Precast – The Perfect Fit for Design-Build Projects

Virtually any type of design-build project can benefit from the capabilities and efficiencies provided by precast concrete components and systems

— Craig A. Shutt

The popularity of design-build projects continues to grow, with many owners, designers, and contractors seeing the benefits in reduced costs and greater speed, constructability, and efficient problem-solving. Precast concrete enhances these benefits through its own inherent capabilities and attributes, as well as the ability of precasters to engineer the material to meet the specific needs of the project.

Precast concrete works especially well with projects where the structural frame is a dominant element in the design. This includes a variety of multi-use projects, where column spacing and the combination of multiple functions adds challenges; and parking structures, where the structural frame provides a large portion of the overall cost and time of construction. Likewise, government and high-security projects benefit from precast concrete's inherent mass and capabilities for meeting Anti-Terrorism/Force Protection (AT/FP) requirements.

Many other types of design-build projects also can benefit from using precast concrete, including offices, retail, residential, higher-education, and other institutional buildings. Fabricating precast concrete components offsite while site-preparation work is underway helps speed the project's construction, and the aesthetic versatility of architectural precast concrete panels offers a wide range of appearance options from matching a historic neighborhood to standing out with a bold, contemporary look.

The following projects give an overview of some of the ways design-build teams are using precast concrete as structural and architectural systems to meet a variety of challenges.

Twin Retail Buildings

In today's market, developers need to keep tight budgets to ensure the success of any type of project, especially small retail buildings. When Six-Mile Investments in Mount Pleasant, S.C., decided to develop two small plots across the street from each other, the firm needed a plan that would attract tenants and customers while also providing a sturdy and attractive design on a cost-effective budget.

To achieve those goals, the developer hired Southern Construction Services in Mount Pleasant as the construction manager on the design-build team. LS3P Associates in Charleston, S.C., served as the design architect, while ADC Engineering in Charleston served as structural engineer.

"These buildings were being developed at a time when business in the area, as throughout the country, was depressed, so going ahead with any project was risky," explains Gary Long, owner of Southern Construction. "We had to ensure the project remained cost-effective while providing an attractive appearance and effective building for retailers to want to set up shop."

The two buildings, one 10,000 square feet and the other 11,000 square feet, feature a precast concrete structural system consisting of load-bearing architectural precast concrete walls and double tees for the roof structure. Thin brick was cast integrally into some of the panels, providing a contrast with the textured stucco paint used on other portions across the street. Metromont Corporation in Greenville, S.C., worked with the design team to create the precast concrete components.

In determining the most cost-effective design, the contractors considered "every type of system we could think of—stud infill, steel, tilt-up, and others," he says. "We ran all of the numbers, and the owner was still looking for a better alternative. He suggested precast concrete, so we estimated it." The team initially had not priced out precast concrete, he says, because they assumed it would be more expensive than the tilt-up concrete panels. They were surprised to learn that was not the case.

'A hurricane won't take out this building.'

"The price was just about the same, and since precast concrete provides better quality control, that made a great combination. It turned out to be the best choice." Twelve storefronts, six per building, were created for the two structures. With the contractor driving the project, the precast concrete simplified designs and construction by providing a single-source manufacturer for the entire building shell, reducing the number of subcontractors to manage and the associated liability.

The precast concrete components also enhanced the design inside and

Photos courtesy of Metromont

A total-precast concrete structural solution of double tees and load-bearing architectural panels provided the building shell for these two retail buildings across the street from each other in Mount Pleasant, S.C.

PROJECT SPOTLIGHT

Six-Mike Development Retail

Location: *Mount Pleasant, S.C.*

Project Type: *Two retail buildings*

Size: *21,000 square feet (10,000 and 11,000)*

Designer: *LS3P Associates Ltd., Charleston, S.C.*

Owner: *Six Mile Investments Inc., Mount Pleasant, S.C.*

Structural Engineer:

Construction Manager: *Southern Construction Services, Mount Pleasant, S.C.*

PCI-Certified Precaster: *Metromont Corp.*

Precast Components: *Double tees, load-bearing architectural panels.*

The double-tee roof design created column-free areas that made it easy for retailers to lay out their spaces.

out, he notes, as the inlaid thin brick provided architectural details and a traditional look that suited the neighborhood and the owner's marketing plan. A quirk miter joint was used at corners with the brick facing to eliminate corner joints and reduce costs. Inside, the double-tee beams provided 60-foot clear spans. "That makes it really simple for retailers to lay out their store," he says. "There are no structural columns, so any layout will work, and they can change it easily." Chord connections were cast into the double tees, eliminating the need for a structural topping. Roofing material was applied directly to the double tees.

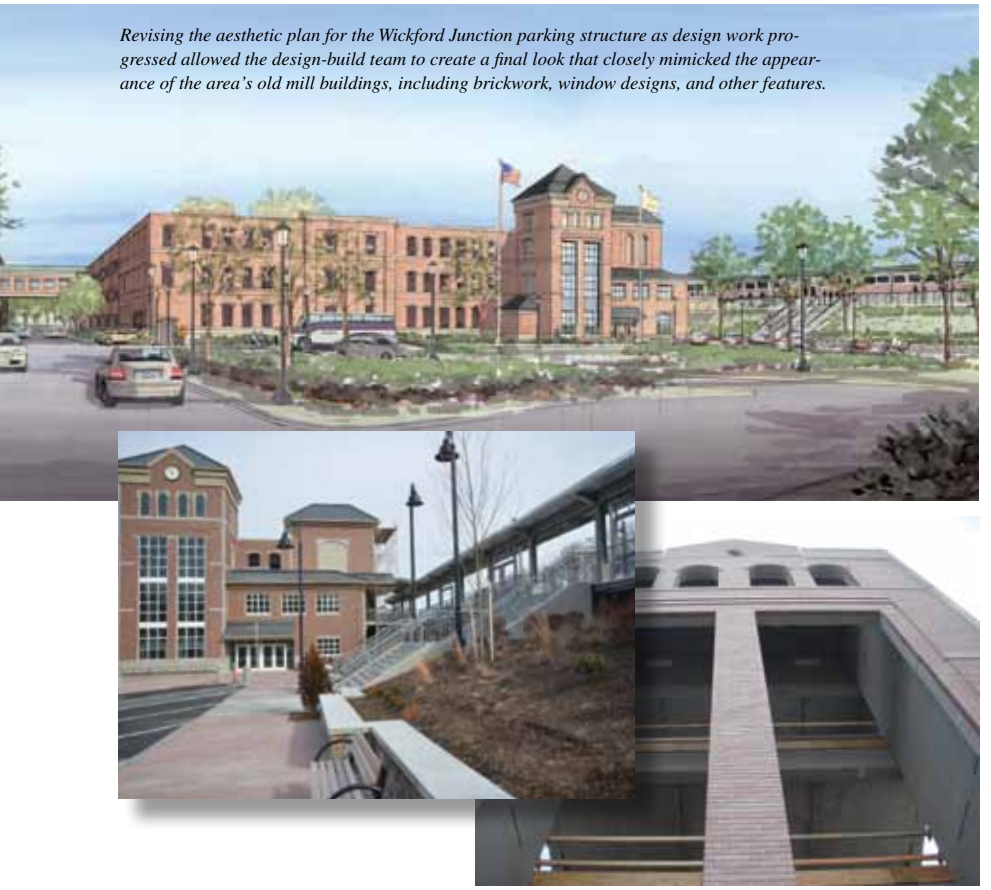
The precast design also sped up construction, he notes. "You spend more time upfront on shop drawings, but time on the site is reduced substantially." Part of the drawing time ran concurrent with foundation planning and surveying. "We wanted to ensure that the weld plates in the footings were precise so when the precast concrete arrived, everything matched perfectly." That meant a shorter construction timetable with fewer disruptions to traffic and other businesses.

With sufficient access around the site, the two buildings were erected quickly, with the smaller one taking only five days and the larger one requiring six days. Some units painted the backside of the precast concrete walls and used them as the finished interior surface, while some tenants did their own finishes such as furring out and drywalling. Some also kept the double-tee stems exposed, painting them to create a distinctive interior look.

Precast concrete's inherent resiliency also helped meet the high seismic needs of the area as well as helping provide wind and impact protection against hurricanes, which sometimes hit the South Carolina coast. "The precast system is so strong that no additional requirements were needed to ensure it could resist the seismic and wind needs," he says. Hurricane-resistant impact glass was used in the storefronts to ensure the buildings could withstand 140-mph winds. "A hurricane won't take out this building."

As a final touch, LS3P architect Brian T. Wurst designed distinctively different aluminum canopies to shade each entry, providing an additional bit of personality to each store and highlighting their entrances. They were secured to the precast panels without a problem.

The result was a quickly erected building that was ready to rent rapidly, and a design that attracted businesspeople. The stores are 100% leased. "Tenants really like the stores, because they have a sense of permanence and durability to them," he says. "Having no structural columns inside is a definite plus."



Revising the aesthetic plan for the Wickford Junction parking structure as design work progressed allowed the design-build team to create a final look that closely mimicked the appearance of the area's old mill buildings, including brickwork, window designs, and other features.

PROJECT SPOTLIGHT

Wickford Junction Parking Structure

Location: *North Kingstown, R.I.*

Project Type: *Parking structure*

Size: *250,896 square feet*

Designer: *Walker Parking Consultants, Boston, Mass.*

Owner: *Rhode Island Department of Transportation, Providence, R.I.*

Erector: *Gibbons Erectors, Englewood, Colo.*

Structural Engineer: *BVH Integrated Services, Bloomfield, Conn.*

Contractor: *Manafort Brothers Inc., Plainville, Conn.*

PCI-Certified Precaster: *Blakeslee Prestress Inc., Branford, Conn.*

Precast Components: *Double tees, girders, columns, shear walls, wall columns, spandrels, stairs, solid slabs, and wall panels.*

Photos courtesy of Walker Parking Consultants

'Making the changes required a complete understanding of the capabilities of the total-precast concrete system and the aesthetics it could provide.'

Wickford Junction Station

Parking structures require special attention today as communities are more concerned than ever that these facilities blend with their surroundings and do not draw attention to their often massive size. This was exactly the problem facing the designers of a large parking structure in an historic Northeastern community. After a design-build team value-engineered the owner's original design concept for a 1,101-car parking structure in North Kingstown, R.I., the aesthetic goals for the Wickford Junction facility not only blended well into the adjacent architectural fabric but they also invoked the community's past.

The 330,000-square-foot, three-story parking structure and commuter-rail station was developed with a combination of private-development and public funds to provide parking space in conjunction with a commuter railroad station. The town is well known for its Colonial textile-mill buildings, and the owner wanted to invoke some of that context to help the structure blend in.

"The owner's intended design called for a precast concrete structure, and a general plan and exterior elevations had been prepared," says Gary Glines, project manager for Walker Parking Consultants in Boston, Mass. "We worked with BVH Integrated Services and Blakeslee Prestress to refine the design to make it more efficient for precast concrete components, but we didn't change the basic plan diagram. We tried to optimize the use of the floor area and to creatively fit the required number of cars into the smallest space that could be constructed."

The precaster proposed using 12'6" wide double tees for the 525-foot-long structure, along with columns, beams, shear walls and K-

frames, spandrels, stairs, solid slabs, and wall panels. "They created an efficient design that minimized the number of precast pieces, while we adjusted the pattern of vehicular flow and geometrics for functional efficiency," Glines says.

The owner asked for plans for the original design, as well as suggestions for alternative technical concepts explaining how the team could change the plan to make it more cost effective, using fabrication tips, structural efficiencies, and other enhancements. Although the schedule was tight to simply complete the project as designed, Walker's team proposed an alternative technical concept for the exterior appearance, proposing that precast concrete panels embedded with thin brick could provide a more historically appropriate solution than the developer had suggested.

'The process was very proficient and well coordinated.'

To consider this option fully, they studied existing mill buildings in the area as precedent for a new design proposal. The new design, which was accepted by the owner, uses key elements of those historic mill buildings, such as overall massing, the color and style of the brickwork and other materials, window proportions, and articulation of the building elements.

The use of a design-build team allowed the aesthetic touches to be revised without conflicting with the fast-track schedule, Glines notes. "Making the changes required a complete understanding of the capabilities of the precast concrete system and the aesthetics it could provide," he says. The team created a look with embedded thin brick, but it also provided corner details and setbacks to provide shadows and relief.

"A lot of buildings with thin brick can look very flat if you don't take care to understand the nature of the materials and what can be done with them," he explains. At the corners, for instance, the team eliminated the bricks and used exterior precast concrete perimeter columns that simulate limestone. This modification kept the panel widths consistent, expedited production, and avoided corner joints.

Thin brick corner units were used for returns in some areas, such as at recesses, expansion joints, and windows to give the brick a three-dimensional look, Glines notes. In some areas, the design also incorporates soldier-course accents of brick, which are laid vertically to add visual interest. These soldier courses are set back one-inch from each other to emphasize their design.

At the base of the building at grade, a light gray concrete mix with black flecks was used to mimic the look of granite from the area. "Our goal throughout all aspects of the design was to recreate the look of a traditional mill building," he says.

The window opening pattern and rhythm helped the design to meet that goal. "To replicate the tall, narrow windows of traditional mill buildings required some sleight of hand, as the building code requires a vehicular bumper wall and guard rail up to 42 inches above the floor," Glines explains.

The window openings begin at that height and extend to the underside of the double-tee flanges of the floor above. The window openings are placed between the double-tee stems that are located six feet on-center. Placement of these window openings was worked out carefully to avoid having to make any cuts in the thin brick that is cast into the panels.

Flat arches were added at the tops of the window openings using stone-like precast concrete accents. Horizontal bands were added at each level to hide the horizontal panel to panel joints, while vertical joints are often set back into corners and out of sight. "It all went together extremely well, and much of that resulted from our team's knowledge of what the system can do and what could be created using it."

Part of that success resulted from using three-dimensional modeling software to review panel designs and connection details for the large structure. This allowed the precaster to design more efficiently and provide more helpful visual aids when discussing challenges with the architect as the design progressed.

Blakeslee's team used its knowledge and experience of precast concrete in combination with this emerging technology to offer immediate feedback during design development, including cost controls, while maintaining schedule demands. The three-dimensional model was then used to create plans and details for the fabrication and erection of the precast. The highly detailed model and shop drawings accounted for the size, location, and orientation of every brick in the structure.

Erecting the structure also proved challenging, as the adjacent rail line remained operational throughout construction, including high-speed rail service. "The process was very proficient and well coordinated." Blakeslee manufactured 687 pieces and about 20 pieces were erected per day. Most required little or no additional finishing, thus, no additional trades onsite, which saved both time and money.

Even with the change in design, the Wickford Junction parking structure opened on time this April, alleviating the tight supply and encouraging more people to use the train. To prepare for continuing demand for public transportation, the building was designed with a stronger lateral-load system so that two 80,000-square-foot levels could be added on top of the building to serve more commuters.

Mountain View Medical Center

A panelized façade design of precast concrete and glass-fiber reinforced concrete (GFRC) walls facilitated the delivery of panels on a just-in-time basis for expedited erection, at the Mountain View Medical Center in Mountain View, Calif.

The state-of-the-art, 250,000-square-foot medical office building is owned by the Camino Medical Group of the Palo Alto Medical Foundation, an affiliate of the Sutter Health Systems. The three-story center includes more than 13 physicians' offices, 260 exam rooms, 34 treatment rooms, a 20,000-square-foot outpatient surgery center, 30,000-square-foot laboratory and diagnostic radiology center, infusion-services department,

'We created performance metrics that made the design and building teams accountable to each other.

Using GFRC panels on this medical office building lessened the panels' weight sufficiently that a crane could erect them from only one location, helping retain the heritage trees on the site that were used as a healing garden.

PROJECT SPOTLIGHT

CMG Mountain View Campus Medical Facility for Palo Alto Medical Foundation

Location: *Mountain View, Calif.*

Project Type: *Medical office building*

Size: *250,599 square feet*

Cost: *$101.5 million*

Designer: *Hawley Peterson & Snyder Architects, Mountain View, Calif.*

Owner: *Alto Medical Foundation/Camino Division, Mountain View, Calif.*

Structural Engineer: *KPFF, San Francisco, Calif.*

Contractor: *DPR Construction Inc., Redwood City, Calif.*

PCI-Certified Precaster: *Walters & Wolf Precast, Fremont, Calif.*

Precast Components: *Glass-fiber reinforced concrete (GFRC) panels and architectural precast concrete panels.*

Photos courtesy of Hawley Peterson & Snyder Architects

6,000-square-foot urgent-care center, and a pharmacy. The structure was built with a steel framing system as the support for GFRC panels, many with a two-color integral brick appearance.

The project was designed using integrated-project delivery (IPD), highlighted by virtual-model collaboration and information sharing across the design-construction team which was centered at the jobsite, explains George Hurley, senior project manager on the project and now project executive at DPR Construction in Redwood City, Calif.

"We didn't have a contract that specified IPD, because one was not yet fully developed, but we created performance metrics that made the design and building teams accountable to each other," he says. Those parameters included maintaining the contract price while looking for innovations that would lessen cost and provide efficiencies. "We are seeing more of that type of approach now, because it improves project quality, reduces costs, and promotes faster construction. But at the time a few years ago, it was fairly unusual."

"It was a very fast-track project, which lends itself to this type of delivery system," explains Scott Sass, project manager on the center and now project executive with DPR. "It was very helpful in allowing us to keep the schedule and maintain our commitments on the project."

One of those commitments was a promise to the city to respect the site, which includes a grove of heritage trees. To achieve this, the building was organized along and around the trees, providing a verdant courtyard that serves as a "healing garden" for the medical center's patients.

"We created the design to work around the canopy of trees and produced a workaround to ensure the park area wasn't disturbed," Hurley says. "The goal was to retain the older trees, which also worked very well with the functional needs of the building."

"This created challenges," Sass agrees. "It produced a pinch point at the center of the project that complicated delivery of materials and erection, but it produced an incredible design component." Especially with a major state highway adjacent to the building, the trees help absorb sound and provide a bit of solitude for patients and employees where one otherwise would not exist.

Retaining the grove of trees created a pinch point at the center of the project.

The connection between the building and this natural site was heightened by the use of brick-like GFRC and a muted, but vibrant color palette that included four colors within the panels. The brick-textured appearance of the GFRC panels was created by laying out a pattern of bricks at the precaster's plant and producing a rubber mold from that pattern, which was then used to cast the panels. Walters & Wolf Precast in Fremont, Calif., developed the plan and provided the GFRC panels.

The panels' authenticity was enhanced by a two-color procedure, in which the brick-red color was cast into the brick modules, like the cups in an egg carton, after which a darker gray color was sprayed on to coat the spaces between the bricks. This created a darker 'mortar' color that simulated the coloration of real brick and mortar. Spandrels with reddish accents were used in other locations to provide contrast, and the three textures—brick, plus light and medium sandblast finishes—added dimension.

Walters & Wolf Precast provided another benefit to the panels by having its glazing division create and install the windows in the panels before they were shipped to the site. Designers devised the panel geometry to ensure the windows could be installed easily into each panel, which was then delivered to the site and picked from the truck for just-in-time delivery. With the windows already installed, the building's shell was virtually complete once the panels were in place. This approach saved about three months in the schedule.

Because of the tight site and the constraint of the highway along one side of the building, all of the panels had to be erected over the building from one crane position on the other side of the building. This necessitated the use of GFRC panels rather than precast concrete panels, as the brick-embedded precast concrete panels would have been too heavy to lift over the building. A 600-ton all-terrain crane was used to erect the GFRC panels, which took only six weeks.

"The fast-track nature of the project led to the GFRC skin being designed at the same time the steel frame was being designed, so there had to be tight tolerances to ensure everything worked," says Sass. "Walters & Wolf Precast was nipping at the heels of the frame design, which is what we needed to keep to our schedule. Early, coordinated involvement by everyone was critical to ensuring this worked."

The east- and west-facing wing walls feature GFRC panels, including some radiused panels, while the pavilion is enclosed with glass in paint-finish aluminum framing and capped by a butterfly roof section raised above the third floor with a cylinder of clerestory windows. It is supported on four monumental GFRC-clad columns. GFRC spandrels interrupt the glass walls at the floor lines as well as forming the perimeter of third-floor balconies on both the north and south sides. Precast concrete sunshades on aluminum frames were designed for the third-floor windows.

The city had final approval on the style and coloring of the panels, and the precaster provided a number of full-size mockups to show the review committee what would be used. "They did a great job of providing just what the committee needed to see to ensure they were satisfied with the final look," Hurley says. "There were many different panel types and colors, and all had to be approved for color, texture, and style."

An adjacent 1,100-space parking structure was clad with architectural precast concrete panels to provide a complementary look to the medical center. The parking structure was constructed concurrently with the medical center, adding additional site congestion and greater coordination.

"The site complications created huge logistics issues that had to be resolved," says Sass. Ultimately, an aisle way was left out of the front of the parking structure, where the crane was positioned, so the contractor could erect the panels on all four elevations of the frame. Then he worked out of another aisle way left out of the center of the parking structure to finish up. The parking structure was built from both ends toward the center, allowing the aisle way to run through the center of the structure to reach the medical center, which then was filled in to complete the project.

PROJECT SPOTLIGHT

Defense Information Systems Agency Headquarters

Location: *Fort Meade, Md.*

Project Type: *Federal information technology and office center*

Size: *1.07 million square feet*

Cost: *$369 million*

Designer: *RTKL Associates Inc., Baltimore, Md.*

Owner: *United States Department of Defense, Washington, D.C.*

Structural Engineer: *Thornton Tomasetti Inc., Washington, D.C.*

Construction Manager: *Hensel Phelps Construction Co., Chantilly, Va.*

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

Precast Components: *Architectural precast concrete panels.*

Photo © RTKL.com

Photo courtesy of Gate Precast Company

Photo courtesy of Gate Precast Company

Photo © RTKL.com

The architectural precast concrete panels fabricated for the three-building Defense Information Systems Agency Headquarters in Fort Meade, Md., had to meet specific blast-resistant criteria as well as provide an air barrier and other characteristics. The precast concrete panels helped the building achieve LEED Gold certification.

To meet the fast-track schedule, the team leveraged the efficiencies of each building-system solution.

A coordinated modeling process was created to ensure smooth collaboration and provide a partnership to resolve issues and challenges, Hurley notes. "Better document coordination resulted in fewer construction-coordination issues to resolve and less rework," he says. "There were no RFIs or change orders from interferences for conflicts between the 3D modeled systems." The subcontractors reported only 43 hours of rework out of 25,000 hours of work on the project.

High-Tech Info Center

The design-build team tasked with creating the Federal Defense Information Systems Agency Headquarters in Fort Meade, Md., faced a daunting challenge. Department of Defense officials wanted the 1.07-million-square-foot building to enable "information dominance in defense of our nation," says Bill McCarthy, vice president in charge of the project at RTKL Associates Inc. in Baltimore, Md.

To reach that goal, the architect partnered with Hensel Phelps Con-

struction Co., DCEngineering PC, and Gate Precast Company to create a design that features three same-sized buildings clad with architectural precast concrete panels secured to a steel frame. The panels not only provide the aesthetic requirements of the project but also helped achieve the Anti-Terrorism/Force Protection (AT/FP) demands for a high-security government facility and aided in reaching LEED Gold certification.

The complex contains an office building, information-technology lab, conference center, training center, fitness center, and cafeteria. Due to the around-the-clock activity in the center, it was designed with diverse and redundant power, water, and building-automation systems to monitor and control the building. The buildings, which serve 4,300 employees, are connected and surround a central courtyard.

The project used a fast-track design-build process and required the early turnover of a number of program elements, McCarthy says. To meet the schedule, the team leveraged the efficiencies of each building-system solution, including the precast concrete. The precaster served in a design-assist capacity, working with the design-build team during the bidding process to develop an exterior system that was modular, appropriately detailed, aesthetically pleasing, and quick to erect.

"The precaster provided accurate technical information from the very beginning, allowing us to design based on real dimensions and characteristics rather than on assumptions and approximations," McCarthy says. "This improved the quality of the project and also helped manage overall project costs for a competitive-bid award." After the award, he adds, the team worked directly with the client to ensure that design goals were met and the facility achieved the desired appearance.

Creating a modular concept was critical to the project, McCarthy explains. "For a design-build project, it is important to come up with modular solutions that can be well refined in design and coordinated across all disciplines. These lead to budget economies, reduced schedules, and increased quality control."

The precaster was one of several that presented a concept to the design-build team prior to submitting proposals, which was then selected

'The precast concrete system provided the most cost-effective, robust solution.'

for the team's bid. Before the proposal was submitted, the team met every week to work through issues and create efficiencies in their proposed concept to meet the government's RFP. Although this required much upfront work with no assurance of a return on the investment, it paid off for the precaster, as about 70% of the submittal and shop drawings were completed when the contract was awarded.

The architectural precast concrete panels consist of panels embedded with thin brick along with some buff-colored lightly sandblasted panels. "The use of samples, mock-ups, renderings, and review meetings allowed the team to quickly finalize design intent and get approval for production," McCarthy says. The buff-colored panels were used for accents and to provide contrast, especially at the entry and other key points, such as window sills.

AT/FP Standards Met

A key element was the need to provide sufficient reinforcing and connection security to ensure the panels would withstand the blast parameters the government set for the facility. Adaptations were made to standard panels to ensure the entire wall system, with windows installed, would resist the blast forces. "The engineered precast concrete system provided the most cost-effective, robust solution for the project," he says.

The most difficult part of the precast concrete design was the sheer volume of the job, which amounted to nearly 175,000 square feet in 780 panels. Typical panel size was about 9 feet, 6 inches by 30 feet, with a weight of 33,500 pounds. Logistics coordination of casting and delivering that volume of material kept the plant busy for many months. But the upfront design-build effort allowed the fabrication to move smoothly with no surprises on site.

The panels were designed and erected in a vertical position so no more than two panels were needed to enclose the building's height. The panels' width was determined by casting them one-third of the column spacing in each section. The most challenging aspect came where the three buildings join at a unique intersection. "The differences in grades, building geometries, and overall construction accessibility supported the selection of precast concrete as the preferred exterior system," he says.

The panels also needed to include a tested air-barrier system, which was greatly facilitated by the precast concrete panels, McCarthy notes. A spray-foam insulation back-up was applied to the panels, with joints incorporating double-backer rods and sealants. "The final tested system surpassed the project's criteria," he says.

As a Federal government facility, the project also had to meet strict sustainable-design standards of a LEED Silver certification or higher. Ultimately, the project was awarded Gold certification. "A large contributor to this achievement was the use of the precast concrete panels," McCarthy says. "It allowed for an extensive use of recycled materials, use of local materials and production, limited site disruption, and contributed to reduced overall energy costs."

The precast offered other benefits, too, he adds. "The off-site fabrication and efficient modularization also allowed just-in-time delivery and erection." That ensured the site remained free of congestion, increasing safety and helping to speed construction.

The result is a formidable building that serves a large base of government employees while offering a stylish, institutional look. It also provides durability and security while offering one of the most efficient designs for sustainability in the country.

These projects show some of the ways that precast concrete structural and architectural systems can be used to meet the challenges of design-build projects of all types. Regardless of the delivery method used, consulting with the precaster early in the process ensures that the design results in a cost-effective, aesthetically pleasing, and quickly erected project.

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