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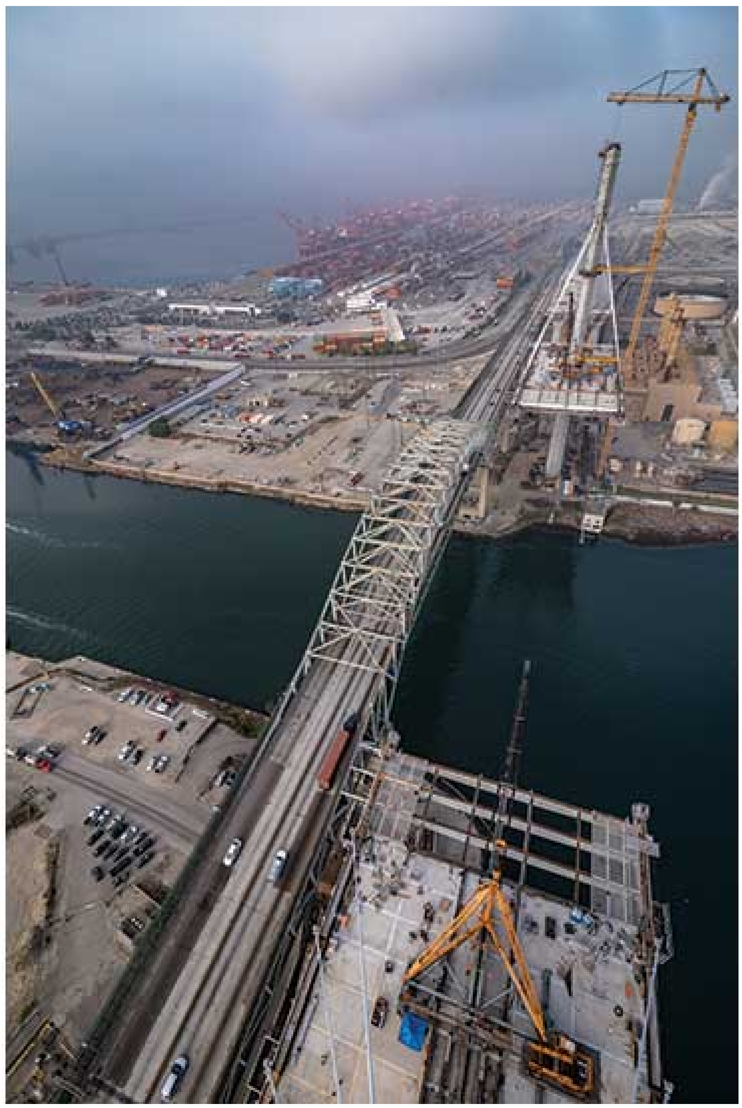
Gerald Desmond Bridge Nears Completion



The old Desmond Bridge (left) and its replacement sit right in the middle of the nation's second-busiest port.

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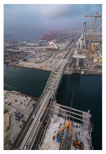

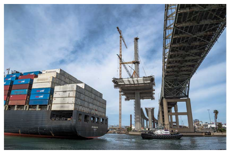

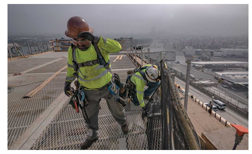

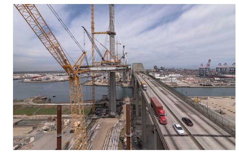

June 12, 2019

Aileen Cho

When crew members this spring dismantled two movable scaffolding systems—never before used in California—it marked a key milestone in the construction of the state's first vehicular cable-stayed bridge. The $1.5-billion Gerald Desmond Bridge at the bustling Port of Long Beach is set for completion early next year. It experienced delays and budget increases due to myriad challenges, but an unusually intense design change process employed on the design-build job has kept the momentum going.

"We are complete with all the movable scaffolding. Approaches are done," says Bob Schraeder, project manager with SFI, the design-build team of Shimmick Construction, Spain's FCC Construction and Italy's Salini-Impregilo S.p.A. "There is a lot of bridge out here."

And a lot of traffic. With trucks carrying 15% of the nation's inbound waterborne cargo through the port over the old spalling bridge, it was critical that construction of the 2,000-ft-long replacement bridge plus 6,400 ft of approach spans occur with minimal disruption to traffic, says Duane Kenagy, capital programs executive with the port. SFI came up with one solution that is also a first in California—a Texas U-turn, placed underneath the bridges. The U-turn is a free-flowing, dedicated double left turn on the inside track of traffic that allows trucks to keep moving and not have to wait at a signal.

"We've been able to maintain the flows in such a way that the port has been able to establish goods movement records despite us gutting the center," says Steve MacLennan, senior vice president with WSP USA, program manager for the project.

Work began in 2013 on the replacement for the through-truss span that connects Interstate 710 to the port's Terminal Island. The new bridge will have a 205-ft vertical clearance, making it high enough to accommodate supersized vessels that can carry up to 9,000 containers. It will have the highest cable-stayed deck in the U.S.

The extensive underground work—plus a California Dept. of Transportation requirement for more seismic reinforcement—delayed completion by about a year and added about $500 million to the original budget, which was nearly $1 billion.

An estimated 85,000 vehicles use the old bridge every day. It has a total of five lanes with no shoulders, steep approach grades of up to 6% and a 155-ft underclearance. Moreover, spalling concrete prompted the installation of catch netting under the bridge deck.

The replacement bridge, featuring two 515-ft-tall towers that transition from an octagon shape at the base to a diamond shape at the top, will have three lanes in each direction, shoulders and a bike path. It has a 100-year design life, says Kenagy. Seventy-five sensors are embedded in the new bridge—another first for a

California bridge, he adds.

Pier Pressure

Early on, during the technical investigation, port engineers discovered a problem they needed to literally unearth—scores of abandoned oil wells from extractions dating back to the 1930s. SFI's test excavations also revealed geological conditions that varied so much that each bridge foundation required its own design (ENR 10/21/13 p. 14).

The job called for about 300 cast-in-drilled-hole piles to depths of 110 ft to 180 ft. "There's a lot of challenges associated with building a project of this magnitude starting from bottom up," says MacLennan. "We installed piles that extend from 120 to 180 ft into the ground. We did this in a completely wet condition, at or below sea level. It required that we not employ dewatering measures. That is because of some artifacts left on site from the Navy. There was a benzene plume that had to be monitored and stabilized. If you dewater, you could get it to migrate."

The contractor developed precise means to excavate casing, place rebar and concrete and then inspect the piles with nondestructive testing. "We only had two anomalies in 500-plus piles," says MacLennan.

Besides liquefiable soils and a high water table, the project also sits in a seismic zone. Lateral movement is a design consideration for the piles and reinforced-concrete main towers. Moreover, numerous utilities—including a 600-ft-long network of transmission and telecommunication lines—stretched beneath the old bridge from a power plant to a substation, says Wayne D. Smith, the port's senior civil engineer. That line was replaced by a new 2-mile-long system.

"We could not release the site to SFI until we resolved the significant amount of utilities in conflict with the proposed construction," says Smith. "SFI could not and would not perform construction near a 66-kilovolt line. We had to protect it or relocate it."

SFI tweaked its design to accommodate some utilities, says Matt Carter, principal with Arup, the team's designer. For example, "there was a sewer pipe fairly deep down beneath the end bents. [The port] asked us if we could design a bigger pile cap to span across the pipe." Doing so eliminated the cost of removing and treating contaminated earth.

Port crews had to locate all the abandoned wells and address which ones would interfere with the new bridge alignment. "Some were abandoned years and years ago when records were poor and protocols were crude," Smith says. That led to another joint effort, with the Long Beach Dept. of Gas and Oil. "We sat down and created oil set-aside areas," says Al Moro, chief harbor engineer for the port.

After extensive discussion with Caltrans, the port determined that a 50-ft separation between the top of any abandoned well and the new substructure was necessary to prevent any potential influence of a leaky casing, says Smith. After a problem well was located, crews used a hollow drill to get down around the well, along with a clamshell excavator. “Once we contacted the well, we cut the casing down to the elevation we wanted,” says Smith. “We entered the casing and set 10-ft plugs at intervals.”

Crews treated 24 wells. They then had to deal with all the infrastructure that allows the current oil well system to work—including injection lines that carry seawater used to fill aquifers to treat land subsidence from old ways of extraction. “There are water lines, collector lines from active wells to holding tanks that we had to relocate,” says Moro. “We spent quite a bit of time; it was a big part of the project.”

The conflicts weren’t just below the surface. Overhead systems had to be relocated out of the way of the higher elevation of the new bridge. The port and its engineers worked with utility Southern California Edison to come up with a system that was practical, rather than prescriptive.

The agencies looked for redundancies that would allow some lines to be removed, and for ways to reroute others while preserving the operation of the bustling terminals at the second-busiest container port in the U.S., after the Port of Los Angeles.

Rising High

The pile caps for the two main-span towers are 8 ft in dia. They each contain 3,400 cu yd of concrete. The columns, spaced at 200 ft, are designed to bear the weight of each of the movable scaffolding systems (MSS) that helped construct 2,800 ft of western approach spans and 3,600 ft of eastern approach spans. That weight totals about 5,000 tons when combined with the cast-in-place concrete and rebar.

Each MSS launched itself out 12 ft on either side of the bridge. After a segment was cast, it moved to the next column and repeated the process. The MSS consists of brackets, attached to the columns, supporting the main girders. Transverse trusses are connected to the main girder and used to support the soffit. The final elements are the exterior concrete forms for the girder and overhang. With the MSS, crews completed 200 ft of deck each month. With falsework, it would have taken six months, says Smith.

“We had tight procedures,” says Schraeder. “We never let it get away from a slope of 5 percent.” The systems, which cost about $12 million, weigh 1,500 tons each when empty, he says. They will be dismantled. “So much labor goes into the assembly— 20,000 hours and 45,000 torqued bolts,” he says. “It is cheaper for us to scrap them.”

The main span, to be supported by 80 cables, is utilizing conventional cantilevered construction of 50-ft-long steel beams topped by precast panels. The new bridge is designed for a seismic event with a 1,000-year return period. “We allowed the roadway deck to slope independently of the towers and columns,” Carter says. “When the ground’s shaking around, the columns shake too, but the deck slopes and relieves a lot of force off the structure.”

Though an independent panel of experts approved the design, the California Dept. of Transportation (Caltrans), which will own and operate the bridge, still asked for modifications. For example, the thickness of the main tower walls increased by 25%. Moreover, the bridge will be packed with 37,000 tons of rebar.

Schraeder says that the tower design was at 65% design when Caltrans requested changes. “Caltrans wanted it stiffer. We had designed it to be elastic for earthquakes.” Moreover, Caltrans wanted changes to the deck design. “There was a requirement that there be compression everywhere,” he says. “It’s the first cable-stayed [vehicular] bridge in California, so Caltrans was somewhat conservative.”

The bridge team also pushed the envelope when it comes to hardening it against external threats like terrorism, says MacLennan. “We have protected our towers, footings, cable stays, et cetera, against threats with the design and sizing and strength of these elements,” he says, adding that the team worked with the Army Corps of Engineers and the Federal Highway Administration. “We built a scaled model and destroyed it, measuring the real-time performance.”

With all these efforts, “we now have a design we are all more comfortable with for the next 100 years,” says Moro.

Collaboration

Design-build was challenging for Caltrans, LA Metro, the port and other stakeholders. “The culture was difficult. Political pressure was high,” says Sam Hassoun, president and founder of GLA, a consultant specializing in collaborative dispute mitigation, which came in to help on the project. “We started from the top. The change was executive leadership-driven.”

Weekly executive sessions and team-building helped build trust and set an example for the entire project team. “We created a matrix of accountability,” says Hassoun, that was “outcome-driven, not task-driven. Not ‘what does my contract say?’ … but ‘what is my role and what is it I can do to help?’”

As a new culture permeated the working environment from top down, “ideas came from everywhere,” says Hassoun. “It became everyone’s risk. Not, ‘it’s your problem, contractor,’ but ‘how can we do this together?’”

MacLennan agrees, noting the implementation of a two-level approach to design changes depending on the magnitude. “The key to building complex projects is to communicate and coordinate. This process is much more intense than I’ve experienced elsewhere in my career, simply because we have so much work going on.” Relatively minor field changes proposed by the contractor were addressed within 24 to 48 hours, without requiring an official stamp from the engineer of record, says MacLennan. Higher-order design changes, such as changes in scheduling for when to tear down an old connector ramp, follow the same procedure, also on an expedited basis.

Gregory Farr, a supervising engineer with Caltrans, notes that the process enabled stakeholders to work with and accept contractor-suggested changes to staged construction in order to make up some of the schedule.

“It was a learning curve for everybody,” he says. “I’ve been attending the quarterly meetings on behalf of the district. It’s been a very good experience and certainly helped move the project forward.”

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Aileen Cho, ENR's senior transportation editor, is a native of Los Angeles and recovering New Yorker. She studied English and theater at Occidental College, where a reporter teaching the one existing journalism course encouraged her to apply for the LA Times Minority Editing Training Program. Her journalism training led to her first stories about transportation, working as a cub reporter with the Greenwich Time. Her work has appeared in the Los Angeles Times and New York Times. Many of her experiences with engineers and contractors have inspired material for her alternative theater productions way, way off Broadway. For ENR, Aileen has traveled the world, clambering over bridges in China, touring an airport in Abu Dhabi and descending into dark subway tunnels in New York City. She is a regular at transportation conferences, where she finds that airport and mass transit engineers really know how to have fun. Aileen is always eager to hop on another flight because there are so many interesting projects and people, and she gets tired of throwing her cats off her computer in her home office in Long Beach, California. She is a very conflicted Mets/Dodgers fan.