UHPC takes on heat, humidity of Malaysia bridge locale

Precast concrete played an important role in the building of a major submersible ultra-high-performance concrete (UHPC) bridge in Perak, Malaysia.

The purpose of the bridge was to connect two communities across the Perak River in one of the nation's key districts. One of the challenges was the aggressive heat and humidity, which limited the type of construction materials that could be used.

A number of options for the bridge superstructure materials were considered, including conventional concrete and structural steel; however, these were abandoned in favor of UHPC, which offered a number of benefits. UHPC is nearly impervious, thus preventing intrusion of moisture and salt into the concrete. In addition, it allows for nearly a total elimination of reinforcing bar and the resulting corrosion and maintenance costs.

The Malaysia Public Works Department opted for UHPC based on good reports on the more than 150 bridges that Dura Technology (the precaster for the project) already provided precast concrete for, and the department had no question about the significant advantages of the material.

Yen Lei Voo of Dura Technology says that design of the UHPC composite bridge presented little challenge. "We have more than 14 years of experience in this type of work," he says.

Production saw shorter curing times than typically used. "Production was done in a single batching per segment, so that did not present a challenge," he says. "However, there was a challenge during the production of the partial box girder segment during the demolding stage. In our production, we normally cast the segment between 4:00 p.m. and 6:00 p.m. in the evening and stripped the mold the next day around 10:00 a.m." As a result, the curing time was less than 24 hours, which meant that special care was needed for the two outermost webs of the partial box section due to the fact that the segment did not come with a precast concrete bridge decking. "The two outermost curved webs were subject to bending due to its self-weight," Voo says. "Special care was needed to ensure no cracking of the webs." To address this, the production line team pulled a single 0.6 in. (15 mm) diameter strand connecting the two webs (at the top flange section) and applied some pretension forces around 2 tonnes (4409 lb), just enough to counterbalance its potential bending due to self-weight. After that, the outer mold could be stripped.

There were no transportation and delivery challenges involving the precast concrete pieces. Each segment was 2.5 m (8.2 ft) wide, 8.5 m (27.9 ft) long, and 2 m (6.7 ft) tall and

The contractor chose a conventional and less expensive way to erect the girders for the new Lambor Bridge using a temporary steel bridge for the first threes spans due to presence of water in the river. The remaining five spans were erected on the ground using a scaffold system. Courtesy of Dura Technology Sdn Bhd.

The University of California San Diego's new pedestrian bridge links pedestrians and cyclists in the Mesa housing area with a medical center complex and the campus. Courtesy of John Durant.

Drop-in girders are being erected for the University of California San Diego's new pedestrian bridge. Precast concrete helped address ecological concerns. Courtesy of Keith Gazaway.

weighed up to 23.6 tonnes (52,000 lb). "As a result, each piece could nicely fit into a single truck," Voo says. "The weight was relatively small compared to conventional precast components, so, generally, transportation was not an issue."

Installation did present some challenges, however. Each fully assembled girder was about 350 tonnes (772,000 lb). "As a result, lifting and launching of such heavy girders was not possible in our country with the available equipment," Voo says. "Therefore, we used the most traditional method to assemble the segment, which involved using a temporary staging method so that the segment could align right on the finished girder positioned," he says. "We then post-tensioned the segments, grouted the tendons, and then used a hydraulic jack to lower it down to be seated on the elastomeric bearings." —William Atkinson

Pedestrian, bike bridge at UC San Diego spans environmentally sensitive area

The $10 million pedestrian and bicycle bridge serving the University of California San Diego Mesa Housing community was built to link the student housing area with a medical center complex and the campus. The bridge ended up spanning 485 ft (148 m) and features a 10 ft (3 m) wide bike lane and a 6 ft (1.8 m) wide pedestrian walkway.

Precast concrete provided by Oldcastle was selected for a number of reasons, including aesthetics, durability, and cost effectiveness, says Keith Gazaway, the project manager for Kleinfelder, the engineering firm selected for the project. "Because the bridge crosses the campus's Ecological Reserve, permanent and temporary supports could not be used within the canyon," he says. "Spliced precast concrete girders accommodated the 190 ft middle span and minimized environmental impact."

Kleinfelder initially considered several alternatives, including steel truss, steel plate girders, signature bridge (stress ribbon), and precast concrete girders. "The precast concrete alternative was the winner because this alternative provided the lowest construction cost and highest durability," says Sami Megally, Kleinfelder's project engineer for this project. "The use of precast girders was necessary due to site environmental sensitivity."

There were some challenges with the project. "During construction, a survey error resulted in the bridge being 6 ft longer than originally planned—a challenging situation especially when using precast concrete," says Gazaway. "Our team quickly designed an abutment retrofit scheme, and the bridge was opened in time to synchronize with the ribbon-cutting ceremony of the adjacent Mesa Housing apartments."

In addition, site constraints made the design and construction difficult, Megally says. Precast concrete girders were spliced due to the relatively long main span crossing the environmentally sensitive canyon. Temporary supports were not allowed to support the girder before splicing. Therefore, the girders needed to be spliced in the air. This resulted in a unique construction sequence and corresponding high-level accurate analysis.

"Construction challenges included construction sites with steep slopes, sharing the site with another ongoing project, and the use of heavy cranes with high capacity and boom reach to erect the precast girders of the main span," Megally says. "The construction obstacles were resolved by extensive coordination between the design team and the contractor and between the construction teams for the simultaneous ongoing projects sharing the site."

Overall, the project was a success on all levels. "The bridge design is inspired by the canyon it spans and the long-standing San Diego tradition of pedestrian and bike bridges that span from one mesa to the next," says Eric Naslund, the project architect with Studio E Architects. "The simple and elegant spans of the concrete beams make a perfect foil for an organically shaped deck that morphs as it arrives at either landing."

"Use of precast concrete was the alternative with the highest cost savings, resilience, durability and least maintenance," Megally says. "The use of precast girders allowed the addition of all aesthetic features that made this bridge an architectural icon in the UC San Diego campus." —William Atkinson