

Civil Engineering

saice

March 2021 Vol 29 No 2

Sivili Enjeneereng



**THINKING LIKE AN
ETHICAL ENGINEER
IN CHALLENGING
TIMES**

**NO STEEL, POOR
SOIL: NO PROBLEM
FOR PRESS PLANT
CONSTRUCTION**

**WATER WEEK –
MOVING PAST
PROMISES AND
RHETORIC**

**T
R M PILING**

Upgrading the De Beers Interchange

The De Beers Interchange in the Western Cape dates back to 1970. Although the structure was in good condition, it needed to be widened to allow for an additional traffic lane as part of an upgrade co-founded by the City of Cape Town and South African National Road Agency Limited (SANRAL).



Chad Peacock
Engineer
HHO Consulting Engineers
chad@hho.co.za



Nadine De Mink
Technologist
HHO Consulting Engineers
nadine@hho.co.za

The De Beers Interchange (Bridge B4407) was originally constructed in 1970 over the N2 to the west of Somerset West. The bridge was designed as a four-span 70 m long continuously post-tensioned deck, to carry the R44. The superstructure rests on elastomeric bearings at the piers and abutments. The piers are 900 mm diameter reinforced concrete columns founded on pad footings, while the abutments are spill through type walls with stone pitching.

PRELIMINARY DESIGN

As-built information was provided, which allowed the designers to determine the load capacity of the existing structure. As the structure was constructed in 1970, it was assumed that the original design had adopted the BS 153 (1954) loading system in its structural analysis, which called for a uniformly distributed linear traffic load of 2 200 pounds per foot to be applied, along with a single heavy axle line load of 2 700 pounds per foot.

By comparison, current loading requirements prescribed by TMH7 Part 1 and 2 have requirements of 20% to 60% higher than the BS 153 loading code. Despite this, the existing structure was assessed using SOFISTiK finite element analysis software and deemed to comply with TMH7:1981.

WIDENING OPTIONS

The existing structure had sufficient capacity to comply with TMH7:1981, however



Aerial View of Completed pedestrian bridges (Credit: Bruce Sutherland)

further widenings of the deck would impose additional dead loadings that the structure would not be able to accommodate.

The initial proposal was a simple widening strategy that involved adding a lightweight steel sidewalk at the farthest edge of the deck to accommodate pedestrians, and thus allowing for the reconfiguration of the road layout on the deck. However, this proposal added too much dead weight to the existing structure and was not pursued.

The revised proposal involved building a new structural steel pedestrian bridge directly adjacent to the existing deck on both sides to accommodate pedestrians. This ensured that pedestrians could cross the bridge safely, while still allowing for a reconfiguration of the road over the deck. The structure would form an exoskeleton which incorporated a full height screen. This proposal was discarded due to potentially high maintenance costs because of the site's proximity to the ocean.

The proposed new pedestrian bridge option was then revised to reduce the

maintenance requirement over the lifespan of the structure. The result was a pre-tensioned concrete structure, comprising precast superstructure elements placed on an in situ substructure. The structure was also designed with a unique side profile to be visually appealing to the vehicle user below.

COLUMN IMPACT LOADING

Due to recent impact damage experienced by similar pedestrian structures, it was decided to increase the vehicle impact loadings that the piers would be required to accommodate. The resulting design is for triple the nominal forces required in TMH7.

PRECAST BEAM DESIGN & SEQUENCING

The superstructure is built up of three components: the precast beams, precast slabs and in situ stitching. The beams are designed to maximise their bending moment capacity at the mid span, while also maximising the shear capacity at the



Micro piling at the northern abutment (Credit: W Scheepers)

Completed piers (Credit: W Scheepers)



Night launch of precast beams over the N2 (Credit: N De Mink)

was allowed a 19-hour window over a weekend to launch the 12 precast beams. This resulted in two night launches of 10 and 9 hours each, for Saturday and Sunday night respectively. This accounted for the time required to transport the beams from the concrete yard, and the re-positioning of the crane truck on either side of the bridge. The inbound carriageway was closed on the Saturday night, and the outbound carriageway the Sunday night, and all the beams were successfully placed within the stipulated hours.

TRAFFIC ACCOMMODATION

To minimise traffic congestion due to the closure of the N2, traffic was directed to detours through intersections at Victoria Road / N2 intersection; Macassar Road Exit Ramp / N2; and through the Broadway Boulevard (R44) / N2 interchange via the exit ramps back onto the N2. This was achieved with careful interaction between the construction team and local traffic control authorities. □

supports. The beams therefore had a variable cross section over their length, which had to be considered with the design software.

Using SOFiSTiK, the beam was modelled using a parametric function which added a vertical curve to vary the cross section over its length. The results were checked against several spreadsheets and hand calculation techniques. The outcome is a visually appealing, structurally robust beam element.

FOUNDATION CONDITIONS

Due to limited space available in the road reserve, and the positioning of the pier foundations in proximity to the edge of the N2 roadway and existing embankments, sheet piling was used to preserve the layerworks and integrity of the embankment.

The beams and slab elements were manufactured offsite at the Cape

Concrete yard to very strict tolerances and brought to site prior to launching.

BEAM LAUNCHING

Part of the N2 highway at Broadway Boulevard Bridge had to be closed in order to place the precast beams. The contractor

Placing of precast concrete slabs (Credit: N De Mink)

