Barron River bridge (Kuranda)

Outcomes of Structural Management Investigation

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Queensland Government

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Contents

Image: Barron River bridge near Kuranda. © State of Queensland.

Summary

The bridge over Barron River near Kuranda is a 257-metre-long, high-level bridge that opened to traffic in 1963. The bridge is located around 26 kilometres north-west of Cairns on Kennedy Highway, which is the primary route between Cairns and the northern tablelands for standard vehicles and heavy vehicles up to 19 metres long. This section of Kennedy Highway carries around 9000 vehicles per day, including around 1100 heavy vehicles.

Due to its age and unique design, the Department of Transport and Main Roads (TMR) has been closely monitoring the condition of the bridge for many years. Investigations initiated in 2015 led to the discovery of fatigue cracks in several steel elements of the bridge and in February 2019, TMR imposed a 50.5 tonne load limit to manage heavy vehicle impacts. In November 2020, TMR imposed changed traffic conditions to manage the risk of fatigue and brittle fracture.

The bridge has been operating as a single lane structure with a reduced speed limit and traffic management in place and loads have continued to be limited to 50.5 tonne. During this period, the bridge has been inspected at all critical locations with short-term repairs completed. Cameras and sensors have been installed to measure the performance of the bridge and the control measures.

The remediation works have been successfully completed and it is safe to reopen the bridge to two lanes for vehicles under 50.5 tonne, with pedestrian access moved to the southern side of the bridge and a speed limit of 60 km/h. TMR will continually assess the effectiveness of these control measures and revise them if necessary.

With the bridge reopened to two lanes, TMR will continue investigations into short, medium and long-term options for the bridge that will allow the removal of the weight restriction, allow the operation of larger, heavier vehicles, and increase pedestrian safety.

Investigations

In 2020, Arup undertook structural assessments that:

(1) identified locations that were vulnerable to fatigue cracking, mainly associated with welds in steel girders

(2) concluded that theoretical fatigue life had been reached at some of these vulnerable locations – a consequence of:

  (a) 60 years of trucks crossing the bridge

  (b) an increase in the mass of trucks by around 50 per cent since the bridge was designed

  (c) fatigue sensitive details incorporated in the bridge

(3) showed that the bridge could support the current 50.5 tonne freight vehicles, subject to the satisfactory management of the risks of brittle fracture

(4) recommended TMR consider instrumentation of the bridge to measure the actual stresses and loads in the bridge to update the fatigue and brittle fracture analysis.

Targeted inspections subsequently identified fatigue cracks in some welds. To manage the risk of fatigue and brittle fracture, it was concluded the bridge be operated as a single-lane bridge with access limited to 50.5 tonne freight vehicles. TMR implemented this change in November 2020 and started a program of inspections, testing and remedial works.

Consequences of brittle fracture
Brittle fracture is initiated when a combination of brittle steel, stress and cracks exceed a threshold. If cracks and loading on the bridge were left unmanaged, and a brittle fracture were to occur in a bridge girder, the chain of events that could follow is difficult to predict but could lead to the partial collapse or the collapse of a segment of the bridge.

In early March 2021, TMR installed a monitoring system on the bridge and its approaches. The cameras and sensors

record the response of the bridge to traffic and provide TMR with information about compliance and the effectiveness of the control measures.

As part of the investigations, the original lead paint was carefully removed at more than 1000 locations across the bridge. Access was provided via a specialist under-bridge inspection vehicle positioned on the bridge deck. The cleaned areas were carefully tested via Non-Destructive Testing (NDT) which identified fatigue cracking in more than 150 welds across the structure. Immediate short-term repairs were undertaken by removing the cracks and in some cases rewelding the steelwork.

The paint coating at the testing locations was replaced to prevent corrosion and to more easily facilitate future NDT inspections on the bridge. Ongoing NDT inspections will ensure appropriate management of any future risk of brittle fracture.

To date, the cameras and sensors have recorded traffic for six months. Load tests were undertaken to calibrate the sensors monitoring vehicle compliance and the effectiveness of the single-lane operation of the bridge. The data has also been used to verify modelling for the rate of fatigue damage and combined with the NDT results to update the expected fatigue and brittle fracture behaviour of the bridge.

The updated modelling indicates that the rate of fatigue damage is less than predicted. This reduces the risk of a fatigue and brittle fracture occurring to safe levels. Moving the pedestrian access from the northern to the southern side of the bridge and the inclusion of a 60 km/h speed limit further reduce any risks.

As a result, it is safe to reopen the bridge to two lanes with a limit of 50.5 tonnes.

TMR will undertake regular NDT inspections at appropriate intervals.

Trials were conducted with pedestrians and bike riders on the southern side of the bridge and the traffic operating in the proposed revised lanes to confirm the structural modelling e and the viability of two-lane operation.

TMR is currently investigating further solutions for the short, medium and long-term operation of the bridge.

Conclusion

The Barron River bridge at Kuranda was constructed using brittle steel. The identification of fatigue cracks increased the assessed risks associated with the brittle steel, which compelled TMR to act by implementing changed traffic conditions in November 2020.

The remediation works have been successfully completed and it is safe to reopen the bridge to two lanes for vehicles under 50.5 tonne, with pedestrian access moved to the southern side of the bridge and a speed limit of 60 km/h. It will be necessary to undertake NDT inspections at critical locations in early 2022. These inspections will require changed traffic conditions on the bridge, including a single-lane closure for one to two weeks.

Next steps

The reopening of the bridge to two lanes requires line marking changes to place pedestrians, bike riders and road users in the optimum position to reduce risk of fatigue and brittle fracture. The lowered speed limit of 60km/h will improve safety and further reduce fatigue impacts. Other considerations include lighting, the locations for pedestrians to cross the Kennedy Highway and signage on the bridge.

The monitoring of the stresses in the bridge will continue to provide information about compliance and the effectiveness of the control measures. TMR will review the 50.5 tonne load limit regularly.

Access by other vehicle types, such as cranes and low loaders, will need to be evaluated on a case-by-case basis to ensure that the stresses within the bridge are controlled to the current levels.

In March 2021, TMR announced a $2.1 million planning project to assess options for rehabilitating and strengthening or replacing the bridge. This planning has commenced, with a Preliminary Evaluation scheduled for completion in late 2022.