Precast Concrete Expands Rental-Car Facility's Capabilities

California's largest precast concrete parking structure features creative seismic and rental-car designs that expand the facility's capabilities

— By Craig A. Shutt

The San Jose International Airport's $260-million improvement project creates the state's largest precast concrete parking structure, with 1.8 million square feet of raised levels. The project also includes an innovative seismic design and a creative application of rental-car operations, including features that other airports will want to adopt.

"The rental car companies love this facility," says Jeff Fredericksen, project manager for Hensel Phelps Construction Co. in San Jose, which led the design-build team. "The design has cut their operational costs substantially, and the schedule was tremendously efficient. I think when other airports look at this design, they're going to ask, 'If San Jose can do that, why can't we?'"

'The rental car companies love this facility.'

Many airports and rental car companies are consolidating their operations into one master facility. This reduces the amount of land required, number of buses, and helps make their operations more efficient. This also makes it easier on their customers, as they only have one facility to pick-up and drop-off from. These combined facilities are incorporating time and energy saving ideas such as the refueling stations in this project.

The eight-level, total-precast concrete structure is nearly twice the size of the state's previously largest precast concrete parking structure, the 1-million-square-foot facility at Universal Studios. The new 3,350-car structure contains 3,817 precast concrete components, consisting of 32,600 cubic yards of concrete. The components include the precast concrete structural system, containing double tees, L beams, inverted-tee beams, transfer girders, rectangular collector beams, columns and spandrels.

The 1.8-million-square-foot parking structure was erected while airport operations continued around the construction.

Precast Saves Five Months

One reason precast concrete was chosen for the project was the speed with which it could be constructed, fabricating components off-site while other work progressed and delivering components as needed. This approach saved five months in scheduling, which was critical for the airport, as all operations continued during its construction. Not only did construction end earlier, reducing disruption, but the airport had faster use of the structure, which provides car-rental customers direct access to the facility without added transportation needs.

The facility features a consolidated rental-car facility and a Quick Turnaround (QTA) area adjacent to the parking structure that provides fast servicing of vehicles. The three QTA levels, which include refueling stations and car washes, were constructed at intermediate levels of the garage so each QTA can service two parking levels.

The project provided the first-ever use of refueling and washing capabilities on supported levels. "Rental-

The San Jose International Airport's $260-million improvement project includes a three-level quick-turnaround area (at narrower end of structure) that connects to the main rental-car facility via ramps.

car companies have always wanted to have this ability, but it was never possible," Fredericksen says. "It was a challenge, but we were able to supply it."

The design-build process helped emphasize constructability, Fredericksen says. "We worked with the precaster to analyze all of the options and ultimately found the best approach to achieve the airport's goals for economy, efficiency and service. City and airport officials stressed the need for quick construction to alleviate disruptions to the airport. Time is money, and the ability of the precast concrete to save five months in the schedule was critical." The design team included A/E firm TranSystems in Phoenix, structural engineer Watry Design in Redwood City, Calif., and precaster Clark Pacific in West Sacramento and Woodland, Calif.

"The design-build process definitely aided our fast-track approach," says Norman Lin, project manager and senior architect with TranSystems. "The needs of the city, airport and rental-car companies had to be balanced, because they had different

Precast concrete collector beams were placed on top of the shear walls to support the double tees, which were then post-tensioned to provide the seismic support required to minimize the shear walls used, opening up the space.

An M250 crane was used to erect the components, positioned at each corner as needed. The site was constrained both by airport activity and busy highways surrounding the airport.

Collector beams on top of the shear walls were post-tensioned using between 19 and 38 strands per beam. This achieved a compressive force of 1.8 million pounds.

First-floor service levels feature all the accoutrements of rental-care facilities, allowing quick access to cars on upper levels.

Fact Sheet

Project: *San Jose International Airport parking structure*

Type: *Parking structure for rental cars and quick turnaround services*

Location: *San Jose, Calif.*

Designer: *TranSystems Corp., Phoenix, Ariz.*

Engineer: *Watry Design, Redwood City, Calif.*

Contractor: *Hensel Phelps, San Jose, Calif.*

Owner: *City of San Jose, Calif.*

PCI-Certified Precaster: Clark Pacific, West Sacramento and Woodland, Calif.

Project Size: *1.8 million square feet*

Precast Components: *3,817 pieces, including double tees, various beams, girders, columns and spandrels*

Project Cost: *$260 million*

An array of 4,680 photovoltaic solar panels were installed on 3.4 acres of the roof to supply about 20% of the facility's electrical needs on an annual basis.

priorities, so the design team needed to be on the same page. There was a high intensity to the work for four months, when we were virtually able to read each other's minds to solve problems."

The site posed a number of challenges, due to its nonrectangular shape and nearby obstructions. The 6-acre footprint had to be accommodated on a 6.5-acre site hemmed in by highways and other airport functions. Delivering 5,000 loads of precast concrete components into this space, via construction roadways that encircled the site, required careful coordination, Fredericksen notes. "Using precast allowed much of the structural work to take place offsite, which greatly aided maneuvering on the congested site."

Providing Open Spaces

A key element for the design was meeting the unique needs of rental-car companies, which require open expanses to allow visual connections for renters and to eliminate obstructions as drivers flow through the space. This created challenges for both the ramping and seismic designs.

"Rental-car facilities want to be high in customer service, and that means no internal ramps with cars parked on them," Fredericksen explains. To alleviate that need, circular helix ramps were placed so incoming cars enter at one end and vehicles exit from the other down these selfcontained structures.

The seismic design was complicated by the need for open spaces, which minimized support options, explains Jon Purinton, CEO and principal at Watry. "In high-seismic zones, a lot of shear walls are needed, but rental-car companies don't want shear walls on what is essentially their showroom floor. We needed an approach that resolved the high-seismic requirements without placing shear walls throughout the space."

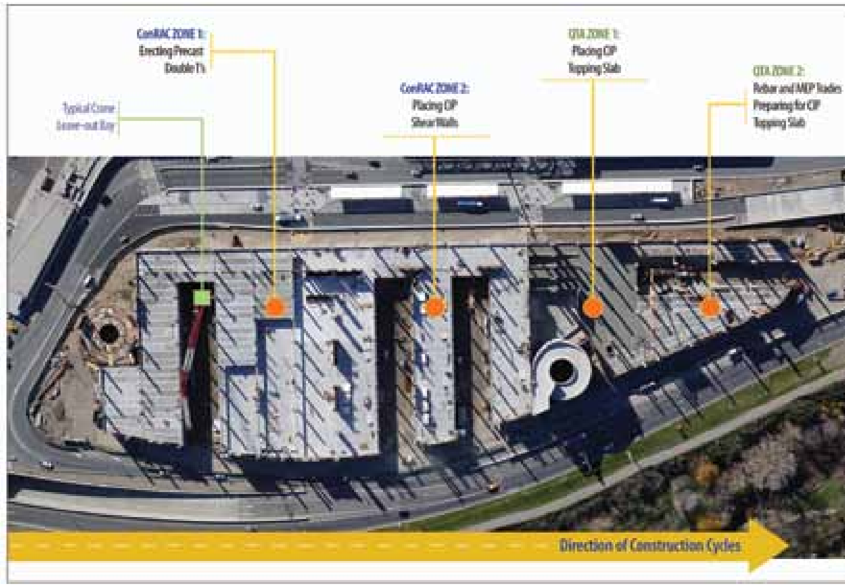
The team initially looked at moment frames, but the distance between columns needed to achieve the facility's open-space requirement created spans that were too long, says Don Clark, president of business development with Clark Pacific. That led back to shear walls—with a structural load-collection system that could shift the loads in the decks to a smaller number of strategically placed shear walls.

"We needed to create large collectors for the loads without requiring a lot of walls," Purinton says. The initial design proposed cast-in-place beams to act as drag struts, with precast concrete L beams on either side. To save time and money, the precaster suggested replacing the cast-in-place beam and precast L beams with rectangular precast collector beams to support the double tees. The precast collector beams used post tensioning to bring the load to the shear walls that were located from 90 to 150 feet from the ends of the decks.

"Using precast concrete collector beams avoided the wait that would have been required while the cast-in-place concrete beams were formed and poured on the site," Clark explains. "This way we could fabricate those beams away from the site and deliver them as they were needed along with the other pieces."

The collector beams aligned with the shear walls. The joints between the beams and the columns were grouted, and the system was post-tensioned using between 19 and 38 0.6-inch strands per beam. This achieved a compressive force of 1.8 million pounds, which was transferred to the beams. The design was created in conjunction with consultant Susie Nakaki of the Nakaki Bashaw Group, who has done extensive research on precast concrete systems in high-seismic regions.

"The collector beams and the shear walls had to align with very tight toler-



Clark Pacific used a "Push" schedule, in which each subcontractor followed the preceding one rapidly to finish each 260,000-square-foot level every four weeks, with the full project completed in eight months. Note locations where bays were left open to facilitate crane access until erection was completed.

Providing the fuel and water requirements for these levels created structural challenges.

The quick turnaround area features special services for washing (bottom) and refueling (top) vehicles, the first time such activities have been provided on elevated levels of a parking structure.

The structure's east façade features dramatic full-length murals that were decided on after the precast had been erected. Embeds in the spandrels allows the artwork to be attached after construction.

ances" Clark says. They also couldn't take a lot of time doing it, he notes. "This project was all about scheduling."

Push Schedules Speeds Work

Indeed, the team created what Clark Pacific calls a "Push" schedule, with each subsequent activity following rapidly—usually the next day—behind the previous one. The shear walls were poured, followed by the erection of the precast collection beams, installation of double tees and pouring of the deck in each section of the structure as work progressed horizontally, one level at a time.

"Crews have an easier time pouring the deck when they can do it prior to the deck above being installed," says Thad Saunders, Clark Pacific senior project manager. "This approach allowed everyone to do their part efficiently and keep up the pace. The precast scheduling created and sustained the pace of the project." If any disruptions caused a subcontractor to fall behind, he notes, they were required to make up the time in overtime or weekend work to ensure the next crew coming right behind could begin on time.

The project progressed at a rate of one floor every four weeks, comprising 260,000 square feet. In all, the project took just eight months to erect, using a just-in-time delivery process for the precast concrete components. Additional components were staged at an area 2 miles away to provide a cushion. "There was rebar, precast and concrete trucks coming and going every day, with the terminals active all around us," Saunders says.

An M250 crane was used to erect the components, Because of the tight construction site in some locations, parking bays were left out to facilitate crane and truck access. The double tees in these locations were easily backfilled to complete the bay once the balance of the structure was complete.

The erection was complicated by the narrow, curved shape of the north end, required to maximize space in the QTA, explains Lin. "The owners wanted to use every square foot possible, and squaring off the end of the structure would not have achieved that goal."

To meet that need, both the shear walls and double tees in that area were curved, with the tees cast in a pie-shaped wedge to perfectly align with the curve of the wall. "Precast concrete made it much easier to complete that curve from an architectural standpoint," says Lin. Adds Clark, "There were large forces on these tees due to their shape and the structural loads in the QTA, but they were erected without any difficulty."

Once the frame was completed, another nine months were needed to install the equipment, Lin says. "This was a big project with many more services than a typical parking garage would require."

Services Added On Floors

That was especially true for the QTA and its need to refuel and wash cars. It was designed as a separate section that connects to the rental-car structure via vehicle ramps. Floor-to-floor heights of 12'2" were created for the rental-car levels, and they connect to the QTA, where floor levels are 24'4" apart. That allows two rental-car floors to connect to one intermediate QTA level via sloped ramps.

Providing the fuel and water requirements for these levels created additional structural challenges. Wash and rinse water was provided in multiple 2,000-gallon tanks on each level, including a reverse-osmosis system for spot-free rinsing. To protect against moisture penetration with such high water use, the floors in this area feature added water resistance. A $3^1/_2$-inch topping was applied on top of the double tee, followed by a hot asphaltic waterproofing layer and another 4-inch topping.

Meeting fire concerns around refueling stations proved more challenging. The main fueling tanks are secured at grade level, with fuel delivered to pumps on each QTA level via pressurized pipes. But a variety of objections were raised by the fire marshal before approval was given for them to be installed.

"We worked closely with the fire department to alleviate their concerns as each arose, digging in to find a way to overcome it to their satisfaction," says Fredericksen. "None of them was too unusual, but there were many to address from a safety standpoint."

The structure's west façade features architectural metal panels and mesh to dampen lighting and create an attractive finish.

For instance, a key concern was protecting the pumps on each level from accidental vehicle damage that could spill gasoline and cause an explosion or fire. This was met by adding shear valves to the pumps that stop the flow if the equipment is hit. Additional bollards were added around the fuel dispensers, delineated striping was provided, and 8-inch curbs separate inbound and outbound car lanes to ensure no vehicles drift and cause collisions.

"We created exercises to deal with each possible scenario and devised a plan to prevent any damage," Fredericksen says. "It was a true partnership of the entire team."

Façade Added Afterward

The partnership extended to the façade treatments, which were still being discussed as the structure was built. City officials were considering a variety of options for façade treatments, so precast concrete spandrels were installed that serve as car-impact shields as well as a base skin. Metal mesh and metal panels were later applied to these spandrels on three sides, while large artwork murals were applied to the east side, adding visual interest.

To allow for these variations, the precaster placed embeds every 12 feet along the face of the spandrels to allow for whatever curtain wall was later specified, Purinton says. "We worked closely with Clark Pacific to ensure we created an envelope to which any finish could be applied once the plan was decided."

> Providing the fuel and water requirements for these levels created structural challenges.

As a finishing touch, a 1.12-mw modular system of 4,680 monocrystalline solar panels were installed on 3.4 acres of the roof. The panels are expected to produce an annual output of 1.7 million kWh, which will offset at least 20% of the facility's electrical needs, according to reports.

The design-build process ensured challenges were met promptly to keep the project on schedule. "The project came together very well, with no surprises," Lin says. "The precast concrete tees worked well to achieve the intensive loads we required, and the spandrels provide the flexibility to accommodate the interesting façades."

The design offers creative techniques that other projects can adapt to solve similar challenges, especially in high-seismic zones and where speed of construction is a high priority, says Purinton. "These aren't techniques that solve problems that arise every day, but they're definitely worth having in your arsenal."

Involving the precaster in the design-build process was a key to the smooth process, he adds. "That helped foster solid teamwork, which led to unique solutions for integrating the different functions of this multifaceted building," he says. "The combination of pretensioning and posttensioning was the best solution to meet the client's needs for wide-open floors while minimizing the number of shear walls." ■

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