Khangela Bridge and Roads Project

KHANGELA BRIDGE AND ROADS PROJECT

Technical Excellence category

KEY PLAYERS

Client Transnet National Ports Authority / City of Durban
Professional Team Transnet Capital Projects
Main Contractor Stefanutti / Basil Read Joint Venture

PURPOSE OF THE PROJECT

For a number of years the issue of congestion in the Bayhead / Port of Durban precinct has plagued port users due to the increased volumes of cargo being moved via road transport. It was envisaged that the congestion would be alleviated by the construction of Khangela Bridge.

Khangela Bridge, constructed as an extension of Bayhead Road, provides direct access from the Bayhead Port precinct to the Freeways and National Roads M7, N2 and N3 to Gauteng, thus linking Bayhead Road and Old South Coast to Sydney and Umbilo Roads.

This was, however, a most challenging bridge designing exercise. Space and access constraints necessitated a design comprising the following three different bridge types:

- Twin box structure with vertical curve – incremental-launch
- Trapezoidal cast *in situ* void former transition deck
- Post-tensioned precast beams with *in situ* top slab deck

Furthermore, modifications had to be done to the existing bridge BE 5576 which required partial demolition and reconstruction for widening.

1 Aerial view of site prior to commencement of bridge construction; note truck congestion in Bayhead Road
2 Aerial view of site showing progress with the construction of the Khangela Bridge
3 Launched deck factory

DESIGN DRIVERS

The design 'drivers' for the technical solution were lack of space (both vertically and laterally), the requirement to maintain rail (both passenger and freight rail) and road access on the M4 Southern Freeway.

The bridge was thus either launched over or constructed adjacent to existing infrastructure and did not interfere with the operational and user requirements of the following:

- Access to various commercial and industrial sites
- Four passenger rail tracks (with overhead live 3 000 volt DC traction lines)
- Albert Luthuli M4 Southern Freeway (six traffic lanes, bi-directional express way)
- Transnet Freight Rail (six rail tracks, access to North Coast and Port of Durban, with overhead live 3 000 volt DC traction lines)
- Multiple services, and the relocation thereof (water, storm water, electrical including super-tension cables, fibre optic cables and telecommunications)
- Public access and safety

INCREMENTAL LAUNCH TO SPAN SERVICES

The launching area was situated on the western side of the Metrorail tracks. The incremental launch decks were constructed first and pushed out over the piers. Each of the deck segments took approximately two weeks to cast on site. The concrete decks were cast in 18 metre long segments and when they had gained sufficient strength, were stressed and then pushed out along the piers using hydraulic jacks.

Some 48 precast beams were laid down and the deck slab covered them, leaving only an infill section of the bridge to be cast *in situ*. The land beneath this span was the only land without railway lines or other services after an existing railway traction substation had been removed. The cast *in situ* span was constructed between the incremental-launch section and the precast section. It was constructed last, from the bottom up, with conventional scaffolding and formwork. Void formers were used in the deck slab.

DECK DEPTH PRESENTS CHALLENGES

The three-bridge-type design had been drawn up to accommodate the clearances required for electrified tracks beneath the bridge decks. The incremental-launch type bridge works well when having to span the services below. However, in this instance the deck depth posed a problem beyond the fourth span, because the depth of the box girders were approximately 2,5 m. The *in situ* and precast spans are shorter because the distance between piers is shorter as they have to fit between the gathering tracks. This allowed for a shallower deck at only 1,2 m depth, but even at that, clearances were just met.

ALL RAILWAYS AND ROADS REMAINED OPERATIONAL

The benefit gained from all the extra effort was considerable. Neither the Metrorail lines nor the Freeway had to be closed for any period of time during the 32-month construction period. The Transnet Freight Rail lines were only closed during limited occupations to accommodate the lifting and placing of the precast beams.

Railway lines were slewed to accommodate heavy equipment for pile driving, capping and construction of the piers. Once the piers were in place, the lines were reinstated including some realignment. Work was undertaken in various stages and scheduled over weekends when there was minimal rail traffic.

OPERATIONAL COMPLICATIONS

Besides the rail- and road traffic considerations, there was also a plethora of other services that were not to be disrupted. The following services posed a challenge to the team:

- The overhead 3 000 volt power lines had to be slewed together with the rail lines.
- The traction substation was in the path of construction and had to be disassembled and replaced by two new substations – one for each rail network (Transnet and Metrorail).
- The electricity cables from a large municipal substation that services suburbs in the area had to be relocated.
- Fibre-optic cables that carry information for the major banks, for example, had to be removed or managed.
- Telkom cables, storm drains, water mains, sewers and many other infrastructure services were also affected.

This project certainly presented some tough challenges. It was quite a rare occurrence to have such a variety of disciplines involved on one project, and that in itself required tight planning, organisation and control for success.

PUBLIC INTEREST AND BENEFITS

For the majority of the infrastructure services that were affected there will be no direct benefit from the bridge. The only departments intended to directly benefit are eThekwini (Roads Provision) and the Port of Durban. However, all the service providers approved the project and cooperated fully with the project team. The construction of the bridge encroached on their space for approximately two years with no direct benefit to them. But the need for the bridge was clear to all and vital cooperation was forthcoming.

IMPROVED TRANSPORT INFRASTRUCTURE

Although there was no direct benefit to some stakeholders, there will be indirect knock-on cost benefits for the transport companies that have trucks waiting in the traffic snarl where Bayhead Road intersects South Coast Road, as vehicles leaving the port no longer need to turn at this intersection.

ENVIRONMENTAL AND PUBLIC INTEREST

All environmental statutory processes were adhered to and no deviations encountered.

Community liaison was undertaken continuously and construction operations were informed and moderated, when necessary, to respond to concerns and issues raised.

PROJECT MANAGEMENT

Spanning a 32-month period, the project was completed on time, on budget and to the highest quality and safety standards. The

value of the project was R180 million. Khangela Bridge and the associated road structure will leave a lasting legacy for the Port of Durban and the eThekwini Municipality.

ADDITIONAL TECHNICAL DETAILS

- Bayhead Road extension and Khangela Bridge:
  - Twin box incrementally launched section (127 m long, 4 span, 8 segments)
  - A cast *in situ* section (15,5 m long, one span)
  - Precast beam section (29 m long, 2 span) on precast pile foundation
  - Structure is on a hogging vertical curve (2 767 km radius, total width 24 m)
- Construction of four concrete load retaining walls, reinforced earth load retaining walls and associated earth and road layer works
- Relocation of pumping gravity sewer mains (100 mm, 150 mm and 450 mm diameter)
- Relocation of water mains (50 mm, 150 mm and 250 mm diameter PVC and 500 mm concrete lined welded steel)
- Deviation of electric power, telephone and coaxial communication cables
- Deviation for construction of bridge, and reinstating of railway lines including some realignment together with all the overhead electrical traction equipment
- Construction of two new electrical substations and relocation of all equipment. □

4 Preparation for *in situ* deck
5 The completed Khangela Bridge deserves a backdrop

Source:
http://www.saice.org.za/downloads/monthly_publications/2010/2010-Civil-Engineering-dec/#/0