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SCORPION CREEK BRIDGE REHABILITATION, VICTORIA HIGHWAY, KATHERINE REGION

Abstract

The Victoria Highway is the only road link between the Northern Territory and Western Australia. When an overloaded vehicle crossed over Scorpion Creek Bridge after the heavy 2006 wet season, the severely scoured substructure gave way and punctured through the underlying shale. The puncture lead to a 75mm subsidence and overstressed concrete deck. The highway was closed immediately and a side track constructed.

The structure in its deformed position effectively weakening the bridge's load carrying capacity to the point that legally loaded trucks could not use the bridge. An innovative bridge jacking technique was used to provide a quick solution to a possibly large problem.

Advance Civil Engineering was awarded a contract to jack the bridge back into position. Due to the urgency to reopen the highway and the looming wet season approaching, Advance Civil Engineering slightly modified the DPI design to minimise construction time.

With a concerted effort by the project team, the bridge was reopened on time and was successfully restored by to its original condition.

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The Project

The Victoria Highway is the only road that links the Northern Territory and Western Australia. During the 2006 wet season, extensive flooding occurred along the Victoria Highway. Scorpion Creek Bridge was one of the crossings that experienced the extensive flooding. The bridge is located approximately 380km west of Katherine on the Victoria Highway. (Photo 1)

Photo 1 – Scorpion Creek Bridge in late 2005, before the 2006 wet season

During a routine inspection in mid July 2006, Department of Planning and Infrastructure (DPI) officers in Katherine noticed the bridge had suffered large amounts of scour underneath the envelope of the bridge. (Photo 2) The large scour had not been noticed until the inspection due to the high water levels from the preceding wet season hiding the evidence. The DPI Katherine Office requested an inspection by DPI structural engineer, Louise McCormick to assess the condition of the bridge. No structural damage was evident at the time.

Photo 2 – Scorpion Creek after the 2006 wet season

Upon inspecting the site, Louise concluded that the skew of the creek flow was hitting against a natural bank of hard shale. The extended wet season weakened the soil profile and the shale bank effectively concentrated the flow at the abutment creating one large eddie/whirlpool that continuously scoured the one position. The final scour depth was approximately 5m. Figure 1 shows the flow profile that created the scour.

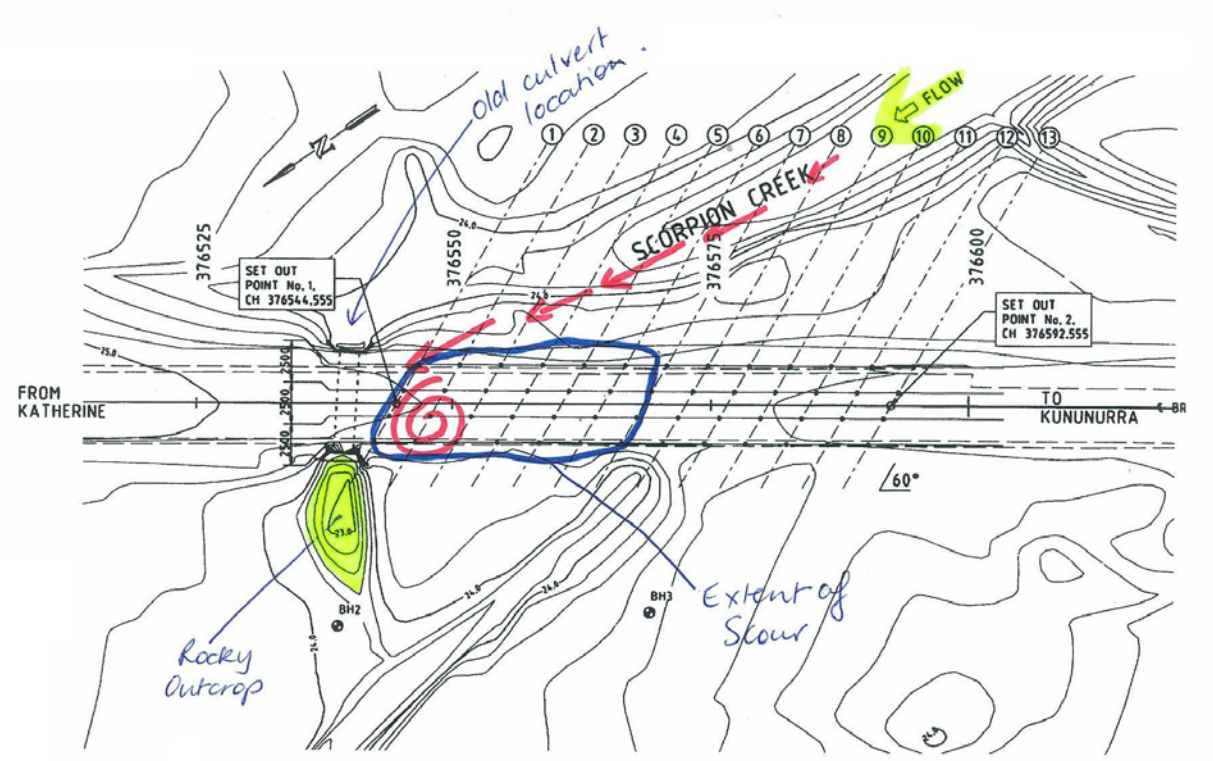

Figure 1 – Flow path of creek to encourage scour

Whilst the structural assessment report was being finalised, an unknown, overloaded vehicle is assumed to have crossed over the bridge at a great speed to produce enough impact on the bridge deck to puncture the piles through the underlying shale. This is the only plausible reason for the settlement as the bridge had withstood the scour for approximately 4 to 5 months without any signs of structural distress. DPI inspector Mal Hunnam, was the first to notice a large deflection in the bridge rail and closed the bridge to traffic immediately. (Photo 3)

Photo 3 – Deflection in the bridge rail

The DPI Katherine office immediately contacted structural engineer, Louise to inspect the damage. The inspection found that the bridge deck had deflected approximately 100mm (later surveyed to be 75mm). In bridge terms, this is a very large deflection and much larger than the code defined Span/800 allows. (The spans on Scorpion Creek Bridge are all 4000mm, which gives an allowable deflection of 5mm!)

The bridge was then officially closed until further notice and a side track was constructed following the confirmation of a structural problem.

Many structural cracks through the full depth of the kerb appeared where they had not been previously. (Photo 4. Note that a line has been superimposed to clearly map the typical crack pattern)

Photo 4 – Cracked kerb section

The kerb cracking clearly identified that there was an overstress problem. The change in support conditions for the deck produced tensile forces in the tops of the kerbs at the point of contra flexure. Figure 2 gives a graphical representation of the normal bending conditions of the deck under dead load and Figure 3 shows the over stress condition. Note in Figure 2 that the tensile stresses in the top of the deck are relatively even under dead load and in Figure 3 the vast difference in tensile and compressive deck stresses, again under dead load.

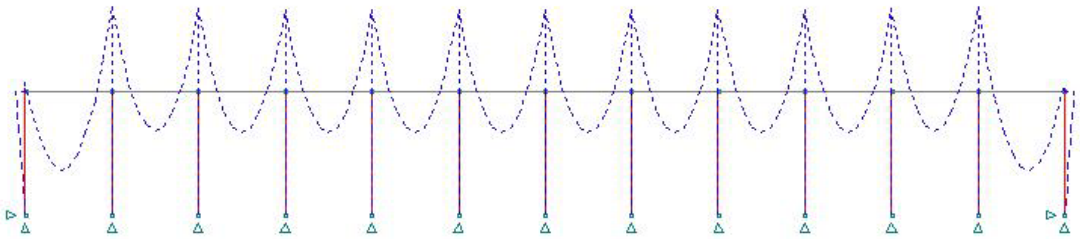

Figure 2 – Normal deck Stresses

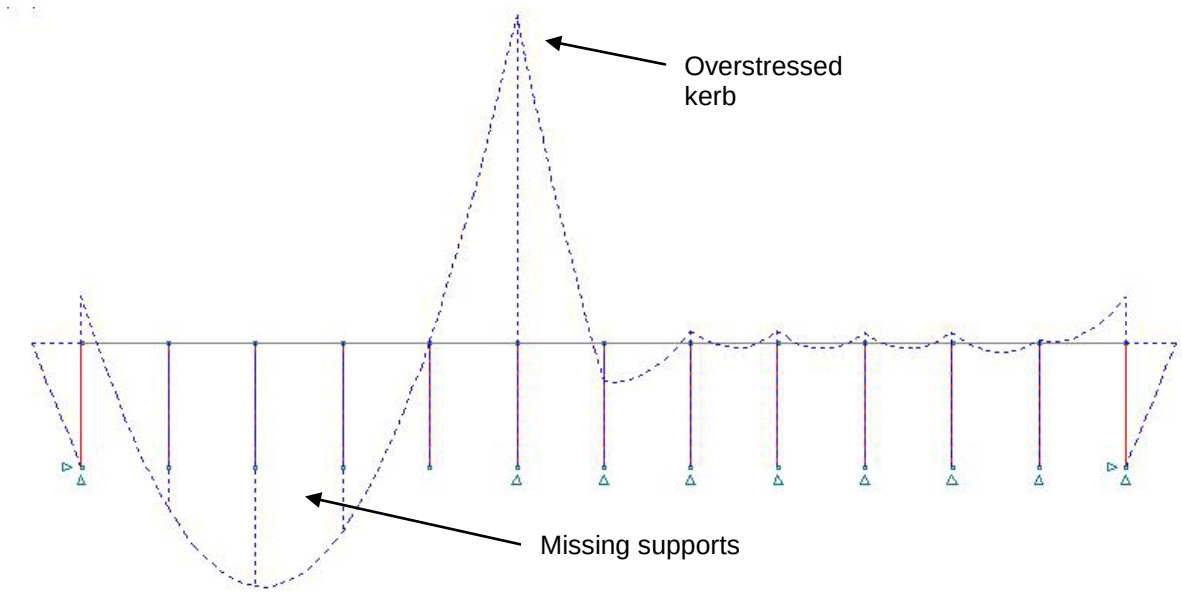

Figure 3 – Overstressed deck condition

The supporting soil that created friction forces for the steel piles had completely scoured away. This reduced the support capacity and effectively allowed the steel piles to puncture through the rock with the overload.

Analysis of the crack patterns and support conditions lead to one logical solution – to jack the bridge back into the original position. Jacking the bridge into the original position would relieve the deck stresses. Strengthening of the foundations was also investigated to prevent this happening again if scour occurs in future wet seasons.

Contract documentation and government approvals were initiated almost immediately and a contract was awarded to Advance Civil Engineering in early September.

Due to the length of time the highway had been closed and the looming wet season approaching, Advance Civil Engineering slightly modified the DPI design to decrease the time it took to reopen the highway. Six, 100t hydraulic jacks and Megashore props were used in succession to jack the bridge into position. Extra Megashore props were used to provide the safety supports to the bridge in case of a jack blow out. Photo 5 shows the general arrangement of the jacking equipment and photo 6 gives a closer view of the jacks and propping.

Photo 5 – Scorpion Creek Bridge Jacking

Photo 6 – Hydraulic jack and Maegashore support

The new foundations were also designed to act as the strong points for the bridge jacking points. However, this presented problems with the existing steel piles and their attachment to the new foundations. Advance Civil Engineering proposed casting of the existing piles into the new foundations, supporting the bridge from the Megashore props, cutting the existing piles and welding new steel sleeve to the extension of the existing pile. This worked remarkably well. Photo 7 shows one of the steel sleeves used on the project.

Photo 7 – Steel sleeves around piles to be jacked

The steel sleeves were also used to provide a datum point for measuring the displacement on each pile as the jacking progressed. (Photo 8 and Photo 9)

Photo 8 – Measuring the amount of displacement

Photo 9 – Amount of displacement on pile sleeve

After a couple of hours of carefully jacking and checking of cracks, the bridge deck was back to the same level it was originally designed to be. A few days later, the Scorpion Creek Bridge was back in service.

Technical Details

Project cost:	$0.5M (Ex GST)
Key dates:	Awarded 11 September 2007. Bridge jacking 20 October 2007. Original date for bridge to be reopen 27 October 2007. Actual bridge reopening 26 October 2007. Actual completion date 3 November 2007

Scorpion Creek Bridge is approximately 380km west of Katherine on the Victoria Highway.

The bridge has the following geometric and design parameters:

- Twelve, 4m continuous spans giving a total length of 48m;
- Designed for T44, HLP400 and NT road train design vehicles;
- The bridge is level with a 30^{o} clockwise skew and provides two lanes and shoulders to give a total width of 8.6m between kerbs;
- The deck consists of a continuous reinforced concrete deck with integral headstocks;
- The substructure consists of driven steel piles; and
- Bridge barriers consisted of the NT standard “half New Jersey parapets with two galvanised RHS steel bridge barrier system”

The rehabilitation solution details were as follows:

- New bored piles and pilecaps to four of the piers; and
- Jacking of the bridge to the original line and level using a particular jacking sequence to balance the stresses throughout the jacking operation.

Aspects of Engineering Excellence

The rehabilitation technique of the bridge was commendable mainly due to the complex nature of the bridge itself. Firstly, repair options of both a practical and economical nature were explored. Jacking the bridge back into its original position was determined to be the best solution to relieve the stresses in the deck. Leaving the structure in the deformed position and only strengthening the foundations would have left the stresses in the deck, effectively weakening the bridge's load carrying capacity.

Although bridge jacking is a common technique used for replacing bridge bearings, the jacking for Scorpion Creek was significant due to the complex nature of the structure. Scorpion Creek Bridge has a reinforced concrete deck which is both continuous and highly skewed, which has the effect of distributing load to all parts of the structure in a non-intuitive manner. Thoughtful analysis of the bridge was required to determine a jacking sequence that would not overstress any one part of the bridge at anytime. The jacking sequence required the stresses in the structure to be balanced at all times.

The precarious nature of the existing foundation material was not suitable for support the loads the jacks were going to carry. To ensure a steady and safe load bearing area, an innovative solution was to incorporate the new strengthened bridge foundations as the jacking point strong areas.

Advance Civil Engineering had only limited time frames to work due to looming wet season and urgency to reopen the highway. Replacing the purpose built jacking support frames proposed by DPI with "off the shelf" Megashore props cut down the construction time considerably. Extra Megashore props were also utilised to minimise the risk of dropping the bridge in case of a jack failure.

The bridge jacking was expected to take approximately two days to complete. It was actually completed in half a day.

Overall, the effort given by all on the project team produced a seamless transition of the Scorpion Creek Bridge back to its original condition.

Acknowledgment

Acknowledgement and Thanks should also be given to George Curran from SKM Darwin for his ingenuity and lateral thinking.

Attachment 1 Working Drawings

Attachment 2 List of People and Firms Eligible to Receive Award

SCOPRION CREEK BRIDGE REHABILIATION, VICTORIA HIGHWAY,

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