WINNER: BRIDGES

PLETTENBERG BAY: PEDESTRIAN BRIDGE

Footbridges around the world have become statements of aesthetics and engineering wonders. In South Africa we have seen some extraordinary bridges for communities and companies to be proud of – we also have a few on our Steel Awards winners lists e.g. the Moretele Gardens spiral bridge, the Standard Bank skywalk... But this year’s winner of the bridge category has all the elements of a special bridge – innovative concept, excellent engineering, carefully thought through architecture, quality workmanship and very quick erection procedures.

CONCEPTUAL DESIGN

The brief from the client, the South African National Roads Agency, was to create a safe, functional structure with a location and geometry that follows the preferred routes of pedestrians crossing the N2. As Plettenberg Bay is a popular holiday destination, it also required the creation of a structure that was both aesthetic and functional.

The intuitive response to the site was its suitability for an arch bridge. The visible rock outcrops on the northern side of the cutting provide a natural springing point for an arch and inclining the supports of the arch allowed an efficient span configuration. A design that incorporated an inclined arch with a slender steel torsion box deck was developed. The central span of 28.1m is supported by the inclined arch with the continuous back spans of 9.0m and the bridge length is 46.1m.

The bridge spans from the high points on each embankment and is not square to the road. This alignment reduces the ramp lengths and encourages pedestrians to use the structure. A key component of the design was that the structure may be accessed without the use of stairs. The double curvature in the deck allows the required road clearances to be met and the desired lines of the pedestrians to be followed. These conceptual design decisions were derived from the analysis of pedestrian surveys undertaken during the morning and evening peak periods.

STRUCTURAL SYSTEM AND ELEMENTS

The bridge is constructed from steel plate and tubing. Although not immediately apparent, the structural system is relatively simple and is a first in South Africa. The main structural elements are the fixed arch, the tension hangers and the torsion-box beam. The arch is set at an angle of 10 degrees to the vertical. The vertical load from the deck is transferred to the arch via the tension hangers. Although this load is out of plane, the tension hangers prevent the arch from buckling by the restraint of the horizontal stiffness of the deck.

As the deck is not centred under the arch it wants to rotate under gravity and the applied loads. The torsion beam resists this rotation by transferring the torsional moment to the arch supports.

Although the design relies on a concept developed by Santiago Calatrava, this bridge is unique in that it is supported by inclined circular hollow steel struts that effec-
MANAGEMENT, PLANNING, AND DETAILING

A key challenge was the structure's 'buildability'. The bridge deck is set out on a vertical and horizontal curve and the dimensioning of the steel plates used to fabricate the deck required a high level of technical review. The fabricator was provided with detailed dimensions of each steel plate. They then independently modeled the assembly of the plates in a three-dimensional CAD package and the results were cross checked against the numerically calculated design values.

TECHNICAL DETAILS (FOR THE TECHNICALLY Minded)

Fatigue stresses and the dynamic behaviour of the structure were significant in the design. The structure is a fixed arch so the temperature load case was also important, as were the effects of longitudinal sway due to asymmetric live loads. The transfer of the torsion moments induced in

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ENGINEERING A BETTER WAY

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the deck, and the compressive stresses from the arch, into the inclined circular steel struts required careful detailing of the connecting elements. A circular section was used for the supporting struts because of the varying biaxial and torsion moments applied at the deck and base connections. The steel base plate of strut was pre-stressed against the reinforced concrete base to reduce fatigue stresses.

CONSTRUCTION

Fabricated and painted in Cape Town, split into four parts and then transported 550km to Plettenberg Bay, the bridge was reconstructed in the central island of the N2 and the full length of the bridge was lifted into place and welded onto the circular steel supports. The project therefore required a high degree of quality control in cutting of the steel plates, the trial assembly and the re-erection on site. A laser survey of the completed bridge in the fabrication yard in Cape Town was undertaken. This was then checked against the set construction tolerances achieved in setting out the supporting steel struts on site.

Erection engineering was undertaken by the design team and took into account the locked in stresses associated with the construction sequence. On Sunday, 10 December 2006, the construction team lifted the bridge into place in one day.

SOCIAL, ENVIRONMENTAL AND ECONOMIC SUSTAINABILITY

What is exceptional to even the lay mans eye is the quality of the workmanship, the uniformity of the weld and the neatness of the finished product. The construction of the bridge has provided safe crossing to the many pedestrians walking to and from Plettenberg Bay each morning and evening. Its design is integrated into a transportation node including a labour desk office and ablutions. It has provided an integrated solution that is aimed at encouraging pedestrians to use the bridge and be proud of it and also be eye-catching to the passing motorists.

nomination: bridges

CHILUBI ISLAND, ZAMBIA:
PONTOON BRIDGE

project team

Developer/Owner
Road Development Agency: Zambia
Structural Engineer
UWP Consulting
Project Manager
UWP Consulting
Steelwork Manufacturer
Agni-Fuel Lusaka

The brief was to create pedestrian access to an isolated Chilubi Island in Zambia crossing 100m of water which can rise or fall 2m. No heavy plant could reach the site so unusual innovative solutions were required. Bridge sections on floating pontoons provided the answer.
nomination: bridges

FOOT BRIDGE: CENTURY CITY

project team
Developer/Owner
Century City Property Developments
Architect
Boogertman & Partners
Structural Engineer
HHO Africa
Main Contractor
Peak Projects
Steelwork Contractor
DLE Engineering

Man made lakes, canals, buildings, parks, roads and accesses have created a wonderful ambience at Century City. To retain this feeling, pedestrian access with bridges across the canals are an important role player. This foot bridge entry epitomises the opportunity that architects and engineers have to create exciting structures in steel.

We are proud to have been involved with the construction of the structural steel footbridge at Knight’s Bridge, Century City.

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Steel Awards 2007
Category Winner
Bridges

awarded to

SA National Roads Agency

for their role as

Developer/ Owner

in the construction of the

Pedestrian bridge, Plettenberg Bay

Chairman: ................................

Director: ................................