Far left: View showing the approach structures and the challenges of access and material delivery

Above: Installing the steel box girders on the approach structures

Left: The interim delivery system in the foreground, with the new high-line shown behind

LIFE LINE

Despite earlier setbacks, North America's longest arch bridge is now making progress over the Colorado River

"The bottom line is that we are very excited about where we are at right now," says Federal Highway Administration Hoover Dam Bypass project manager Dave Zanetell. He has reason to be excited, with joint venture contractor Obayashi/PSM poised to begin erection of the main arch for the new bridge, after more than a year of delays. "The joint venture team is now in the final days of certifying and load testing the new high-line system," Zanetell explains.

The high-profile project, to build a new bypass of the US93 roadway, crossing the river in a dramatic location just downstream of the Hoover Dam, suffered a major setback in September 2006 when the contractor's high-line system collapsed. The system was intended to be the means by which the materials and precast units would be delivered to the main concrete arch, and its failure created a big challenge for the site team.

"We worked hard together to get the interim delivery systems set up," Zanetell explains, "and we are very proud of what we've done. The collapse of the original system more than a year ago was a serious setback, and since then we have been busy with two major activities – we have worked together to continue to progress the project, developing and implementing the alternative delivery system, and at the same time the joint venture team has had to sort through the high-line and work out how we could get a new high-line up and running," he says.

The contractor has developed a new system from scratch, specifically designed for this site, says Zanetell, not a modified system like the previous one. Initial observations suggest that the refurbished Nevada South tower was the first to fail, causing support cables to the adjoining towers to be compromised, and resulting in the collapse of the remaining towers.

The investigation is still ongoing, he says, and adds that is it now is 'a confidential matter between the contractor and his insurer'. "We are not a party to those discussions," says Zanetell.

But even without the high-line system, construction work has been able to continue on the approach structures, once the interim delivery system had been installed, and the contractor has also been progressing with precasting the units for the river bridge, even though they cannot be erected until the new high-line is in operation. "Overall, we are now about 50% complete on the river bridge in terms of work required; the final phase is the crossing of the Colorado River. The columns on the approaches are complete – the foundations, twin columns and girders are in place – and the work that remains is to cast the deck on the approaches, build the cast-in-place arch, and then erect the spandrel columns and girders, all of which are cast and ready to go. The deck on the arch span can then be cast.

"Unfortunately the current phase is linear in nature, so it is limited in terms of opportunities to speed it up – we are working together to find opportunities more in terms of efficiencies, maximising shifts and equipment use, progress and so on," Zanetell explains.

Heavy equipment specialist F&M Mafco was contacted by Obayashi shortly after the collapse of the first cableway. Due to the geography of the site and the long radius lifts, there was no simple solution. A crawler crane, even a very large one, would not have the capacity required at the 100m radius. In the end, F&M Mafco supplied an American S-70 stiffleg derrick and an American 550 hoist to be placed on the Arizona side of the river. In its standard configuration, this derrick did not have the reach required to set the outer piers where some 55t had to be lifted at 100m radius. To solve this, F&M Mafco made arrangements to ship a complete 600t boom that it owned, all the way from Scotland. While the boom was in transit, Somerset Engineering designed the boom suspension and redesigned the boom base to fit the horizontal strut on the S-70. F&M Mafco also prepared a 24m-long jib which could be used for the long radius lifts. Special boom suspension blocks were used, components were fabricated, load charts engineered, site preparation done, and items shipped in from around the world all in about 120 days.

In late March 2007, the derrick was erected and load tested, after which it was brought in to use for up to 20 hours a day, lifting in the piers, caps, and girder beams on the Arizona approach bridge. In late September last year, it was dismantled to make way for the installation of the new cableway.

Supply of the two replacement cableways was also contracted to F&M Mafco, a year ago. The system was designed by Somerset Engineering and consists of four 102m-high towers, two head towers on the Nevada side, and two tail towers on the Arizona side. Four hoists are used to take up the tension of the 75mm wire ropes that cross the canyon, luffing each of the towers side to side – the towers are designed to luff 9m in each direction to enable precise placement of the loads. There are two hoists used for pulling the trolley in and out and additional hoists for raising and lowering the load block. Finally small hoists are used to hold the tension on the trolley lines.

The setback means that the completion date of the US$114 million river bridge has had to be put back to mid 2010, with the bypass not now expected to be open to traffic until late 2010.

The first segments of the arch at the springing have already been built in situ, and the remainder will be installed using the cableway system. When it is complete, the two arches will contain a total of 106 individual segments, 53 in each arch.

The Hoover Dam Bypass will include approximately 5.6km of new four-lane highway including the bridge which crosses the Colorado River at a height of 275m, and about 460m south of the dam. It is being built for a client consisting of five US government agencies, led by the Central Federal Lands office of the FHWA. A consortium of consultants was responsible for the design and development of the project. HDR, Sverdrup and TY Lin International were responsible for the detailed design of the twin rib-framed arch bridge, on which the dominating lateral force turned out to be wind, not seismic activity, as had been expected.

A twin rib design was chosen for two main reasons – the first was to reduce the size of the elements required, enabling it to be built using precast segments. The second reason was its performance under extreme lateral forces – a single arch rib would leave no opportunity for tuning stiffness, or provide for frame ductility, whereas twin ribs provide a means of creating ductile Vierendeel links that could otherwise fully protect the gravity system of the arch.

The composite solution was developed to address the specific design issues inherent to the Hoover Dam site and was recommended on the merits of cost, schedule, aesthetics and technical excellence, as well as to reduce the weight. Meanwhile the spandrel and column spacing was constrained to conventional span lengths to facilitate conventional off-site fabrication, shipping and erection of the steel tub girders.

One consideration was that above 50t, there is a jump in the cost of the highline system required; the 37m-long spans limit the steel box sections for the composite deck to 50t. The aesthetic committee that reviewed the design also preferred this spacing from a visual perspective.

The design of the spandrel columns, which are up to 90m high, also considered the effect of drag and vortex shedding, and found that a substantial advantage would be gained in terms of both vibration and drag, by chamfering the corners of the columns and the arch ■