Queensland Rail Mainline Upgrade

January 1997

This case study was written at the time when InfraBuild (formerly Liberty OneSteel) was part of BHP. In that context, in some instances within this case study reference may be made to BHP.

Structural STEEL Casebook

Structural Steel
Development Group
Issue number 15
January 1997

Queensland Rail Mainline Upgrade

Over the last four years Queensland Rail has undertaken a massive $590m capital investment program in rail infrastructure in Queensland, referred to as the Main Line Upgrade (MLU) project. Due for completion in 1997, the program includes the acquisition of new generation rollingstock, and the upgrading of the North Coast Line from Brisbane to Cairns and selected South West Branch Lines. The upgrading of the North Coast Line represents approximately 64% of the total capital investment. The planning, organising and design work involved in the upgrade of the 1,680km long rail line was undertaken under the direction of Queensland Rail's Engineering Services and Project Services Divisions, of the Business Services group. The Planning and Research Division of the Freight Group was also heavily involved. The scope of work for the North Coast Line component of the MLU project includes:

- realignment of curves and grades (deviations) to improve transit times
- elimination of the majority of timber bridges and strengthening of the remainder to 20 tonne total capacity
- upgrading of steel bridge spans from 15.75 tonne axle load capacity to 20 tonne axle load capacity
- partial re-sleepering of the line north of Rockhampton with steel sleepers (total of 420,000 sleepers)

The MLU project will improve travelling times from Brisbane to Cairns and will increase the competitiveness of rail passenger and rail freight transport in Queensland. The line's capacity will be increased by 25% and freight travel time reduced from 40 hours to 27 hours.

The magnitude of the project necessitated the involvement of five principal civil engineering consultants to carry out detailed design, documentation and supervision services for the deviations, timber bridge replacements and steel bridge strengthenings.

Steel bridge strengthening and timber span replacement:

Part of this work involved the upgrading of approximately 56 steel bridges (at a cost of $26m) from 15.75 tonnes to 20 tonnes axle load capacity, as well as the replacement of a large number of timber approach spans with steel girder spans.

The various steel bridge strengthening techniques adopted depended on the type of bridge and the particular structural members which were under-capacity. The versatility of structural steel is demonstrated by the ease with which the structures were modified. The ability to strengthen individual steel bridge members or to add new steel members, whilst operating within narrow windows of track possession time, provided Queensland Rail with a cost effective means of achieving the necessary 4.25 tonne increase in axle load.

The condition of the existing steel girders was generally found to be very good and is testimony to the durability of structural steel and the quality of Queensland Rail's maintenance program. Existing steel

girders were reused extensively, which also contributed to the cost effectiveness of the steel bridge upgrade. BHP's Welded Beams featured strongly both as girders and as bracing diaphragm members.

The strengthening options adopted for the various steel bridges included:

- insertion of intermediate piers (either concrete or steel) to reduce span lengths
- replacement of longitudinal girders with larger girder sections, or inclusion of additional girders
- replacement of cross-girders with stronger units

To simplify the task, the line was broken into five main segments - Brisbane to Bundaberg, Bundaberg to Gladstone, Rockhampton to Mackay, Mackay to Townsville and Townsville to Cairns. In addition, four Brisbane suburban bridges were upgraded at South Brisbane. A further two bridges, at Cribb Street and Boomerang Street, were undertaken by Queensland Rail.

BRISBANE SUBURBAN STEEL GIRDER BRIDGES

Kinhill Cameron McNamara Pty Ltd carried out the engineering design for the upgrading of the Russell, Glenelg, Ernest and Tribune Street rail bridges, all of which are over road. The contractor and steel erector for the four bridges was J.F. Hull Holdings Pty Ltd, whilst steel fabrication was undertaken by Belconnen Steel Pty Ltd.

Russell Street bridge:

The Russell Street bridge, which was originally constructed in the 1890's, has an overall length of 16.5m and a width of 14m, excluding the pedestrian walkway. The bridge construction comprises three riveted through-girders, each 1.5m deep, which span 16m between abutments and which are spaced at 7m centres. The structure further comprises steel trough decking which spans laterally between the girders and supports a 75mm concrete topping and a ballast top (see fig A). The original troughing, which is in good condition and has been retained, is a heavy profile W.H. Lindsay & Co. 'D max' steel section. It consists of a 300mm deep riveted 'W' profile with crests at 810mm centres and it has 19mm thick flanges and 10mm thick webs.

The bridge deck was strengthened between 1910 and 1920 by the addition of a single 10"x6" RSJ under each crest of the troughing. The present upgrading of the bridge capacity has seen the effective girder span length greatly reduced by the introduction of centre piers and the eastern side girder has been stiffened and the troughing strengthened. The outer face of the eastern side girder has been stiffened by extending the web of the original 'tee' shaped vertical web stiffeners a further 50mm by bolting a 100x10 plate to the original stiffener (see fig B). Load bearing stiffeners, one each side of the web and fitted to the girder bottom flange, were added to the girder at a location above the new centre pier support. 125x125x16 EA's were used for the outer girders and 200x200x26 EA's used for the inner girder.

The troughing capacity was increased by replacing every second RSJ (located below each troughing crest) with a 370 deep fabricated beam (see fig C) which is connected at each end to the girders and to the decking.

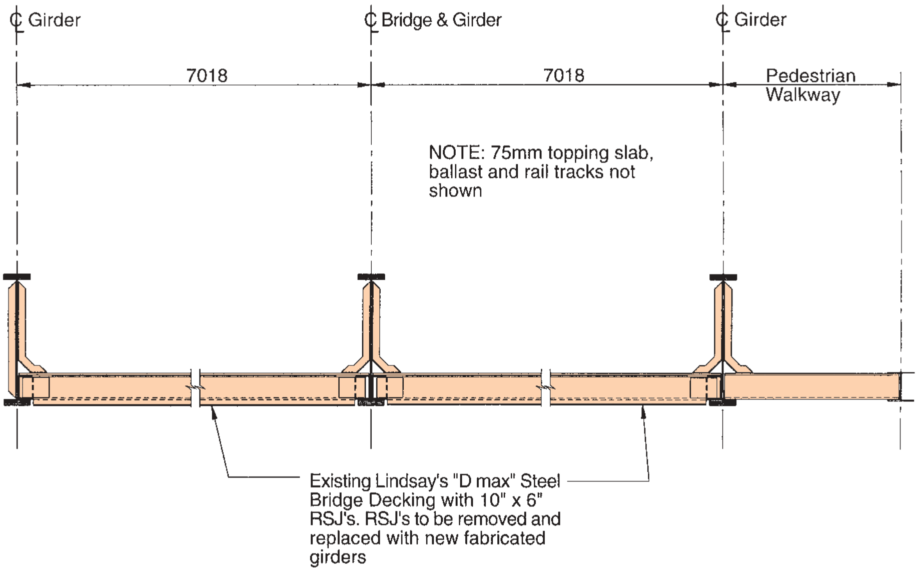


Figure A **RUSSELL STREET BRIDGE CROSS-SECTION**

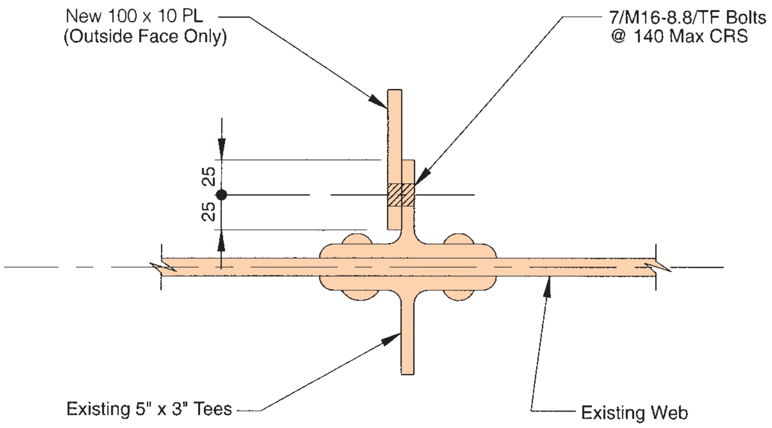


Figure B **STRENGTHENING OF EXISTING STIFFENERS**

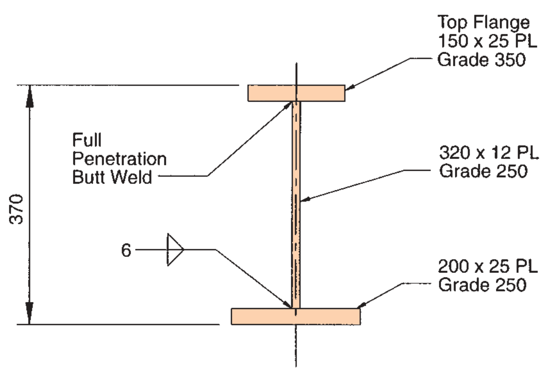


Figure C **FABRICATED BEAM**

Glenelg, Ernest and Tribune Street Bridges:

These bridges are of a similar age to the Russell Street bridge and each have an overall length of 22m. The original 21m single span bridge was converted to a three span bridge having a centre span of 14m, by the introduction of piers at each side of the street, along the kerb line. The 14m wide Glenelg Street bridge comprises four riveted steel through-girders and steel troughing which spans laterally between the girders and which supports a 75mm concrete topping and a ballast top (see fig D). The 8.8m wide Ernest Street and Tribune Street bridges have been upgraded in a similar manner but, being narrower, have only three riveted through-girders. All three bridges have girders which are 2m deep and which are spaced at 4.4m centres.

The original steel troughing (Dorman Long & Co Ltd, 'D min') is a lighter decking than the Lindsay profile which is incorporated in both the Russell Street bridge and the eastern side of the Glenelg Street bridge. The Lindsay troughing profile consists of a 300mm deep riveted 'W' profile with crests at 810mm centres and has 13mm thick flanges and 9mm thick webs. Interestingly, the original safe load capacity of this profile for a span of 14 feet (4.3m) is 12 hundredweight per square foot (64.5kPa). The deck has been strengthened by the installation of new 310UB46 beams under each crest of the troughing (see fig 1).

The girders have been stiffened by extending the web of the original 'tee' shaped vertical web stiffeners a further 50mm using a bolted 150x12 plate on one side only. 200x200x18 EA load bearing stiffeners, one each side of the web and fitted to the girder bottom flange, were added over the new pier supports. 125x75x10 UA intermediate web stiffeners, one each side of the web, have also been added at locations between existing intermediate stiffeners.

A distinguishing feature of the Glenelg Street bridge upgrade was the necessity to reduce the depth of the eastern girder, which protruded below the troughing, by 400mm to enable bus access to the adjacent Brisbane Southbank hotel. Concerns over the weldability of the steel in the existing girder web led the designers to adopt a bolted solution which involved the removal of the bottom flange and web to a point 10mm below the underside of the troughing. A 125x125x12 EA was then bolted each side of the web, and a new 450x28 bottom flange plate bolted to the angles (see fig E). The deck adjacent to the eastern girder bridge was propped from the road and the eastern track was closed over a Sunday (the western track however remained open) to enable removal of the lower section of the existing girder and

Figure 1. Glenelg Street bridge, showing additional strengthening beams.

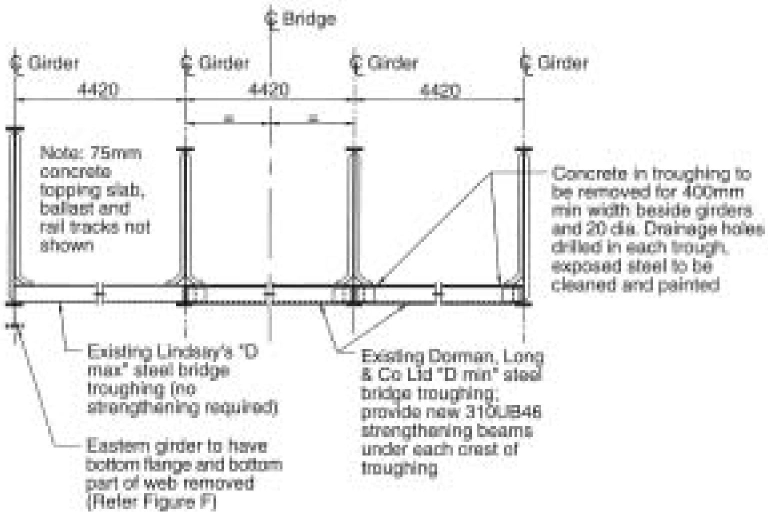


Figure **D** **GLENELG RIVER BRIDGE CROSS-SECTION**

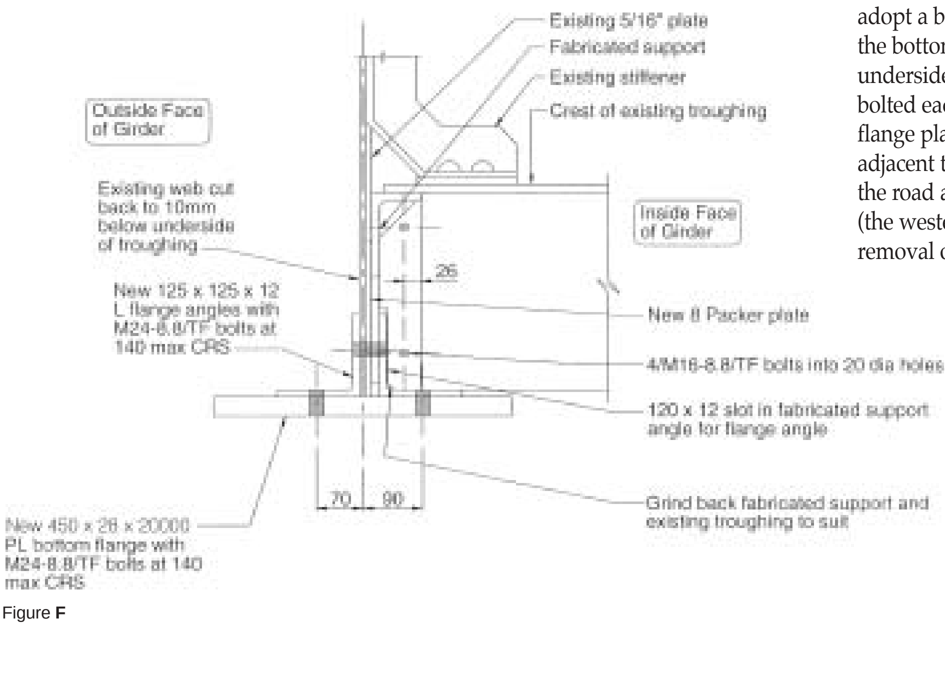


Figure **F**

installation of the new flange angles and flange plate. For installation and grouting of bearings at all bridges, one overnight track possession only was required.

The design was carried out in accordance with ANZRC 1974 (working stress design). The design philosophy assumes that the dead load is resisted only by the end abutments whilst the live load is shared by the interior piers (which utilise pot bearings).

Care was taken to ensure the safe removal of the existing red lead primer paint by utilising full protective clothing and breathing apparatus, washing and shower facilities, induction training for site personnel, and collection and safe disposal of sand and lead waste products at the local authority disposal site. According to design engineer Ken Ross of consulting engineers Kinhill Cameron McNamara Pty Ltd, very little corrosion was observed in the existing steel structures. Protective coating of new and modified steelwork comprised a Class $2^1/_2$ abrasive blast clean followed by a 75 micron zinc-rich primer (Dulux Zincanode 304) and a 150 micron two-pack epoxy top coat (Dulux Amerlock 400).

BRISBANE TO BUNDABERG

CMPS&F Pty Ltd was the project manager for the strengthening of the steel bridges and timber approaches in this region. All bridges are transom top and are located over water.

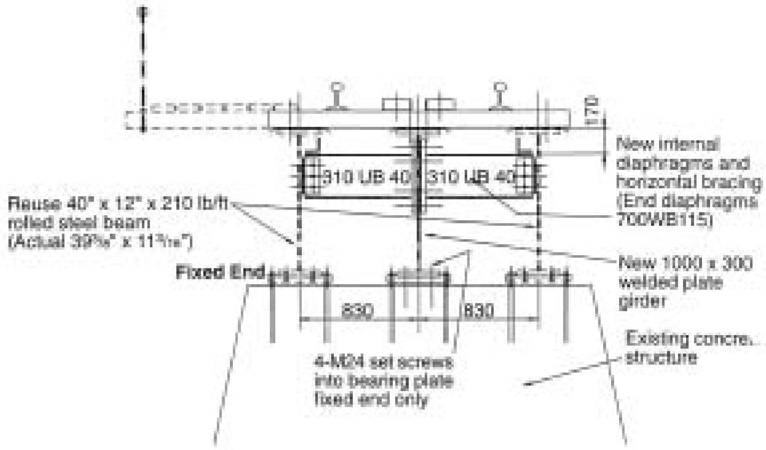
Nambour Region Bridges:

Sinclair Knight Merz Pty Ltd designed the bridge strengthening procedures for all bridges in this region except for Petrie Creek, at Nambour, which was designed by CMPS&F Pty Ltd. The most cost effective method of strengthening the superstructure of the eleven bridges in the Nambour region was found to be the addition of a third steel girder. The bridges typically have multiple single spans of approximately 14m. By reusing a large proportion of the existing girders and timber transoms, a highly cost effective, rapid, and environmentally sound construction solution was achieved.

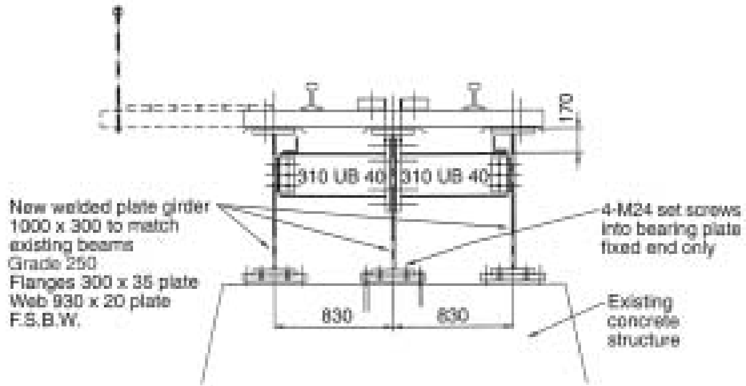
The new superstructure incorporates either three new girders within the same span or one new central girder with a recycled girder each side (see fig F). New 1000x300 welded plate girders were designed to match the existing 40"x12"x210lb/ft girders so as to simplify installation and were fabricated with 35 thick flange plates and 20mm thick web plates, in Grade 250 steel. The girders are supported on the existing concrete piers, are spaced at 830mm centres, and are supported on new 450x450x50 bearing plates which are connected to the bottom flange of the girder by 4-M24 set screws (fixed end of the beam only).

After removal of the existing diaphragms and horizontal bracing members, lateral stability was provided to the girders by new 700WB115 end diaphragms located each side of the support piers, and new 310UB40 internal diaphragms spaced at 2.7m centres between the end diaphragm locations. 100x100x12 EA horizontal cross bracing panels, each 2.7m long, replace the existing girder bottom flange bracing. All new steelwork was hot dipped galvanised, whilst all recycled steelwork was abrasive blast cleaned and painted.

John Holland Constructions Pty Ltd was the contractor for all the bridge work in the Nambour Region, with the exception of Petrie Creek bridge which was strengthened by Concrete Constructions (Qld) Pty Ltd. The steel fabricator was G.M. Gurr Pty Ltd. Strengthening of the Petrie Creek bridge includes replacement of the 30m truss with two 15m plate girder spans recovered from the Don River bridge near Bowen.



Typical Section - Type 1



Typical Section - Type 2

Figure **G**

NAMBOUR REGION BRIDGES

TYPICAL STRENGTHENING DETAILS

Mary River bridge:

The major rail bridge in the Brisbane to Bundaberg region is the 311m long Mary River bridge which, prior to being upgraded, comprised fourteen timber girder approach spans, seven steel girder approach spans, and four steel truss main spans over the river. The engineering design was carried out by Maunsell Pty Ltd and the bridge strengthening program consisted of the following:

(1) Timber approach spans

The first activity was to replace the fourteen timber approach spans (typically 6m spans) with six steel girder spans (typically 12m spans). The existing timber trestles were replaced by 4.8m high steel trestles in the shape of a truncated triangle (see fig 2). The new trestles are constructed from built-up steel sections (see fig G).

The replacement superstructure comprises three 900WB257 girders spaced at 850 centres and has 800WB122 diaphragms located at each girder end, as well as at mid span. Girder bottom flange bracing consists of 100x100x10 EA diagonal members. Each superstructure span was pre assembled, complete with transoms, and erected as a single unit (see figs 3,4).

Below: Figures 2,3,4. Mary River bridge, showing erection of substructure steel, and changeover erection of new steel spans.

(2) Steel Truss - 22m and 25m spans

The two smaller truss spans are located at each side of the two centre truss spans and were upgraded by strengthening the cross girders and replacing the two existing 18"x 7" RSJ stringers by three new 460UB82 stringers. The installation procedure was as follows:

Activity	Rail traffic
Strengthen Existing 940mm deep Cross Girders:	
• replace the existing top and bottom flange rivets with bolts (maximum of two rivets at a time)	normal traffic
• bolt new 250x12 flange plate to the bottom flange	no traffic
• bolt new 250x12 flange plate to the top flange	no traffic
New Centre Stringer:	
• install new stringer support stools at pier supports and cut existing bracing to allow installation of new stringers	normal traffic
• remove existing end diaphragms (end bays only) and install new central stringer to end bays	no traffic (end bays) normal traffic (interior bays)
• install temporary end diaphragms (end bays only)	no traffic
• install new bracing steelwork to new central and existing outer stringers	normal traffic
New Outer Stringers:	
• existing outer stringer end connections - replace rivets with bolts (one rivet at a time)	normal traffic
• remove new bracing steelwork sufficient to allow existing outer stringers to be removed	normal traffic
• remove temporary end diaphragms (end bays only)	no traffic
• remove existing outer stringers and install new stringers, one at a time	no traffic
• install new end diaphragms (end bays only)	no traffic
• re-install new bracing steelwork	normal traffic

(3) Steel Truss - 46m spans

The two larger truss spans were strengthened generally in a similar manner to the smaller truss spans, except that the two existing stringers were retained and an additional 460UB82 stringer added. All the new structural steelwork is hot dipped galvanised.

Construction work on the Mary River bridge was carried out by John Holland Constructions Pty Ltd and steel fabrication was undertaken by Evans Deakin Industries Ltd.

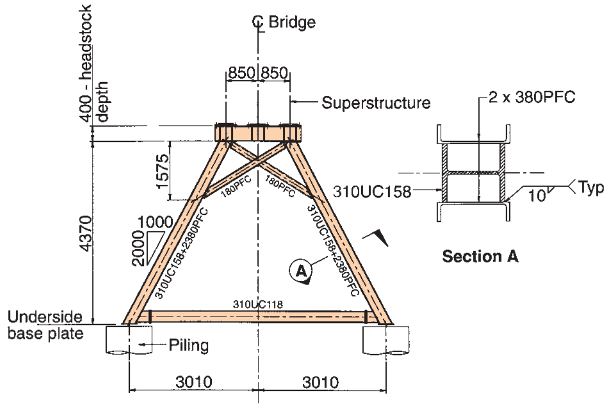


Figure **H New trestles**

BUNDABERG TO GLADSTONE

Civil engineering design of the single track steel bridge upgrading work in the Bundaberg to Gladstone region was carried out by Connell Wagner (Qld) Pty Ltd and included bridges over the Burnett River, Kolan River, Littabella Creek, Murray's Creek and Boyne River.

This region features one of Queensland's earliest major rail bridges - the picturesque Burnett River bridge at Bundaberg (fig 5). Construction of this bridge was a prerequisite to the extension of the railway north from Bundaberg to Gladstone, and commenced in 1889. Through the 1890's, a number of timber spans were replaced by steel spans and in 1922 the bridge was strengthened by replacing the steel lattice spans over the river with steel trusses capable of accommodating 15 tonne axle load rollingstock. Today, the 534m long structure consists of a combination of riveted steel Pratt truss spans over the main river section, plate web girder spans supported on steel cylindrical piers, and steel girder spans supported on steel trestles (see back cover pic).

Brisbane based contractors, Kilpatrick Green Pty Ltd, carried out the upgrading work associated with the Burnett River and the Kolan River. Construction work on Murray's Creek, Littabella Creek and Boyne River bridges was undertaken by Canstruct Pty Ltd with steel fabrication generally being carried out by the Canstruct/Henry Cash Welding joint venture (part of Murray's Creek was fabricated by Factory Fabricators Pty Ltd). The upgrading of the timber approach spans and timber trestles was achieved by replacing them with steel trestles and steel girders. The three steel girders, cross bracing and timber transoms were pre-assembled in the fabrication shop (see fig 6) and then transported to site as complete units of one span each. Erection of the new girder spans took place during rail closures and the erection procedure shown for Murray's Creek bridge (see fig 7) is typical of the other bridges.

It was observed with the longer span, riveted steel truss bridges (Burnett, Boyne (see fig 8) and Kolan River bridges) that some of the stringers exhibited fatigue cracking with the cracks propagating from the tight radius cope at the ends of the beam. These stringers were replaced. Fewer problems were observed with the shorter span truss bridges and the fatigue cracks weren't present in the transverse beams (cross girders). All new stringers were supplied with the end section of the flange and web mitre cut and a new 185x185x10 flange plate welded to the mitre cut web so as to avoid potential fatigue crack initiation at that location (see fig 11). The capacity of the cross-girders in the short span bridges (Littabella, Murray's Creek) was increased by a simple technique of post-tensioning the girder bottom flange with a 29mm diameter stressbar.

Canstruct programmed the 'on-line' replacement of the 126 truss stringers on the 277m long Boyne River bridge around track possession times of 1 or 2 possessions a day, of 1 to 3 hours duration each. The construction procedure adopted for a typical 5.4m truss bay is as follows:

Below: Figure 5. The original Burnett River bridge.

Figure 6. BHP's Frank Rapattoni (left), with project manager, Canstruct Pty Ltd.

Figure 7. Erection of new girder spans at Murray's Creek bridge.

Right: Figure 8.
Boyne River bridge.

(a) between trains or under Type A Track Possession (ie no interruption to train services)

- install hanging scaffold at each cross-girder (see fig 9) & install 2 jacking beams between bottom flanges of stringers
- remove rivets in existing girders & replace with bolts. Drill additional holes in cross-girder for new centre stringer & install seating angle for centre stringer
- prefabricate, galvanise & deliver to site new stringers & fixing angles
- prefabricate lightweight track-mounted gantry wagon having overhead gantries supporting chain blocks. Include outrigger supports to transfer lifting loads directly to truss cross girders. Wagon is moved by manpower.

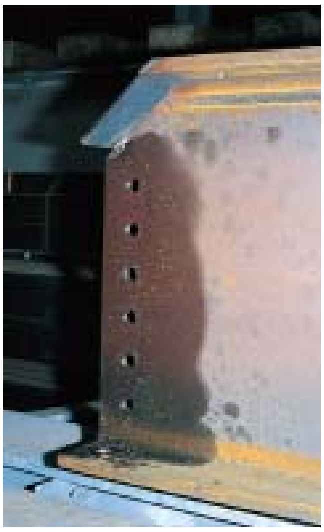


Figure 11.
New stringer, showing new end design to prevent fatigue cracking.

Figures 9 and 10.
Removal of old, and installation of new beams at Boyne River bridge, showing underslung scaffold for safe working access.

(b) under Type B Track Possession (2 to 4 hours duration, involving train timetable alterations)

- load new stringers on to the gantry wagon located at temporary level crossing at northern approach to bridge. Concurrently, remove transom bolts from existing stringers, loosen bolts on adjacent bays, and remove bolts connecting existing stringers to cross-girders. Jack rail track up by 25mm.
- move new stringers to relevant truss bay location using the gantry wagon
- using gantry, transfer existing stringers to rail wagon & remove from the bridge, then place new stringers in position and bolt to cross-girders (see fig 10)
- remove all equipment from the track via the level crossing & jack the track down while the transoms are bolted to the new stringers.

All structural steelwork in the above bridges was hot dipped galvanised in Brisbane by Industrial Galvanisers Corporation Pty Ltd.

ROCKHAMPTON TO MACKAY

Consulting engineers, Kinhill Cameron McNamara Pty Ltd, carried out the engineering design of the strengthening of the Alligator, Cattle, Flaggy Rock, Basin, St Lawrence and West Hill Creek bridges. Of these bridges, the 242m long St Lawrence Creek bridge has the most steel spans, all of which are over water.

John Holland Construction and Engineering Pty Ltd was the principal contractor for the Cattle Creek, Flaggy Rock Creek and Basin Creek bridges, whilst Watpac Australia Pty Ltd was the principal contractor for the West Hill Creek bridge.

Doval Constructions (Qld) Pty Ltd was the principal contractor responsible for the strengthening of the Alligator Creek and St Lawrence Creek bridges with Canstruct Civil Engineers being subcontractors on St Lawrence Creek bridge. The additional steelwork for these bridges was fabricated in Brisbane by Darra Welding Works Pty Ltd, transported to site, and then pre-assembled as a complete girder span at a location beside the track. This method provided an economic benefit to the local community by increasing the local labour content in the project.

St Lawrence Creek bridge:

The main purpose of the St Lawrence Creek bridge upgrade was to increase the load carrying capacity to 20 tonne axle load and eliminate the existing timber approach spans so as to reduce maintenance. A secondary benefit was the ability to eliminate infringement into the clearance diagram by raising the deck, so it cleared the through girders, thereby enabling coal wagons from the mines to be run down the mainline from Mackay to Rockhampton for maintenance. The increase in track level was achieved by installing two, twin 300PFC longitudinal beams above the existing cross-girders.

A major challenge faced by the contractors on this project was the need to carry out the track raising activity above a fast flowing tidal creek. This meant that the use of barge-mounted lifting equipment was not practicable and all work had to be carried out 'on line'. Canstruct overcame the challenge by fabricating a purpose-built travelling gantry to erect the replacement track support spans. The gantry was similar to that used by Canstruct on the Boyne River bridge, however in this instance, the gantry incorporated rubber tyred wheels which ran on the top flange of the bridge girder (see fig 12) rather than running on the track. The gantry, in combination with a track-mounted trolley, enabled whole track beam spans to be simply removed, relocated to the creek bank, and new spans to be moved to position and installed.

A typical construction sequence for raising the track level of the through-girder spans was:

(a) After Closure Commencement
- remove temporary ramp, rails and transoms up to six spans at a time (removal carried out by Queensland Rail)

(b) Repeated Cycle
- cut off and remove ends of existing deck stringers and bearing plates over pier headstocks
- bring out new pier headstock beam assembly (comprising two 610UB125 beams bolted together) on track mounted trolley
- lift headstock beam assembly into position over pre-drilled holes with travelling gantry
- bolt new composite headstock assembly to existing headstock beams
- bring out new deck panel assembly (deck panels pre-built with transoms attached)
- lift new deck panel into position using travelling gantry (see fig 13)
- drill and bolt new deck panels in position
- replace rails (by Queensland Rail)

Figures 12 and 13. Erection of new spans from travelling gantry at St Lawrence Creek bridge.

(c) Prior to End of Closure
• replace rails and temporary ramp

The best time achieved for a full cycle (one span) was about 2.5 hours.

The existing timber girder approach spans were replaced by steel girder spans comprising three 24"x 7 1/2"x100lb/ft RSJ's which had been previously removed from other bridges and recycled. This provided an extremely cost effective and environmentally sound method of upgrading these spans, especially considering that the recycled beams had been *in service for periods of up to 80 years*. The travelling gantry was also utilised for the replacement of the existing timber spans.

Other bridges:

There were three steel truss span bridges in this section however truss strengthening was only carried out on the Alligator Creek bridge. The 36.5m span steel superstructure was upgraded by the simple addition of new 380PFC diaphragms at 6m centres between the existing stringers. Bridges having 18.6m plate web girder spans (Cattle Creek and Basin Creek) did not require strengthening whilst the shorter girder spans (typically 7.3m or 8.6m) in the Alligator Creek, Cattle Creek, Flaggy Rock Creek and Basin Creek bridges were strengthened by replacing the two existing girders with three new girders.

An outstanding example of the recyclable nature of structural steel as a bridge construction medium is demonstrated by the West Hill Creek bridge strengthening procedure which utilised recycled plate web girders sourced from other bridges.

All new and recycled structural steelwork was painted rather than hot dipped galvanised so as to avoid potential warping problems. The paint specification for new steelwork required abrasive blast cleaning to class 2 1/2; prime coating with an inorganic zinc silicate (75 microns); intermediate and top coating with a PVC vinyl (40 microns each), or alternatively, two or more coats of two-pack epoxy to 150 microns total thickness.

MACKAY TO TOWNSVILLE

Civil engineering design for the upgrading of the large number of existing steel and timber bridges in the Mackay to Townsville region was carried out by BHP Engineering.

Ayr - Home Hill Region:

Mazelow Construction Pty Ltd carried out the steel bridge work in this region, which included the upgrading of 177 existing two-girder bridge spans to three-girder spans using entirely recycled steel girders. The largest of the bridges in this region is Plantation Creek which comprised 46 spans of 7.3m each (see fig 14). This process not only saved considerable time but was also extremely cost effective compared with a new concrete span alternative which would have required new abutments and headstocks.

The strengthening process involved the removal of the two existing girders (24"x 7 1/2"x100lb/ft RSJ's) and their replacement by three recycled RSJ's of the same size. The existing concrete piers were retained. 300PFC diaphragm members were provided between the girders at locations over the support piers and 380PFC intermediate diaphragms were provided at 2.4m centres between the piers. Horizontal cross-bracing comprising 75x75x10EA's was connected at the top chord location. In total, 513 RSJ's were recycled for use in this region. Uncertainty as to the metallurgy of the original

Figure 14. Plantation Creek bridge.

RSJ's made it necessary for bolting of attachments to the RSJ's rather than welding.

Work was carried out within Queensland Rail's rail closure time, which generally comprised three periods per week of eight hours each, and eight bridge spans were replaced in each eight hour period.

The construction schedule for a typical span comprised removal of the track (by Queensland Rail staff), removal of the existing two-girder spans, installation of new three-girder spans, and finally re-installation of the track (again by Queensland Rail staff). Steel fabrication, galvanising and track-side pre-assembly of the girder spans was undertaken whilst the rail track was open to traffic. New timber transoms were provided and the old transoms stockpiled for reuse in Western Queensland lines.

The existing girders (total weight approximately 600 tonnes) were hot dipped galvanised by Cairns based company, Pollards Pty Ltd. Care was taken with the environmental aspects of the removal of red lead paint from the old girders which involved pickling in a caustic bath and removal of the waste product sludge to settling tanks for later removal of lead based residue. A further challenge was the elimination of tar residue which was resistant to the pickling process and required abrasive blast cleaning. Abrasive blast cleaning was considered as an alternative to pickling to remove the lead paint but was discounted on cost and health grounds, in particular the costs associated with containment of the blasting process and the inability to recycle the abrasive material which would have been contaminated with lead.

Steel cross bracing was fabricated by Murphy Steel Fabrication Pty Ltd and hot dipped galvanised by R. Goedhart Pty Ltd, both of Townsville.

Mackay to Bowen Region:

This region comprised a number of major steel bridges, namely Macquarie Creek, St Helen's Creek, O'Connell River, Andromache River and Elliot River bridges. Contractor, Canstruct Pty Ltd, undertook the construction work with the majority of fabrication being done in Brisbane by a joint venture between Canstruct and Henry Cash Welding. The remaining fabrication was done by Taringa Steel Pty Ltd in Brisbane. Pre-assembly of the girder span units was done in the fabrication shop and included addition of the timber transoms by Queensland Rail staff.

TOWNSVILLE TO CAIRNS

Civil engineering design was carried out by Gutteridge Haskins & Davey Pty Ltd, whilst Civil and Marine Engineers Pty Ltd undertook all the steel bridge construction and fabrication work.

Upgrading of the Healy Creek bridge, which comprises five spans of 7.3m each, involved the replacement of the two existing 24"x 7$^{1}/_{2}$"x100 lb/ft RSJ girders by three identical recycled girders. The three girders, complete with bracing and new transoms, were assembled beside the bridge and erected during track closure. New diaphragms were provided to the truss spans and these consist of 300PFC members at the pier locations as well as two 380PFC intermediate diaphragms located at 2.2m centres between pier locations. Horizontal bracing consists of 75x75x10 EA's.

Some fatigue cracking was observed in the existing truss stringer (longitudinal) beams. This was attributed to the small radius cope at the beam ends. All existing beams which were recycled were visually inspected for cracking prior to reuse.

Sleeper Log Creek and Saltwater Creek bridges each comprise two 18.6m truss spans which have been upgraded by replacing the two existing truss stringers with three new stringers. The transverse girder (cross girder) is stiffened by the introduction of an additional member, 200UC59 by 3m long placed centrally, which is bolted to the girder bottom flange by 2/M20/8.8TF bolts at 160mm centres. The transverse girder strengthening was completed prior to the installation of the three new steel stringers. The girder spans were strengthened in the same manner as Healy Creek bridge.

All new and recycled structural steelwork is hot dipped galvanised.

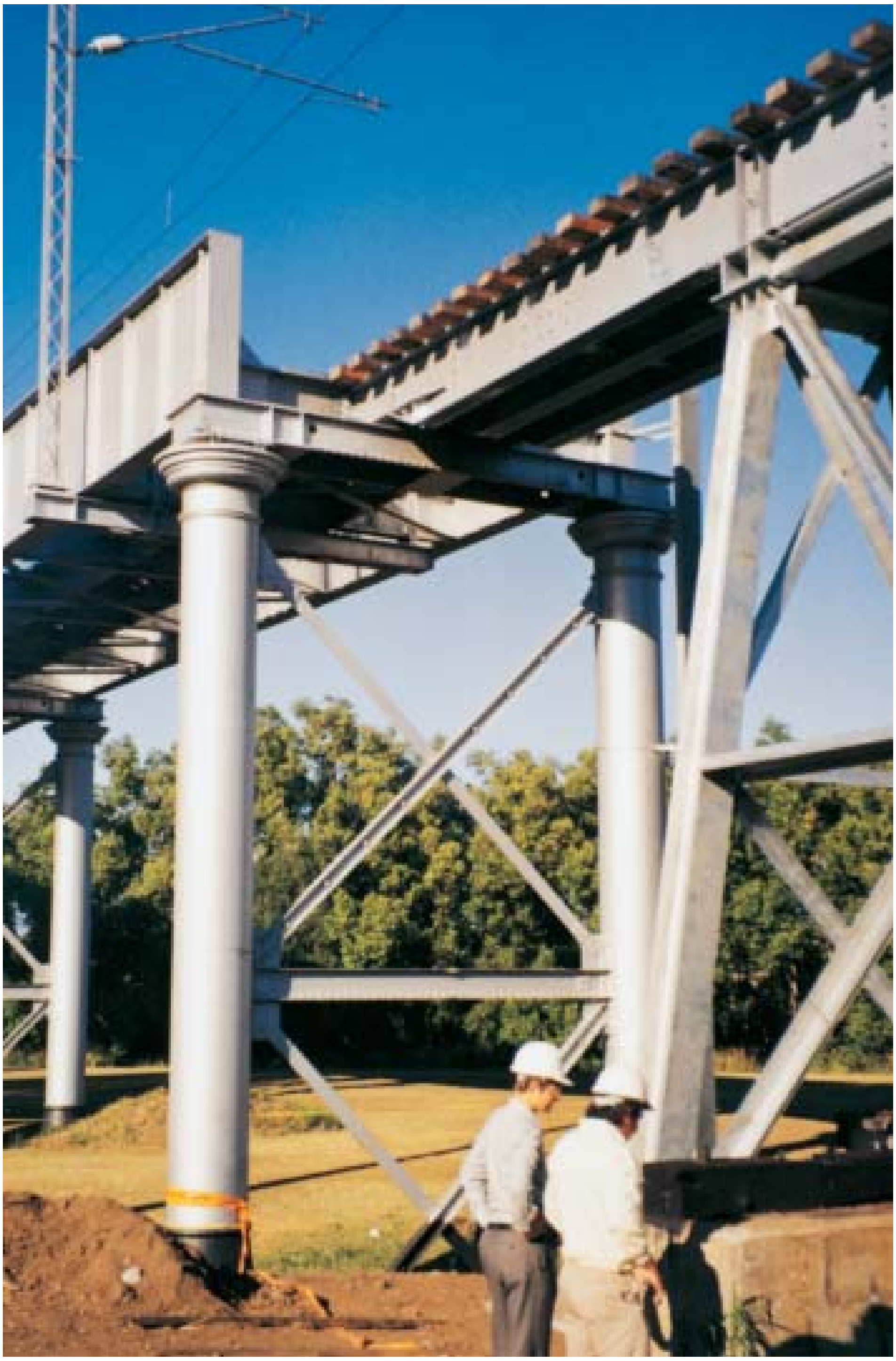
CONCLUSION

The strengthening of steel bridge spans and the replacement of timber approach spans in Queensland Rail's Main Line Upgrade project has demonstrated the versatility and cost effectiveness of structural steel in rail bridge construction.

The ability of existing steel bridges to be simply modified, rather than demolished and replaced on line, has provided a major cost benefit to the project. Steel has ensured simple upgrading and completion of construction within very limited track possession times through:

- ease of modification on site
- lighter mass of steel girders compared with concrete girders which enables reduced crane capacity to be employed and greater pre-assembly and erection of multiple components
- reduced overall construction time due to off-site steel fabrication in parallel with on-site construction
- recycling of existing steelwork
- use of BHP's new cost-effective Welded Beam sections.

The condition of the existing steel girders, some of which have been in service for 80 years, was generally found to be very good and demonstrates the durability of effectively maintained structural steel in bridge applications.



For further information please contact BHP Structural Steel Development Group

NSW and ACT
John Cottam or
David Bell
Level 14
1 Castlereagh St
Sydney 2000
Ph. (02) 9239 0333

Vic and Tas
Gary Oldfield
Level 9
90 Collins St
Melbourne 3000
Ph. (03) 9609 2500

Tasmania
Nick van der Kreek
Level 40
600 Bourke St
Melbourne 3000
Ph. (03) 9609 2738

SA and NT
Trevor Rose
41-47 Currie St
Adelaide 5000
Ph. (08) 212 6700

WA
Spiros Dallas
Level 12
221 St Georges
Terrace
Perth 6000
Ph. (09) 426 5636

Qld
Greg Anderson
153 Wharf St
Brisbane 4000
Ph. (07) 3834 7519