Pavilion parking structure succeeds through innovation

A new five-level underground precast concrete parking structure supports half of the new Penn Pavilion, a 17-story, 1.5 million ft^2 (139,000 m^2) health center in the heart of Philadelphia, Pa., that includes 500 private patient rooms, 47 operating rooms, and a 61-room emergency department.

The parking structure, which was constructed 67 ft (20.4 m) underground, includes 689 parking spaces, two stair towers, a series of elevator shafts, and two precast concrete cisterns as well as provisions for fuel tanks, a network, locksmith, materials management, and information technology.

Although such an underground parking structure typically would have been constructed using cast-in-place concrete, the engineers realized that the accelerated time line offered by using precast concrete made that the ideal solution for the project. Shockey Precast, based in Winchester, Va., was selected as the precaster.

More than 80% of the labor for Shockey Precast's work on Penn Pavilion's parking structure took place remotely at the company's facility, helping to mitigate site congestion in this densely developed West Philadelphia, Pa., neighborhood. Photo: Hover Solutions LLC

Precast concrete enabled a five-level underground parking structure for the new Penn Pavilion in Philadelphia, Pa., to support structural loads from the steel-framed tower being constructed above without the delay that would have been required using cast-in-place concrete. Photo: The Shockey Precast Group.

Impressively, Shockey provided an innovative twist to the structure's design: cast-in-place concrete emulation with precast concrete elements. As a result, and to everyone's satisfaction, the structure was designed and detailed in such a way that it meets the requirements of the applicable building codes, as if it were constructed of monolithic cast-in-place reinforced concrete.

In addition, to keep costs down and increase the speed of the project, the components of the parking structure were divided into a number of structural elements of sizes and shapes that could be plant-fabricated, transported, and then safely and efficiently erected on-site.

One of the reasons timeliness and efficiency were so important on this project was that construction of the new 1.5 million ft^2 (139,000 m^2) steel-framed patient pavilion could not begin until the five-level underground parking structure was complete.

The use of precast concrete for the parking structure enabled an accelerated construction schedule and also meant

Precast concrete perimeter walls as well as interior precast concrete vertical and horizontal pieces were installed throughout using a crawler crane, which was assembled within the parking structure's excavated footprint. Photo: Hover Solutions LLC.

that shop drawings for the precast concrete could be coordinated while design of the structure was being finalized.

As soon as site work was complete, erection of the precast concrete components began. As a result, this fast-track construction timetable allowed construction of the patient pavilion to begin on schedule.

One of the key design challenges involved transfer of the structural load of the tower to the parking structure. This was another reason that precast concrete made sense: Using precast concrete components for the underground structure enabled the structural load from the tower to be transferred to the structural precast concrete parking structure earlier in the overall schedule. In addition, the topping slab could be used as part of the diaphragm.

Precast concrete ended up being the right choice for another reason. Because of the dense development in western Philadelphia, where the project is located, normal levels of on-site labor during construction would have caused excess congestion, public safety concerns, and excess traffic. By using precast concrete, however, more than 80% of the labor for Shockey's portion of the work was able to take place at its manufacturing facility nearly 300 mi (480 km) away.

In all, the precast concrete portion of the project consisted of 1138 pieces, with a maximum piece weight of 82,000 lb (365 kN). Specifically, this included 220,000 ft^2 (20,400 m^2) of double tees, 17,000 ft^2 (1580 m^2) of flat slabs, 125,000 ft^2 (11,600 m^2) of walls, 16 stairs of various thicknesses, 71 columns (typically 33 × 66 in. [838 × 1676 mm]), and 85 beams (typically 30 in. [762 mm] deep).

On a project of this magnitude, challenges were to be expected. The first occurred during the design phase of the precast concrete pieces. "The design of our precast structure was intermixed with other materials designed by the engineer of record for the project," says Matthew Cooper, engineering manager with Shockey Precast. To address this challenge, Shockey created a colocation office, allowing its people to work together with others on the project during the design phase in order to arrive at the best solutions for the project.

Production also posed some challenges. "Due to the heavy loading we designed the structure to bear, we added some rebar threading and shear machines to keep up with the demand for this project," Cooper says.

Transportation also required some innovative solutions. "There was minimal room on the project site to stage trailers for production," he says. "Most loads required permits for shipping due to weight and/or size, so we retained a drop lot close to the project in order to maintain sufficient loads available to keep erection running smoothly."

There were also challenges with installation and erection of the precast concrete pieces at the project site. "Due to site logistics, we had to use multiple cranes during erection," Cooper says. "We assembled a crawler crane in the hole, utilizing a hydro crane. The crawler crane was used for erecting most of the product for the project." The team did leave out one bay of double tees and beams to allow the crawler crane to be dismantled. "We completed installation of the remaining product that we could reach with the hydro crane that was used for dismantling the crawler crane. Then, for the product that we couldn't reach with the hydro crane, we utilized tower cranes," he says. To ensure the success of this challenging process, team members evaluated the complete sequence during the design phase to ensure that product weights were kept in line with the equipment constraints.

—William Atkinson