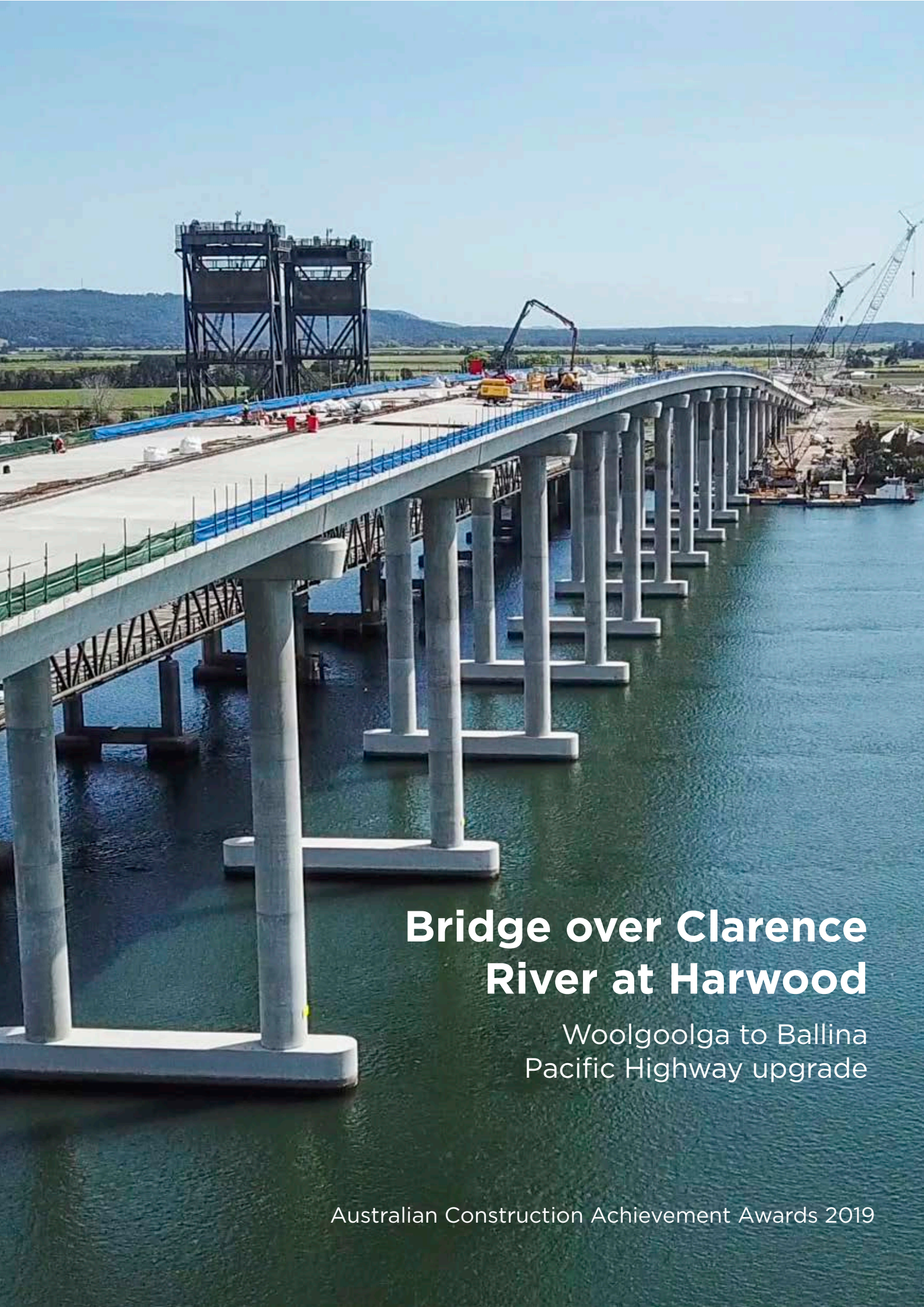


Bridge over Clarence River at Harwood

Woolgoolga to Ballina Pacific Highway upgrade

Australian Construction Achievement Awards 2019

Key features

1.5 kilometres long, dual carriageway

30 x 30 metre navigational clearance

Deepest pile casing in the Clarence river reached 67 metres

144 tonne fully hydraulic impact hammer used to drive piles

Land piles were installed in segments and spliced together in-situ

6 kilometres of steel piles

144 girders, 43.7 metre long and weighing 168 tonne

65 workers making the girders, manufacturing 4 girders per week with 2 moulds

23 piers on the land, 13 piers over the river

31,500m² of transfloor panels

72 deck spans poured

798 parapets

39,500 cubic metres of concrete and 9,920 tonnes of reinforcing steel

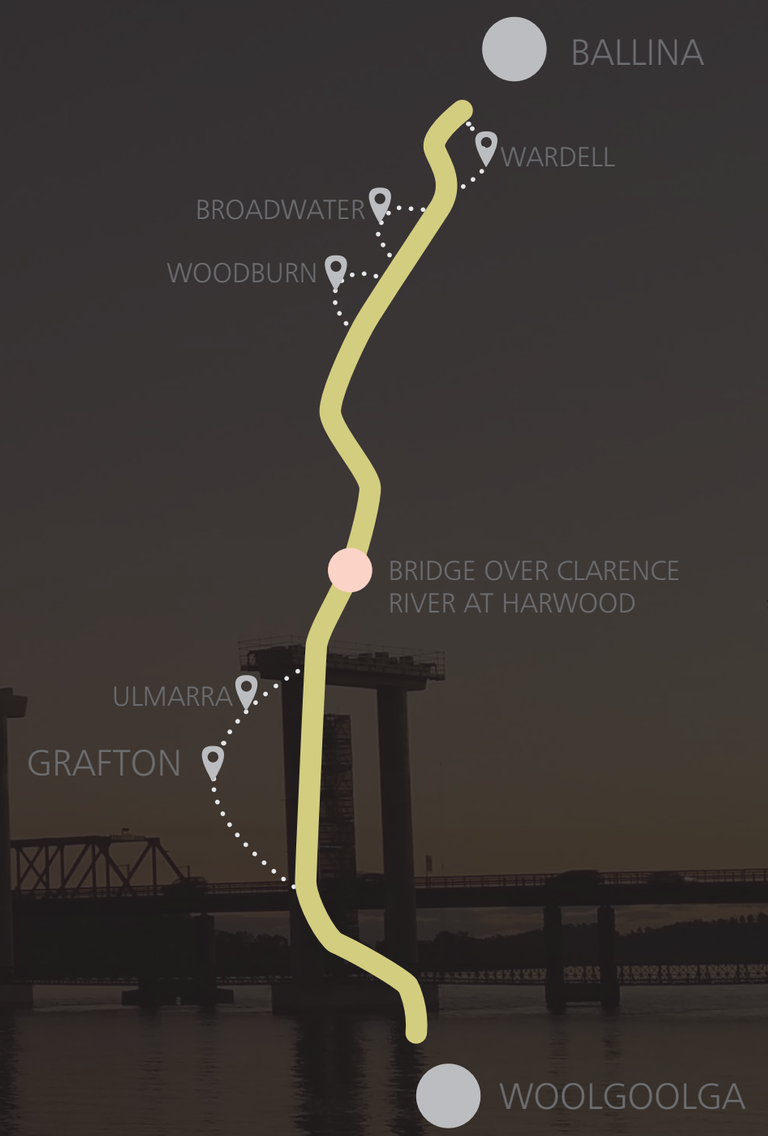
75,000 cubic metres of fill placed

About 397 people at peak employment

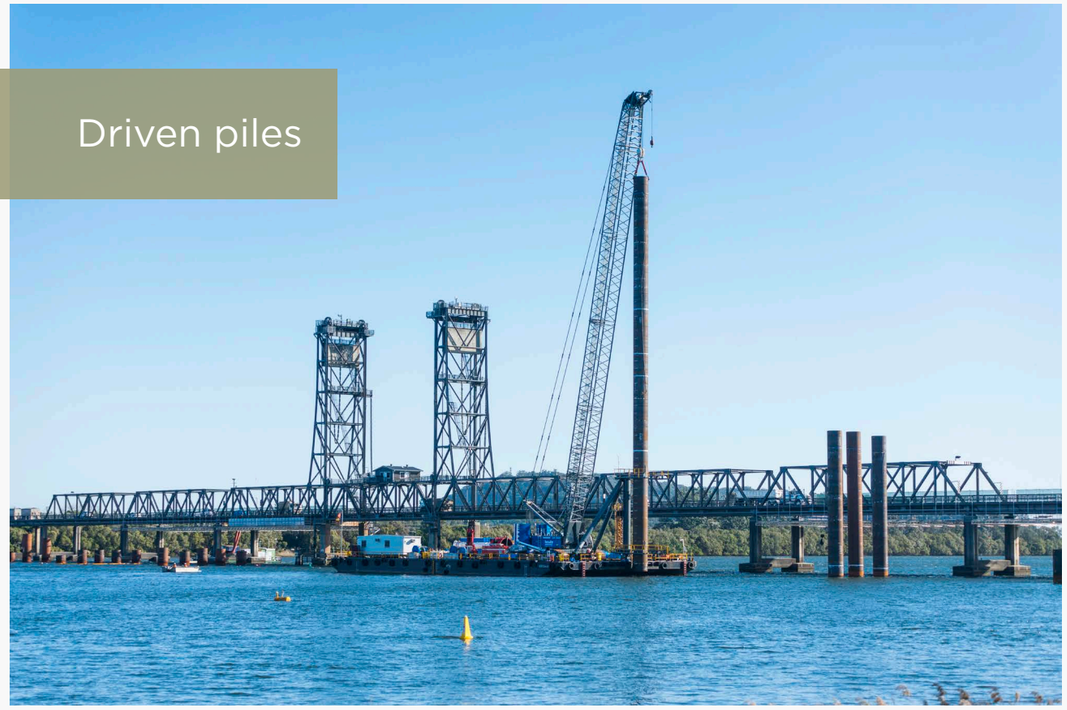
The new bridge over Clarence River at Harwood (the Project) forms part of the Woolgoolga to Ballina Pacific Highway upgrade (W2B). The 155-kilometre upgrade between Woolgoolga and Ballina is the last Pacific Highway link between Hexham and the Queensland border to be upgraded to four lanes. Twenty-six kilometres opened in 2017 and the remaining sections are due to open in 2020.

The new bridge over the Clarence River at Harwood is about 20 metres east of the existing bridge, 1.5 kilometres long and four lanes wide. The new bridge will provide safer, smoother travel for motorists and eliminate the need for highway motorists to stop while the existing Harwood Bridge is raised for maritime users.

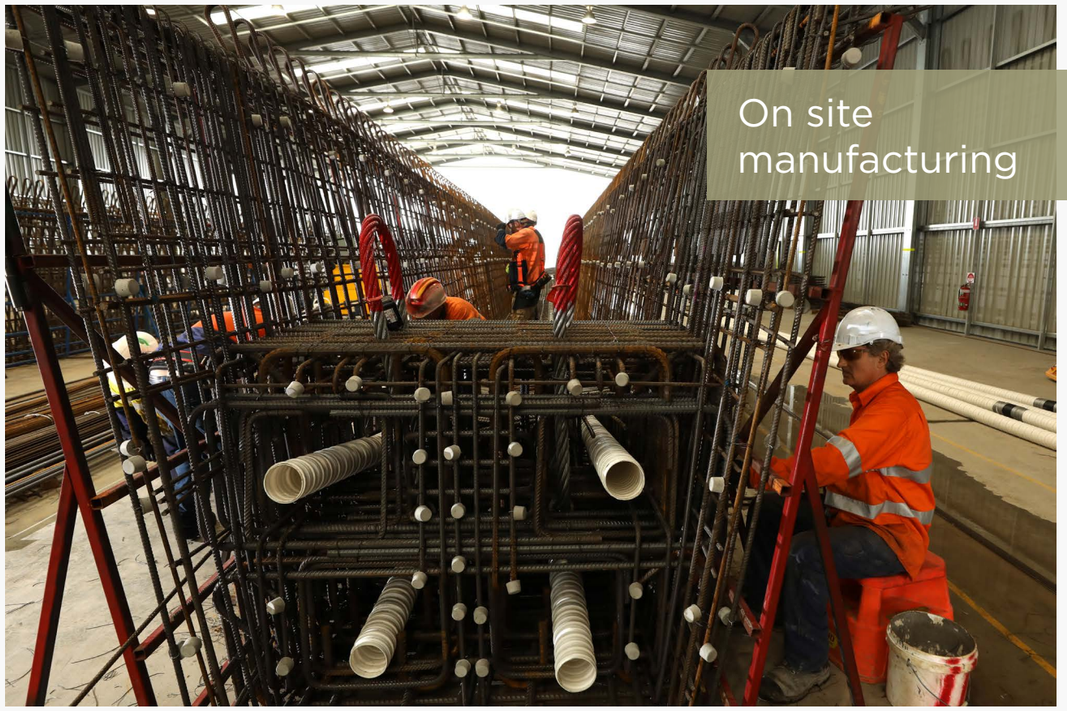
Pacifico worked collaboratively to deliver the new bridge over the Clarence River at Harwood under a design and construct contract.



July 2016	**Pacifico appointed**
April 2017	**First land pile driven**
May 2017	**Rebecca Lily barge arrive from Singapore and first marine pile driven**
August 2017	**First headstock poured**
December 2017	**First U-girder lifted onto headstock**
July 2018	**Installation of U-girders complete**
September 2018	**Deck pours complete**
Devember 2018	**Start of asphalt work**



Driven piles



On site manufacturing

Girder transportion

Installation of girders

The design

Pacifico worked alongside ARUP (the Designer) and Cardno (the Proof Engineer) to lead and guide the design phase.

The project scope included the design for a 1,542 metre long bridge with 36 spans of varying length and a maximum span length of 44.425 metres. Pier locations within the river aligned with the piers of the existing Harwood Bridge with expansion joint locations over land.

A uniform superstructure solution were adopted for the full length of the bridge which consists of T post-tensioned twin U-girders with a composite transfloor/cast in-situ deck slab supporting each carriageway. The northbound and southbound carriageways are supported by twin superstructures on a common substructure with a 50 millimetre nominal separation.

The decks are comprised of twin U-girders with a precast transfloor panel, in-situ deck supporting each carriageway by a single reinforced concrete headstock on two 2.2 metre diameter circular columns.

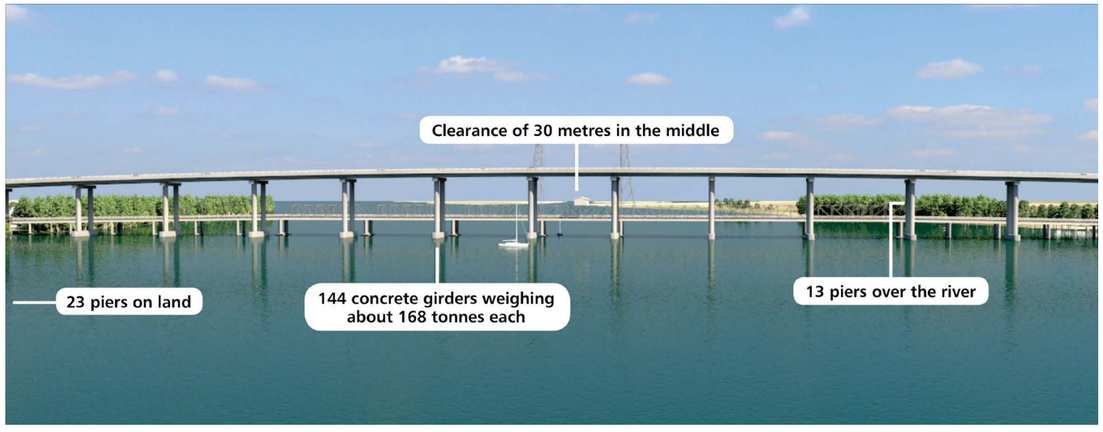
A typical cross section for a standard 10.5 metre wide carriageway consists of five super-T girders with a cast in-situ concrete deck.

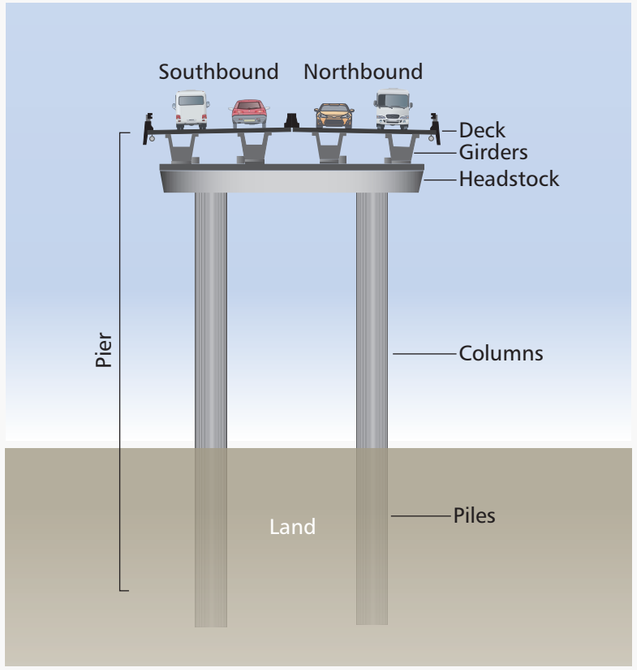
By making use of U-girders, this project is structurally more efficient, from a technical, cost and construction perspective. Using twin U-girders resulted in enhanced acceleration of the construction program and minimisation of the number of girders required.

In addtion, finger plate joints (Freyssinet WP350) have been installed at the abutments and sinus plate modular joints (Mageba LR10-LS85) at Piers 10 and 24. Modular joints were also provided with Robomute noise curtains underneath to limit noise propagation.

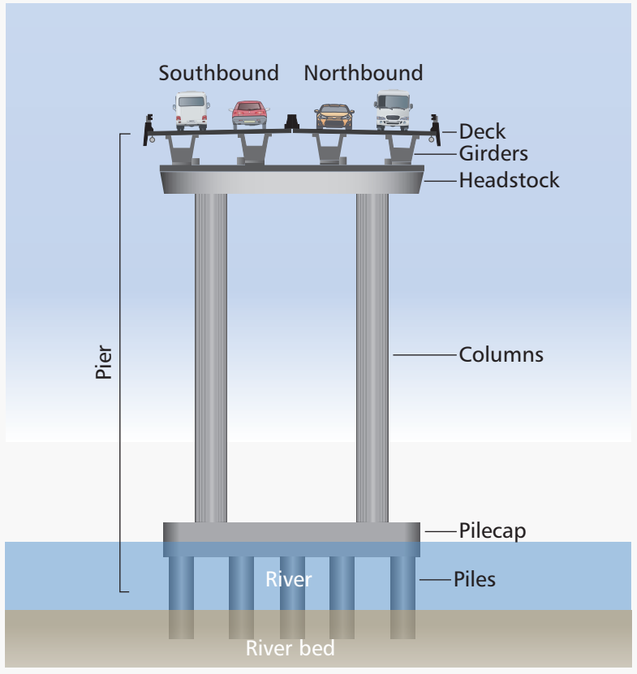
Throughout the design phase, weekly design group meetings were held to review, improve and approve design packages. Safety in design workshops were also held at an early stage of design to identify and design out safety risks.

To ensure continuous improvement, lessons learnt workshops were conducted to ensure continuous improvement from all aspects, including design.





Cross section of bridge over land

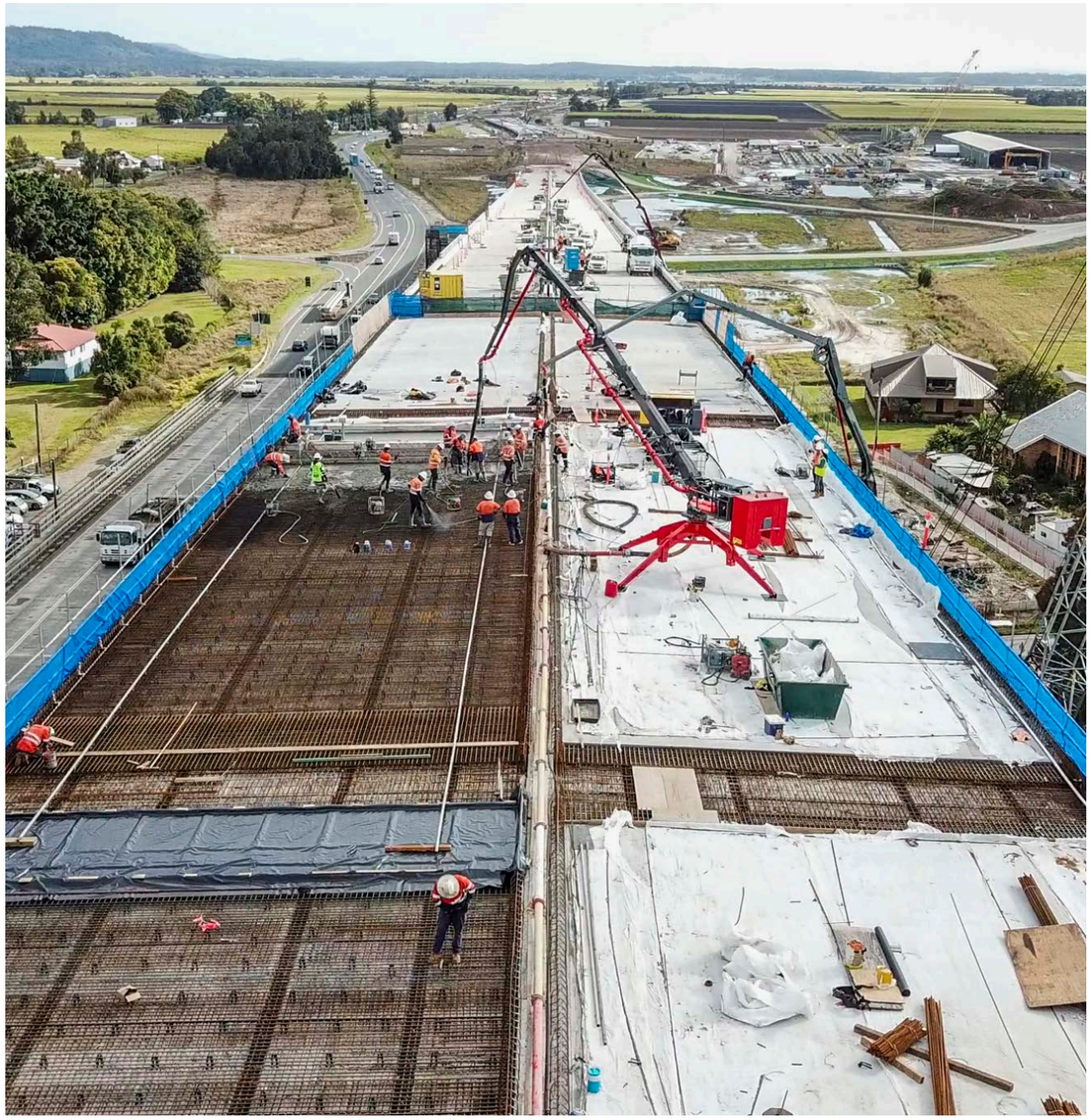


Cross section of bridge over river

Project initiatives

All planning of design, procurement and construction operations were undertaken in accordance with the Contract Program. This was the overarching program developed in Primavera P6 and submitted for review on a monthly basis.

The construction team also developed more detailed programs for specific activities to provide surety that the milestones outlined in the Contract Program would be met. For some activities this included aligning the detailed program with a visualisation of the work using the 3D BIM model to create a 4D model. This method of planning was particularly effective to refine the marine construction activities and optimise the number of barges required to complete work concurrently without clashing with other barges or marine activities.



"Spider" placing boom

A "Spider" placing boom was used for concrete deck pours at the marine spans where access is restricted. This is an innovative type of concrete boom which can be set up at a static location adjacent to the concrete pour and provides a working radius of up to 25 metres. The concrete is pumped to the Spider boom using a traditional concrete pump and static line. However, the use of the Spider boom eliminated manual handling issues associated with only utilising a static line on ground for the concrete delivery and placement.

Geotechnical investigation

An innovative geotechnical investigation was developed which combined the use of conventional boreholes and sonic drilling methods to provide improved recovery of gravel and cobble materials in the variable geological sequences. Cross hole seismic testing, natural gamma logging and a suite of marine geophysical tests (sub-bottom profiling using seismic reflection, continuous marine seismic reflection and bathymetric survey) was then used to profile the ground and predict with increased level of accuracy the founding level of the piles. Dynamic analysis monitoring was undertaken on all driven piles to provide further confidence of pile capacities and ensure quality control was achieved.

Box trials and concrete thermal modelling

One of the most challenging requirements on this project was a maximum core temperature limit of 70°C for mass concrete pours. This was intended to minimise the risk of delayed ettringite formation (DEF). The use of hot box trials and concrete thermal modelling to ensure that the mix designs that were developed would comply with concrete temperatures was critical to achieving compliance with this requirement.

Treatment of Acid Sulphate Soils

Pacifico performed a trial on using Electric Arc Furnace Slag (EALFS) as soil amendment to acid sulphate soils (ASS). Conventionally, ASS soils are treated with agricultural lime to neutralise its acidic pH. The objective of the trial is to confirm that a by-product of steel recycling, which is EALFS could be used to treat ASS soils in lieu of agricultural lime with an additional benefit of improved soil mechanical properties. Advantages include increase in reuse of ASS soil as engineering fill, recycling of industrial by-products and reducing our carbon footprint in the process.

Environmental management

The project avoided producing any hydrocarbon spills in the Clarence River by undertaking risk workshops and consultation with environmental agencies to implement proactive controls such as wrapping or sheathing of hydraulic hoses and bunding of all liquids on barges. Barges were inspected during fit out by the project team and environmental agencies prior to undertaking works to ensure all necessary controls above were in place.

Clearing of vegetation for construction work was minimised to 30% of the approved clearing area. The clearing of mangroves was minimised through the redesign of the temporary jetty and temporary works areas such as crane pads.

Building Information Modelling (BIM)

3D models have been used to provide visualisation of the design, for design coordination and to improve the quality of communication with project stakeholders and the community. Temporary work, plant, equipment and logistic 3D models were produced in-house and federated with the permanent design models. This federated model was used to produce construction sketches to obtain detailed insights of the work activities, working areas, exclusion zones and site constraints.

3D models were used extensively to plan construction activities on site and were linked with the construction program to produce 4D models. Coordination meetings were held frequently during the construction process where 4D models were used to validate, and at times modify, the program in order to optimise equipment and working crews. The 4D construction sequence video was also presented during Site Inductions providing visual representation to those joining the project.

The involvement of supply chain in the adoption of BIM benefited all the parties. Sub-contractors models were validated against the permanent design model, and where discrepancies were identified they were discussed during coordination meetings.

High risk elements of the project were managed effectively through the use of BIM. For the transportation of the 44 girders at night, the digital construction planning allowed Pacifico to check and validate all the possible spatial constrains in 3D. This enabled effective communication of the construction methodology with stakeholders and the night crew on a daily basis.

The metadata embedded in the model, the "I" of BIM, has been used to link the site engineer's progress records with the 3D model and updated automatically on a daily basis. The model can be accessed via a secure cloud (weblink) allowing for the team to view construction status in real-time.

Smart phone apps were made available for model visualisation on site, reducing the need to carry out 2D prints that can be easily superceded. This ensured that the engineers were always looking at the latest available information.

Project team leadership

The contractual framework is unique operating under a delivery partner model and does not include a project verifier. Pacifico was the principal contractor awarded the package to deliver the bridge over the Clarence River at Harwood. Working collabertively has been key to project success and resulted in reaching milestones consistently to ensure project delivery.

Eduardo Gutierrez | Project Director | Pacifico
MSc C. Eng, MIEAust, PMP, ICCP

Eduardo Gutierrez, professional civil engineer, member of Engineers Australia, has been working in the construction industry for 20 years, developing the first part of his career overseas, where he delivered, as project director, major design and construction civil projects with high complexity structures such as bridges and tunnels. He is passionate about bridges, with experience in precast segments, balanced cantilever, precast girders, upper deck arches and suspended bridges.

Eduardo enjoys project management, enhancing the highest performance of the team through commitment and engagement, satisfying all the stakeholders, including workforce, local community, supply chain and the client.

Sebastian Bogaczyk | Construction Manager | Pacifico
MSc C. Eng, PIIB, ZMRP

With over 19 years of experience working on large international infrastructure projects Sebastian brings a broad range of specialist skills in areas such as construction, programming, cost control, quality and safety. His expertise is focused on bridge and underground structures which has enabled him to work as part of a team to achieve client satisfaction and project cost savings through innovative improvements in construction and management. Throughout his career, Sebastian has developed strong relationships with clients, vendors, subcontractors and senior managers alike and is able to work effectively as part of a team.

Logistics and constraints

The logistics and operations strategy assisted in the successful delivery of the project. In order to minimise disruptions to the public and ensuring the control of crucial activities, Pacifico established a large compound north of the construction site (about 5 hectares).

The compound consisted of:

- site compound with offices, including carpark
- welfare facilities for the workforce
- welding area for splicing the steel pile liners
- prefabricated reinforcement steel cages area for pile caps and headstocks
- precast yard for the manufacture of the U-girders and edge parapets
- Acid Sulfate Soils Treatment Area
- precast concrete members storage with specific area for uploading onto trucks
- concrete batch plant for the exclusive use on site, including aggregate stockpiles

In addition to the site facilities, the construction of rock platforms for crane operations ensured not only the access to the bridge work, but the access to the temporary jetty installed on the Northern river bank. The jetty was key to connecting the land with the river barge fleet, delivering through it all the materials and plant necessary for construction of the marine work.

The marine work and logistics were well planned and executed, at peak four crane barges operated concurrently in the river for activities such as piling, marine pilecaps, columns, headstocks, installation of girders and transfloor panels. The installation of the girders was carried out with a 750 tonne crawler crane on a barge. Certificates and stability reports ensured a no risk operation with an average performance rate of more than one girder installed per day.

Key constraints included minimising the impacts due to flooding, restrictions to operating during extreme weather conditions and minimising impact to highway traffic and local road users.

The impact of flooding to adjacent landowner properties and the local community was a critical risk for the project. Comprehensive flood models were developed by the designers to simulate flood impacts and ensure that all construction work was fully compliant at all times. This included the requirement that both during and after construction the resulting afflux (flood water levels), direction of flow and time of inundation for key flood events were not increased beyond the allowable limits prescribed in the Ministers' Conditions of Approval for this project.

Inclement weather provided a challenge for construction of the bridge, with key constraints associated with the operation of large plant and equipment during strong wind, river currents and high tides. In particular the completion of activities such as the installation of U-girders at a height of 30 metres above water level using a 750-tonne crane on a barge in the river needed to be sequenced appropriately to ensure this could be undertaken safely.

A comprehensive Flood Warning and Action Plan was developed in consultation with the NSW State Emergency Service. This provided control measures to ensure the safety of the workforce and protection of the environment during flood events.

Keeping everyone informed

The size and complexity of transporting 44 girders along the Pacific Highway across the existing Harwood Bridge for installation on the South side of the Clarence River required detailed planning to ensure successful delivery. The transportation rig for one girder was over 300 tonnes in mass, 90 metre long and 4.2 metres wide. To spread the load, two trailers each with 10 axles were moved by two prime movers. A full traffic closure of all highway traffic was required for almost 15 minutes to cross the existing bridge.

The traffic closure was undertaken at night to minimise the impact to road users during the peak day time period with higher traffic volumes.

A targeted social media campaign was developed consisting of six posts to inform road users and the local community about the work. It featured technical experts from the project team with video footage to explain the work and closures in more detail.

Other avenues to keep the community informed as the project progressed included four major press releases, regular eNewsletters, construction notifications and project updates. This information was distributed to about 125 residents and the wider community on a regular basis.

The project team regularly attended information stalls at local markets and shopping centres in Yamba, Iluka and Maclean, which provided an opportunity for the community to ask questions and find out more information. This also included presentations to community groups including Lions, Rotary, Chambers of Commerce, CWA, Yamba Yacht Club and Maclean Bowls Club.

Regular meetings and updates were also held with key stakeholders including the Professional Fisherman's Association (the local prawning and fishing industry), Harwood Sugar Mill and Clarence Valley Council.

Facebook campaigns

84
comments

20,000
engaged users

202,441
views

Comments from Facebook

"

Well done guys, you all did a great job also keeping everybody informed. Love your work fellas *three thumbs up

LES ROUGHHEAD

I drove past today, looks great, the progress is fantastic, well done to all the hard workers out there

JOHN KENNY

Fantastic job and great communications with community...

TOM PORTER

Thank you for the update, well done to everyone.

ROSELYN FROST

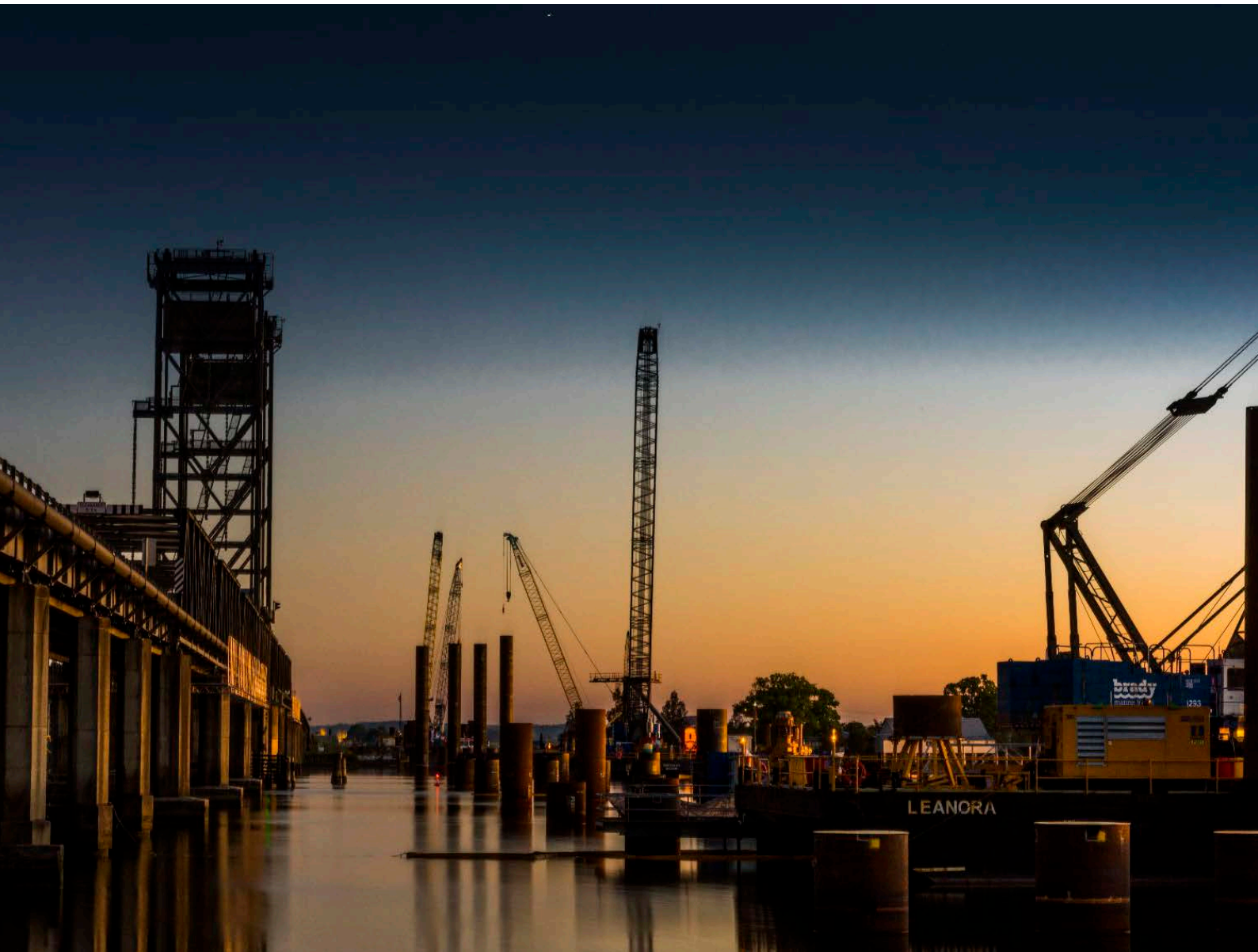
Our new bridge at Yamba turn off. Absolutely amazing watching it all go together. So clever. Job well done so far

LEE-ANN EJ

So cool! Thanks for posting this my boys love watching the girder progress and driving past where the girders are being made

SUMMER LOCKLEY

"


LEANORA