Foot crossing a welcoming feat

Preston River Footbridge, Bunbury

A cable stayed footbridge supported by a single back sloping tower has solved the need for a free-span pedestrian and cyclist bridge that avoids impacting the Preston River below and overcomes a myriad of site constraints above it to be the first of its kind in Western Australia and a striking entry statement into the City of Bunbury.

The WA Main Roads project aimed to reinstate foot and cyclist access across the river after the existing footpath on the main bridge was replaced with a traffic lane as part of the Eelup Rotary signalisation project.

As the Department's Project Manager Structures **Nimal Jayasekera** explained, a conventional widening of the main bridge would have added undesirable differential stresses in the deck whilst a bolted-on option would have overloaded the existing substructure.

The Department of Indigenous Affairs Section 18 Approval was granted on the condition that the footbridge does not impact the bed of the Preston River. This meant that a conventional three span bridge (to match the existing bridge) with driven piles, cast in-situ piers and a reinforced concrete deck would not have been possible.

This led to two preferred options, namely a single span truss bridge and a landmark stayed or arch bridge. Mr Jayasekera said preliminary design and cost estimates were prepared for both truss and stayed bridge options with Main Roads deciding to proceed with the cable stayed one.

"While both options avoided the need to work in the river, the cable stayed option provided the landmark statement Main Roads were seeking," he said.

Having then examined a number of arch and single and dual tower stay options generated by a bridge architect engaged by AECOM, a single backward sloping tower was chosen. The resulting bridge is a single span, 2.5 metres wide and at 53.3 metres, the same length as the existing road bridge adjacent.

"The cable stays meant that the structural depth could be kept to a minimum, less than the existing bridge, whilst avoiding the need for any permanent or temporary works to be constructed in the river," he said.

"The use of steel allowed each connection to be expressed in simple terms clearly displaying how the forces are transferred to the various elements in the deck."

He said the entire bridge was modelled in 3D with 2D extractions taken direct from the 3D model and annotated in 2D. The 3D models were used to directly calculate the varying depths of the machined plates as well as detailing of the cleats welded to the tower.

"Because the 3D model was continually updated as the design progressed and details developed, the electronic model could be used as a design tool to test details in the virtual computer environment before they are finalised in 2D. Numerous details were modified as a direct result of the 3D model despite what the structural analysis might have indicated and how good it might have looked on paper and in 2D.

"The bridge deck was modelled in structural analysis software. A geometric non-linear analysis was required to model the

cable elements and resultant load distribution. And multiple models were prepared to analyse each stage of the construction."

He said that as with most cable supported footbridges human induced vibrations are very important.

"The Australian Code for bridge design, AS 5100 does not apply for cable stayed bridges and the designer is required to consult specialist literature for the analysis and design of such structures," he said.

"For the design of this footbridge, the European Commission's, Joint Research Centre (JRC), *Scientific and Technical Report, Design of Lightweight Footbridges for Human Induced Vibrations* published in 2009 was used. These JRC technical reports are published as a precursor to and as additional guidance to the Eurocodes and represent the latest development in the Codes' evolution.

"The dynamic analysis involved calculating the natural frequencies of the bridge followed by a harmonic response analysis to determine the induced vertical and lateral accelerations based on an equivalent stream of pedestrians. These calculated accelerations were then compared to the acceleration acceptance limits. The analysis covers vertical as well as lateral excitation of the bridge."

Mr Jayasekera said that the design called for the pier to be located in the middle of the deck so the bridge arrangement was tested by setting out red cones in the Main Roads car park with personnel trying to cycle their way through the deck and tower mock up, but found the tower's original location to be too close to the abutment posing a safety risk for cyclists at speed and was subsequently doubled to six metres from the bridge abutment.

"During the constructability reviews, installing the 40m long tower was also highlighted as a potential safety concern given its long length and holding a 60 degree installation angle, whilst making the bolted connection at the tower plinth and installing the temporary prop, so the tower base connection was changed from a fixed end to a pinned connection with the pin itself becoming a key aesthetic feature of the bridge," he said.

"This allowed the tower base connection and pin to be installed whilst supported horizontally and then rotated in position with a single crane."

Business Manager of ASI fabricator Dwyer Engineering, **Mattias Eriksson** said 350-tonne cranes were needed to lift each of the three deck sections into place.

"We needed very heavy cranes due to the radius of the lifts especially for the mid section. We then had two cranes dual lifting with one crane on each side of the river," he said.

"We also had to block two out of three lanes when lifting them off the truck so it had to go quick from truck arrival to get the sections in place."

He said that another factor favouring the steel-intensive approach is that it could be moved to another site more readily if needed.

"There is still a lot of development around this river so if there are changes in the regional scheme they can move it in a few years time instead of building a new one," he said.

He said that one of the reasons why Dwyer was awarded the job was that it was able to contribute all from start to finish in-house.

"Offering a complete steelwork 'solution' was important, going beyond just standard fabrication," Mr Eriksson said.

"Since the Forrest Highway (Perth to Bunbury) is just next to it and every car that goes to or past Bunbury will pass it, achieving a 'landmark' structure was important. A three-coat paint finish was applied also chosen to afford a metallic finish corrosion protection system and a fourth coat of anti-graffiti paint also used.

"The stainless spire on the top completes the aesthetics of the tower and changes appearance as the sun crosses the sky each day and as lit in the evenings."

Project Team

Client: Main Roads WA

Project Management: Main Roads WA

Structural Design: AECOM

Bridge Architecture: MacCormac Architects

Steel Fabrication: Dwyer Engineering

Site Erection: Dwyer Engineering

Coatings Contractor: Dwyer Engineering

Coatings Supplier: International Paint

ASI Steel Distributor: OneSteel Metalcentre

ASI Steel Manufacturer: BlueScope Steel