make a statement for university facilities extends around the world, as can be seen in its use in the design of Sabanc University's Nanotechnology Research & Application Center (SU-NAC). The facility, in the high-seismic industrial Marmara region of the Western Anatolia part of the Turkish Republic, was constructed under the direction of the Turkish Council for Science & Technology and architecturally designed by Cannon Design.

The two-story structure features laboratories and classrooms fronted by an atrium space enclosed by a precast concrete structural façade. The façade was designed to represent the lattice structure of a nanotube, explains Dr. Özgür Bezgin, chief of research and development at Yapi Merkezi Prefabrication Inc., the local precaster that structurally designed, produced, and installed the precast concrete components. The 449-foot-long precast concrete structural lattice is positioned within a hypothetical oval plan surrounding the rectangular footprint of the building. The lattice consists of 53 modules, each 24 feet high and 20 inches thick, cast with high-strength, white concrete.

SU-NAC's structural façade was aligned along arcs that were defined by five radii, Bezgin explains. The lattice components both include thermal layers and house thermally insulated

Photos courtesy of Ozgur Bezgin

PROJECT SPOTLIGHT

Sabanci University Nanotechnology Research & Application Center (SU-NAC)

Location: *Marmara region, Turkish Republic*

Project Type: *Science center*

Designer: *Cannon Design, Boston, Mass.*

Owner: *Sabanci University, Istanbul, Turkiye*

Contractor: *Koray Insaat, Ankara, Turkiye*

Precaster: *Yapi Merkezi Prefabrication Inc., Istanbul, Turkiye*

Precast Components: *Lattice modules, each 24 feet high and 20 inches thick, cast with high-strength C60 grade white concrete.*

layered windows at mid-depth and function as a tilted light funnel to maximize daylight in the atrium.

"The precast lattice also forms an important part of the vertical face of the structure, so it had to simultaneously have its architectural, functional, and structural requirements considered," Bezgin says. Included in the architectural requirements was the need for the concrete mix to maximize reflectivity. White cement was chosen due to its lack of iron oxides, which make it twice as reflective as gray cement, which contain varying amounts of iron oxides, he explains. This switch eliminated the need to apply a reflective coating after installation.

The structural façade had to be transparent enough to allow the infusion of daylight and at the same time had to be strong and ductile enough to support the lateral and vertical loads of the heavy roof material, which consisted of cast-in-place concrete over corrugated metal decks supported by steel beams. "The façade had to be formed using the least amount of structural material to provide the highest amount of window area," Bezgin states. "But it also had to provide enough support for a heavy roof element and provide insulation for the atrium."

Only three types of precast concrete modules were designed to meet

The new Nanotechnology Research & Application Center at Sabanc University in Turkey features an innovative use of precast concrete as a structural lattice that symbolizes the work accomplished at the facility. The precast concrete lattice consists of 53 modules, each 24 feet high and 20 inches thick, with a layer of insulation sandwiched between two layers of concrete.

all of the needs of the various configurations of lattice. They comprise a 10-foot-wide piece (30 in all), a 5-foot-wide piece (20 in all) and a triangular piece with a maximum width of 15 feet (3 in all). These latter three pieces served as the bounding elements positioned at the ends of the façade.

The production sequence involved casting a layer of reinforced concrete, followed by the placement of a layer of XPS insulation precision-cut to match the concrete layer, then casting the second reinforced concrete layer. Prior to the placement of the second layer of concrete, deformed reinforcing bars were inserted through the insulation layer to provide shear connection between the two reinforced concrete layers. Composite fiber-reinforced plastic forms were used due to their versatility in forming curved shapes and ease of maintenance for the repeated production needs, which took three months.

Rods Connect Modules

The 10-foot triangular pieces each weighed about 7 metric tons apiece, while the 5-foot pieces weighed 3.5 metric tons, making them cumbersome to handle. Each prefabricated unit had four specially designed anchor points placed to ease handling. The modules were designed to withstand the imposed design loads individually, but they also were connected to each other through belt beams at the top and through rotation-permitting rods at the contacting elbows of neighboring elements.

"During construction, care was taken to provide as much mutual contact between neighboring units as possible to limit displacement," Bezgin notes. The prefabricated structural façade elements were lifted and placed into sockets cast into each module and grouted into place.

The radial beams that support the roof plate are supported by the façade at every 10 feet along the façade length, he adds. The roof plate that spans between the main structure and the façade over the atrium area has a variable span, creating different loads at differing points on the façade. Rather than producing each of the modules for a different load condition, the elements were grouped into four loading values along the roof slab.

The result is a dramatic sloped surface for the façade that create a lattice to infuse daylight during the day while allowing the spread of internal atrium lighting at night, increasing its visibility and eliminating the need for external façade lighting. The lattice design emphasizes its scientific statement both visually and through its use of a dramatic engineering concept.

"The prefabricated structural façade design and construction was an important challenge to be met," says Bezgin. "The project gave YMP the chance to provide a construction solution that met the architectural, functional, and structural requirements of the façade in a single step of construction. It also advanced structural-design and construction techniques. Initial architectural design called for separate vertical support elements for the roof, but this design managed to fit all the necessary structural requirements into the precast concrete lattice, creating a dramatic and imposing atrium space for SU-NAC."

These projects show some of the range of buildings in which precast concrete components are being used to help meet the needs of universities, community colleges, and even institutions overseas. They also highlight some of the innovative technologies and designs that can be used in today's structures to meet sustainable and project goals. The uses of precast concrete are diverse, but they all help achieve the same goals of creating innovative, functional, aesthetically pleasing, and cost effective structures for higher education. ■

For more information on these or other projects, visit www.pci.org/ascent.