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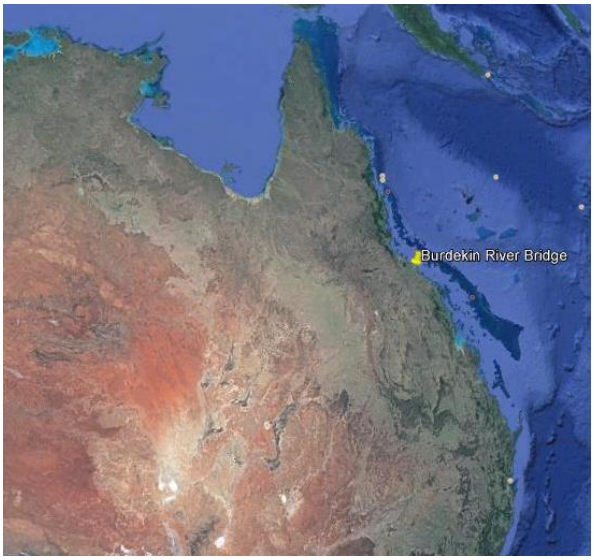
Burdekin River Bridge Maintenance and Rehabilitation Project- North Queensland

Bridge history and construction



The Burdekin River Bridge, known locally as the 'Silver Link', is a high-level, dual purpose bridge located on Queensland's major north-south route, the Bruce Highway. The 1 103 metre bridge spans the Burdekin River, between the townships Ayr and Home Hill south of Townsville.

After the previous Burdekin River Bridge (a vital link between North Queensland and southern areas of the state) was regularly closed due to flooding, construction of the higher, more flood immune bridge began in 1947. Without the higher level bridge, motorists would be forced to take a 355 kilometre alternate route to reach Townsville during wet weather closures.

When originally being planned, no trace of rock could be found on which to build the bridge foundations. However, in 1946 after officials visited bridges constructed in similar settings in India, the Queensland Government applied the same technique for designing the Burdekin River Bridge. As a result, the bridge is said to be the only bridge in Australia that has been built without a firm foothold.

The bridge comprises a single rail track, 10 main spans, 22 approach spans and a pedestrian walkway. The structure is comprised of steel trusses on the main spans and steel girders on approach spans which are supported by reinforced concrete piers and 11 caissons sunk into the river bed. The caissons are 17 metres across at the top, with their widths varying between 5.5 metres and 7.6 metres.

Each of the caissons were sunk approximately 30 metres into the sandy river bed and rise approximately 20 metres above the river bed, making a very impressive structure.

The bridge is 12.8 metres wide, with 6.7 metres of roadway and a rail track bordered by a pedestrian walkway; allowing foot traffic as well as motorists, heavy vehicles and trains.

235 various tradespeople and labourers were employed at any one time during construction. It was a feat of engineering, requiring:

- 7 000 tonnes of high strength steel (sourced from overseas suppliers due to a shortage during World War II)
- 300 000 high strength bolts and washers (used in place of rivets, unlike all other Australian bridges at that time)

- 32 000 cubic metres of concrete

The bridge was officially opened to traffic, by the Premier of Queensland V.C Cair, on 15 June 1957 after more than 10 years of construction.

The Burdekin River Bridge is slightly shorter than the Sydney Harbour Bridge (1 149 metres), but was well surpassed when construction of the 2.7 kilometre Ted Smout Memorial bridge was completed in 2010.

That same year, Engineering Australia awarded the Burdekin River Bridge an 'Engineering Heritage National Landmark' award, which recognises significant engineering heritage works judged to be valuable to a group of people, or have contributed something of value to the nation, a region or to the practice of engineering.

More than 7 000 vehicles now cross the bridge on a daily basis.

Maintenance and rehabilitation works

In 2006 the Department of Transport and Main Roads, who are Queensland Government agency in charge of major roads and bridges, engaged an external consultant to carry out a full inspection of all ten main spans.

In June 2008, TMR – along with Queensland Rail (who own the Burdekin River Bridge rail line) and RoadTek (TMR's commercial transport infrastructure solutions operation) – established the Burdekin Bridge Alliance.

The main aim of the Alliance was to deliver a $43.75 million program of maintenance works under the *Burdekin River Bridge Maintenance and Rehabilitation Project*, to preserve the integrity of the bridge and ensure a safe and durable crossing is maintained for the long term use of motorists, transport operators, pedestrians and the agricultural industry.

The Burdekin River Bridge Maintenance and Rehabilitation project (jointly funded by the Australian and Queensland Governments, with contributions of $25 million and $18.75 million respectively) is the first major structural rehabilitation work undertaken since the bridge was constructed.

These project works directly responded to the inspection report, with repairs prioritised on a span by span basis.

The works will see a wide variety of repairs and safeguarding works carried out on the Burdekin River Bridge, as well as the installation and implementation of initiatives to improve future maintenance. The program of works includes:

- internal and external inspections of the bridge piers
- structural repairs to all main trusses and approach spans

- preventative, reactive and programmed patch painting of the main truss (including main walkway)
- maintenance, inspection and rehabilitation of all existing upper and lower working gantry platforms
- inspecting, cleaning and routine maintenance of the structure other than the running surface and rail track (for example cleaning scuppers)
- development of new work procedures and development of a technical manual for the project
- installation of new link beams to link all main spans to enable future maintenance works to be completed more quickly
- sandblasting of rusted areas and spot welding where required
- re-asphalting and new line-marking on road approaches to the bridge
- testing and replacement of extension joints.

Works were progressing well towards the original Alliance end date (June 2014), however the contract was extended in June 2014 for an additional four years. The additional time was primarily due to the significant increase in work, above the 2006 inspection results, and also allowed for:

- total removal of existing paint, clean and total repaint all approach spans
- paint trial to determine the future painting system
- a full lighting assessment, leading to the removal of existing overhead lighting system and replacement with LED system
- top gantry rehabilitation (the gantry was lifted off the bridge and placed on a nearby pad for rehabilitation)
- replace barrier railings
- repairs to the pedestrian walkway.

Structural repair works on the top structure of all ten spans and bottom structure of four spans are now completed.

Quality Management

Materials

Due to the complexity of the bridge and support structure, many of the materials had to be rigorously tested for suitability before being used on the bridge rehabilitation project.

A strict testing regime was adopted for procurement of high-tensile bolts. As most of the samples initially provided by Australian suppliers failed during mechanical tests, a supplier on

the Gold Coast of Queensland (some 1 300 kilometres from the bridge location) was eventually commissioned to manufacture bolts.

A number of bolt samples (from the steel batch, manufactured from the batch prior to start of production, from mid-way through the production process and random samples from the completed batch) were tested prior to acceptance by TMR; as were steel nuts, nut & bolt assemblies and washers.

High tensile bolts were (and continue to be) procured from a local supplier, once test results from a National Association of Testing Authorities (NATA) registered laboratory were provided and suitability for the project guaranteed.

Following quality assurance, a zinc-rich paint (Zinga) was selected for patch painting on the bridge due to the unique ability to rejuvenate itself even after a period of months or years.

Once applied, the Zinga product will activate the initial coating to form a single coat even though it has been applied in different timelines. No other product was available to provide this same quality, which greatly improved the appearance and durability of the paint surface.

Before applying Zinga, the steel bridge surface requiring painting is cleaned to bare metal either by needle gunning (for smaller areas) or blast cleaning (larger areas, corners and crevices). A coat of Zinga is then applied with a brush to achieve a target wet film and dry film thickness, depending on the surface profile.

Wet and dry film thicknesses are measured for every patch paint.

To further guarantee the works and durability, adhesion tests are carried out to determine how well the paint system adheres to the bare metal or existing surface.

Services

Quality testing was not limited to just materials, with many services also rigorously tested.

Boilermakers are subject to an annual assessment process, which includes visual inspection and testing of sample welds. Randomly selected permanent welds carried out on the bridge are also tested by ultra sound testing. Failures result in not only redoing the failed weld/s, but also all other welds performed on the same day.

Environmental Performance

Due to its presence in the previous bridge paint, management of red lead is an integral part of the environmental management plan for the Burdekin River Bridge Maintenance and Rehabilitation project.

When removing previous paint by blast cleaning, the area is surrounded by a temporary enclosure and waste (existing lead paint as well as garnet, the blasting media) is collected by a powerful vacuum system. This reduces the risk of lead being airborne into the nearby environment, or contaminating the Burdekin River.

The vacuum waste is stored in steel drums, labelled and disposed by a regulated waste disposal company.

As part of the environmental management plan, project staff regularly test samples from the surrounding area (including air samples close to the blast face, the riverbed immediately below and nearby grasses) for lead content.

In addition to the contamination risk, the Burdekin River Bridge Maintenance and Rehabilitation project team also manage the risk of lead ingestion by workers. Regular testing is carried out to determine blood lead levels and, if an increase in lead level is indicated, the employee is allocated non-lead related tasks. The employee is only able to return to normal duties after further medical assessment, and once blood lead levels reduce to with safe limits.

Safety Management

TMR, Queensland Rail and RoadTek are very thorough in managing the safety and wellbeing of all workers on the Burdekin River Bridge project.

Only those trained in working at heights, in confined spaces, from mobile man cages, with lead and in rescue operations (rescue a worker from various locations of the bridge) are employed to undertake works.

Purpose built mobile rescue platforms are available on-site and annual rescue exercises are carried out.

Innovations

Several innovative processes were used on the Burdekin River Bridge Maintenance and Rehabilitation project, including:

Magnetic induction removal of existing lead paint

Magnetic induction removal (MIR), a relatively new technology, allows for removal of lead paint from the bridge structure without the need to totally encapsulate the work area. MRI sends an alternate current, through an induction coil, generating an electromagnetic field in the steel member. The electromagnetic field generates heat in the steel (below the paint coat) which disbands the paint, making it easier to remove with a hand held scraper.

It is a highly cost effective and efficient method of removing paint from a steel surface. And, given the lead content, is also environmentally friendly.

LED lighting system

Following regular lighting disruptions and high maintenance costs, the Burdekin River Bridge Maintenance and Rehabilitation project team began a trial of LED lighting in early 2016. This represents the first TMR bridge infrastructure in Queensland to have LED lighting.

Previous incandescent lighting had to be replaced regularly due to vibration from the high daily vehicle volumes across the bridge.

The new LED lighting has a longer life span given the traffic vibrations, and has also been found to be more visible to motorists during adverse weather conditions and at night.

Based on the results of the trial, the department has continued to install LED lighting in lamps and posts on approach to the bridge.

Finite element modelling

No complete structural analysis system was available to assess the impact of defective or damaged components at the commencement of works. When advised of a potential problem structural engineers analyse the structure from first principals, which is time consuming and costly.

The entire super structure is modelled in Finite Element Computational Model. The model enables the project team to understand the complex behaviour of different material and bridge components under a variety of load and duty cycles, providing accurate results for new or amended work procedures with predicted stress/strain forces in operating conditions.

The Burdekin River Bridge Maintenance and Rehabilitation project is progressing well under the Burdekin River Alliance, and is on track for completion in June 2018 (although maintenance work on the bridge will be ongoing).

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