Isando PEDESTRIAN bridge

The Isando Pedestrian Bridge stands as a visible marker to the current efforts to overhaul and upgrade the freeways in and around Johannesburg. With a total length of 446 m the bridge and its approaches connect the Isando Rail Station with the OR Tambo International Airport (Johannesburg).

> The structure is well used with some 9 000 commuters crossing each day. The new bridge replaces two sub-standard footbridges that were a legacy of urban planning in the early 1970s. Commuters predominately used one of the 2 m wide bridges with the other remaining unused. The new footbridge's 4,5 m wide walkway now provides a much improved level of service to the surge of commuters who exit the trains in the morning peaks.

General arrangement

The central 126,4 m long section of the bridge has a 4-span configuration with spans of 25,4 m, 14,8 m, 22,2 m and 64 m. The superstructure consists of a continuous composite steel box girder with a 5,4 m wide concrete deck slab. The 64 m long main span is supported by two vertical planes of fanned cables that are anchored into the back spans. A main feature of the bridge is its two un-braced cigar shaped steel pylons. One leans forwards at 11 degrees and the other backwards, hence the bridge's name.

Influence of consulting engineer on the design

Dubbed the 'Walking Wonder', the concept design was the selected entry by means of a design competition. The client, the South African National Roads Agency Limited (SANRAL), identified the importance of creating an interesting aesthetic that responded to the site's prominence. For this reason SMEC's engineers were asked to come up with several different solutions and to also invite three architects to submit independent derived concepts. In the end one of the two designs submitted by SMEC was selected. Seeing value in a collaborative design approach, the design team then selected one of the architects to act as an architectural advisor.

Budgetary compliance

In submitting the concept design SMEC's design team was cognisant of the client's desire for aesthetics at a reasonable price. A self-anchored composite steel and concrete cable stayed bridge was chosen as the most economical form. The bridge's individual character was added thereafter. The strategy was successful and the construction costs of the main span proved economical at a rate of R18 000/m². This is considered a very competitive rate for a long span structure. The final structure was completed within budget with a total cost of R38-million.

Quality of engineering

The final form of the structure is a direct product of the quality of the design process and the versatility of the various structural materials used. It is also a function of the bridge's 'buildability'. For the inclined pylons, the use of steel enabled offsite fabrication and the relatively simple erection of sections. The use of a torsionally stiff structural steel box girder proved an economical means of supporting the 5,4 m wide concrete walkway. It also allowed for the asymmetrical cable arrangement on either side of the deck. The depth of the deck section enabled a cable spacing of 11,4 m, which reduced the number of cables required.

Sustainability

The long term relevance and functionality of the bridge was an important consideration during the preliminary design stage of the structure. The width of the main deck is set to accommodate future increased flows of commuters from the Isando Rail Station. The possible upgrade of the Isando Rail Station was also considered. The level of main deck was set to allow direct access from a possible future elevated concourse over the rail lines. The bridge is in fact already providing impetus to that upgrade.

The choice of construction materials was also carefully reviewed. Duplex structural steel pylons were investigated to eliminate the need for future access to re-paint the structures. However, in the final life cycle analysis a painted carbon steel proved the more economical solution. Elements suspended over the highway were galvanised and then painted to extend the maintenance intervals and to reduce future impacts on traffic. This was judged important as the carbon count associated with traffic delays and disruption far outweighs the carbon count of the galvanising process.

The rail station is part of a busy intermodal transport junction that caters for the needs of 19 000 pedestrians per day. Pretoria Road runs parallel to the railway line and is often blocked during peak periods when informal taxi ranks form in two of the four lanes as taxis drop-off and pick-up commuters.

The creation of formalised links between the various modes of transport dictated the crossing position.

Complexity and sophistication

The bridge was analysed in Bentley RM using a simple beam model. In order to model creep and shrinkage effects accurately, the construction sequence was modelled by activating the concrete slab properties at various stages after the structural steel deck placement. The effects were analysed for a 100 year time period and the associated restraint stresses in the steel box section were calculated. The bridge deck was constructed on 30 m long through trusses supported on temporary piers.

Unusual construction methods

Temporary steel trusses spanning 30 m supported the deck section during construction. However, careful account of the temporary truss deflections was required to avoid locked in stresses during the staged construction process.

An initial pre-camber on the temporary support truss was set so that so when the steel deck section was installed the deflected shape matched the required alignment. This ensured that the construction joints on fabricated steel deck sections could be matched and welded. Prior to pouring the concrete deck slab the truss section was manually deflected upwards by some 40 mm. This was done so that when the wet concrete was added the deck shaped again deflected downwards onto the desired alignment. This method prevented locked in stresses developing in the steel box section.

Project information

- **Client:** SANRAL
- **Main contractor:** Raubex
- **Architect:** GAPP Architects
- **Consulting engineer:** SMEC South Africa
- **Project value:** USD3,8-million (project cost)