The aesthetically pleasing Tshelimnyama Pedestrian Bridge over the N3 south of Durban

Tshelimnyama Pedestrian

FINALIST
Technical Excellence Category

KEY PLAYERS

Client
South African National Roads Agency Limited (SANRAL)

Professional team
SMEC South Africa (Pty) Ltd and GAPP Architects

Main contractors
JT Ross (Pty) Ltd and Thina Ross Projects

Sub-contractor
JH Gouws Precision Engineering

OVERVIEW

With urban development taking place to the south of the N3 in Durban, pedestrians from the Tshelimnyama Township, instead of using available but longer pedestrian routes, began crossing the N3 at grade to access work opportunities in the Mahogany Ridge and Westmead industrial areas on the north side.

In order to provide for pedestrian safety, SANRAL decided to put out a tender for the design and construction of a bridge which could span freely across the N3 so that it could accommodate any future widening of the lanes. The design called for:

- Aesthetic appeal
- Appropriate form and function
- Suitable location
- Cost effectiveness

The final bridge is a two-span structure with a total length of 89.75 m, a main span length of 55.75 m and a back span length of 34 m. The 3.2 m wide deck is constructed from pre-stressed concrete and is supported by ten sets of stay cables. A 32 m long inclined, twin-legged, structural steel tower supports the cables by means of spade and fork connections.

DESIGN ASPECTS

Tower legs

The tower legs have a varying three-pointed star section constructed from steel plate. The overall cross-sectional dimensions increase from the base of the tower to deck level, and then decrease from deck level to the top of the tower.

At deck level, the tower is kinked in profile, which necessitated the design of a stiffened elbow joint.

The legs of the section are rectangular boxes with a constant width but varying length. The core consists of three additional plates that connect the boxes.

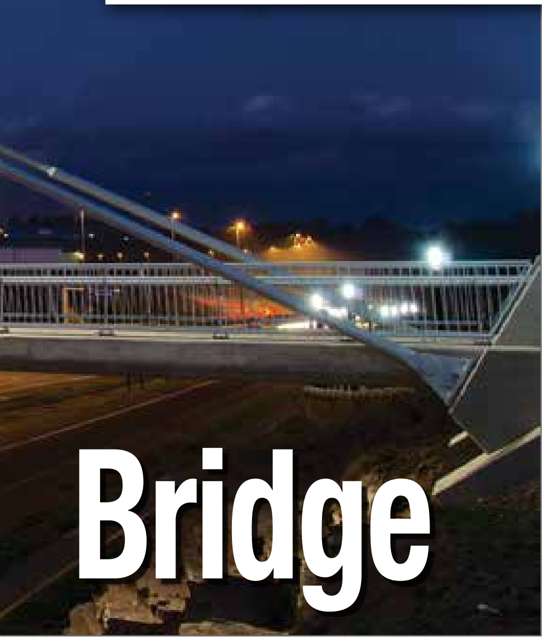
Through a system of connecting the cables to steel connection boxes and a stress bar which was fixed into the anchorage assemblies, the forces in the support system were easily controlled by stressing this bar.

The tower legs are connected below deck level by a fabricated cross beam.

At its base, the tower rests on a set of stainless steel spherical bearings.

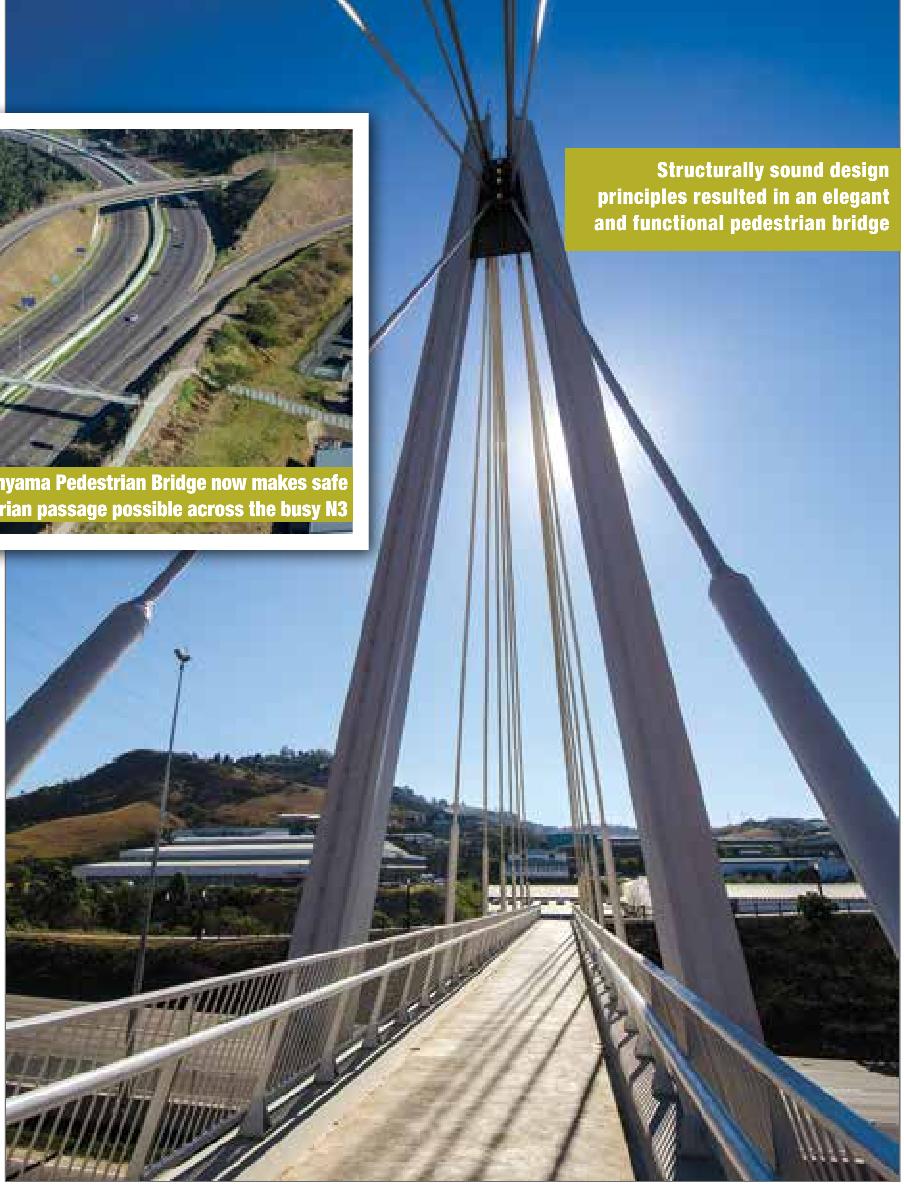
Deck anchorages

A deck anchorage system for cables that protruded from the side face of the edge beam was included. The complete anchorage assembly was tied into the beam reinforcement cage by pre-stressing strand or hooked reinforcement bars depending on the geometry. The use of structural steel provided versatility for the engineers in this aspect.



Bridge

The Tshelimnyama Pedestrian Bridge now makes safe pedestrian passage possible across the busy N3



Structurally sound design principles resulted in an elegant and functional pedestrian bridge

Tower anchorages

During the investigation into possible stay-cable systems, it was realised that a fork and spade type anchorage would provide the desired compact anchorage. This was desirable from an architectural point of view, too. In deviation from the norm, the spade plate was detailed in a horizontal plane rather than a vertical one.

Stay cables

The Freyssinet stay-cable system was employed which uses fixed length cables with a non-adjustable fork at the top, and a threaded cylinder and locking ring at the deck to allow for stressing of the cables.

CONSTRUCTION TECHNIQUES

One of the biggest challenges on this project was the fabrication of non-standard plated sections due to the varying shape of the tower.

Fabrication and geometry control

As the tower has a sculpted look, it was modelled graphically in 3D CAD in order to ensure accurate build-up of the plates. Once the model had been completed, the plate dimensions were extracted and used to check the fabrication drawings submitted by the contractor.

During the fabrication of the upper cable anchorages, the angles of the anchorage plates were closely monitored, as the horizontal layout of the fork only allowed for a tolerance of ±0.5 degrees.

Following a six-month fabrication and approval period, the painted tower was delivered to site in one piece. It was lifted into place and supported by temporary cables.

These cables were anchored with temporary steel anchorage assemblies at the fixed abutment and a micro-piled concrete structure at the other end of the bridge.

Functionality and visual impact

The following aspects of the bridge render the structure functional and aesthetically appealing:

- Effective deck supports at close intervals minimise the deck thickness and weight.
- A single intermediate tower support, away from the main carriageway, minimised construction work in the roadway, which maximised sight distances and road-user safety.
- It boasts inviting approaches with wide walkways and lighting to a clearly defined walkway on the bridge 'outlined' by the overhead cables.
- Good quality rock at the site permitted the use of relatively short rock anchors to anchor the left abutment and the inclined tower.
- Enviro blocks were used and colour-matched to the surrounding rock slopes, which saved on costs.

CONCLUSION

The cable-stayed bridge solution is a simple, yet elegant and dramatic form. It shows a good understanding of the best use of different materials in an integrated structural form where the structural materials are functionally efficient and provide a critically important benefit to the local community who can now cross the N3 safely and securely on a defined walking route. □