Railway Bridges of Queensland by Greg Stephenson

1.0 Introduction

The timber bridge has provided the backbone of bridge construction in Australia. As one example, when in Queensland the total length of railway was 10,500 km, there were 217km of timber bridges, and the same has been true for both the rail and roadway systems in other States. What could be more evocative of the Australian landscape than the spindly timber girder railway bridge? In Queensland, the availability of large quantities of first class hardwoods had a very important influence on the choice of timber for railway bridges in preference to materials such as steel and concrete. Masonry and brickwork proved expensive compared to timber construction.

In the early years of the development of the rail system, metal truss bridges were only used for major river crossings, often where long spans were required for navigation. I have used the term 'metal' because in different eras cast iron, wrought iron or steel may have been used. The most common early form was the lattice truss, typical with a 100 feet (30.5 metre) span. Many of those that remain in service have had their spans subdivided by the addition of mid-span piers. Many examples exist of only the main span/s being metal trusses or plate girders with timber approach spans.

There are some examples of concrete arch bridges built in the period 1900 to 1913, however it was not until the 1960's and the introduction of prestressed concrete that concrete became the major material for bridge construction.

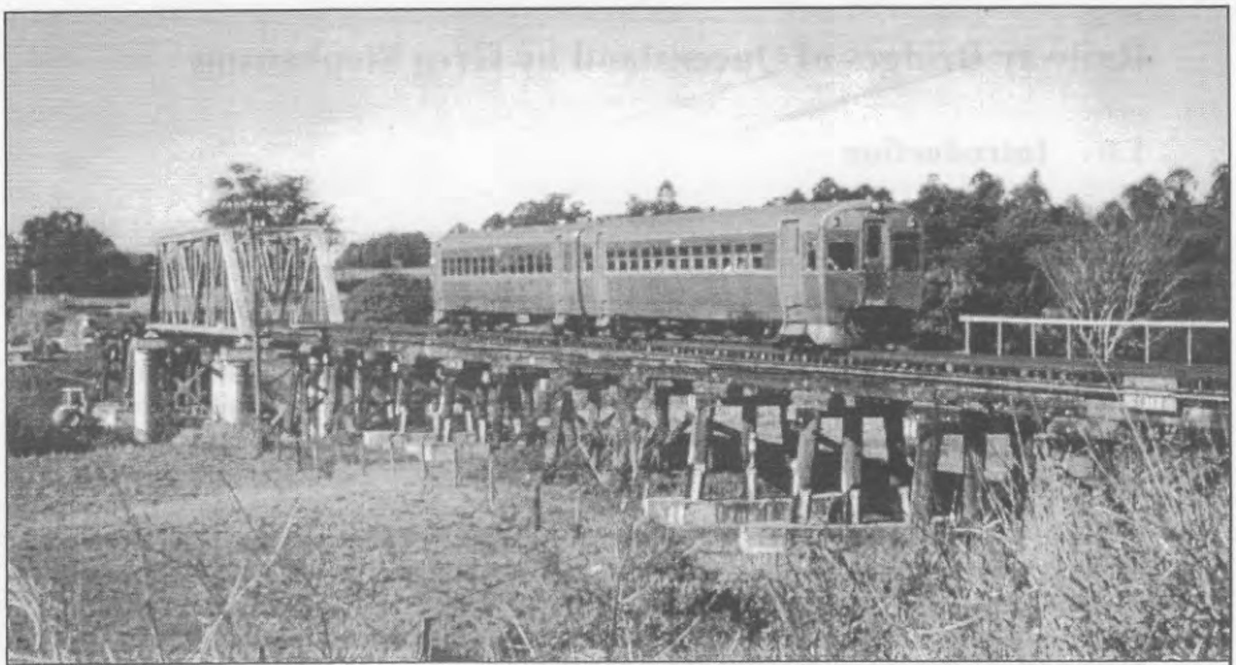
In keeping with the theme of this Convention, my discussion on Queensland Railways bridges will focus on what would typically appear on a branch-line. This is the standard timber bridge. For the tramway (cane railway) network, the coverage will be broader and I hope to provide some information that will be of interest to all modellers.

2.0 Queensland Railways "Standard" Timber Bridges

The oldest existing timber bridge is believed to be that at Splitters Creek, west of Bundaberg on the closed Mt Perry branch. The timber spans on this bridge are up to 11.0 metres long and are understrutted and tied or undertrussed. Similar methods were used to strengthen the long timber approach spans to the Dickabram Bridge over the Mary River at Miva. Timber spans of these lengths are now uncommon.

Timber bridges typically built during the 1880's were mostly 14 feet (4.3 metres) to 18 feet (5.5 metres) spans having alternately two and three girders which were arranged to be alongside one another at the piers. This gave a very simple method of providing supports of sufficient width compared to the case where all girders are in the one line. Corbels were not used. Headstocks were typically solid 12" x 12" or 12" x 14" and piers consisted on a minimum of 2 piles.

In 1915, W. J. Doak , Assistant Engineer for Bridges, discussed the "Design of Timber Railway Bridges in Queensland" in a paper read before the Queensland Institute of Engineers. This paper introduced the philosophy behind the design of what became the standard timber bridge. In a further paper in 1935, he added "In timber bridges, which might be said to have been evolved rather than designed" and "...the extensive experience in the Railway Department extending over nearly 70 years....had never indicated any weakness in the timber bridges". There's another 65 years of experience to add since those comments were made.



QR Bridge at Yandina. An example of timber approach spans to the steel main span. Also illustrated are repairs of ground line rot of the piles by installation of concrete sills at ground level on some of the piers. The timber spans consist of double girders.

Former Queensland Railways' Bridge – Wallaville.

This bridge is now used for the cane railway between Wallaville and Bingera Sugar Mill. This bridge shows a typical application where the main span over the watercourse is a steel section – typically a truss or plate girder.

Features of this bridge are the double piers to support the truss span and the use of double girders in the timber approach spans.

The girders for timber bridges in Queensland used round timber with as little removed as possible rather than squared timber. The girders were "sapped" ie the sapwood removed. There are durability benefits of using the round timber and a round girder was stronger than a squared girder that could be cut from the same sized log. A minimum size of 17" (430mm) diameter was adopted as it was readily available in ironbark and spotted gum.

The size and number of girders are dependent upon the span and the loading. The following table summarizes these relationships. A double girder consists of one girder located directly on top of another girder.

Size of Timber Girders
For Queensland Railways' Bridges

Location of Bridge	Number and Diameter of Girders	Max. Permissible Span Length
All Lines	2 single 435mm (17")	4400mm (14' 6")
(Except Normanton	3 single 435mm (17")	5600mm (18')
to Croydon)	3 single 460mm (18")	6250mm (20' 6")
(16 tonnes axle loading)	2 double 435mm (17")	6700mm (22')
	3 double 435mm (17")	8200mm (27')
Normanton to Croydon	2 single 435mm (17")	5600mm (18')
And Certain "B" Class	2 single 460mm (18")	6250mm (20' 6")
Lines	3 single 435mm (17")	7000mm (23')
(11 tonne axle loading)	3 single 460mm (18")	7750mm (25')
	2 double 435mm (17")	8200mm (27')

Notes The dimensions are measured at the small end clear of sapwood.
For certain species of timber, girders are 25mm (1") larger.

Girders sit on top of corbels at the piers. The size of corbels is dependent upon the girders that they support. They allow for fixing and increase the bearing area for the girders. The specified sizes are shown in the Table.

Size of Timber Corbels
For Queensland Railways' Bridges

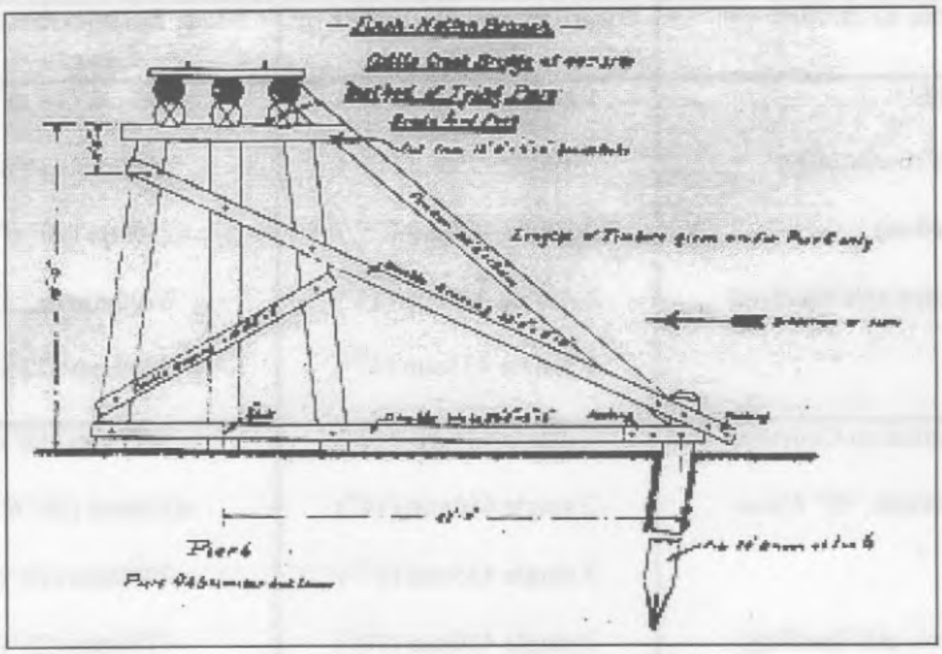
Size of Corbel	Size of Girders
435mm dia. x 1800mm long	Single 435mm girders in one or both spans
435mm dia. x 2100mm long	Double girders
460mm dia. x 1800mm long	Single 460mm or larger girders in both spans

More recent girders are either round or hexagonal; the latter probably dating from the 1970's. The hexagonal girders were often sawn from the logs by chainsaw whereas the round girders were dressed by broad axe.

Copies of drawings of the general details of these bridges are attached.

Many Queensland railway (and road) bridges were built as low level structures designed to be overtopped in floods. To resist flood forces, inclined round members were added to piers. The upstream ones are called fenders and help to turn floating timber to allow it to pass between the piers. The downstream members are called struts and resist the flood forces.

Typical Arrangement of Fender Pile



Where bridge piles are located in salt water, there is potential for attack from toredo borers. The common method to prevent this was to encase the base to timber piles in concrete pipes which were filled with sand and capped so that the borers could not reach the timber.

Doak tells us "To preserve the superstructure from effect of weather, the practice until recently (1915) has been to apply three coats of hot coal tar, well boiled, and with a little resin added. Wales and braces are treated in the same manner… Piles are not tarred because the sapwood is left on. …... The idea is to leave the sapwood until, in the course of time, it deteriorates and begins to come off. It is then stripped off and the solid well-seasoned pile tarred."

"In addition to the tarring, galvanised iron covering is applied to the ends of timbers, such as headstocks and tops of piles."

"The latest instruction (1915) is that the whole of the superstructure, including headstocks, is to be painted. The paint is to be red oxide of iron, except for the upper surface of the footplanks, and the ends of the corbels, which are to be white. The object in the case of the footplanks is to make them visible at night."

The 1980 version of the standard drawings includes the following comments:-

- "The top face of girders for a width of 150mm, the upper surface of footplanks, escape planks and handrails to be given 3 coats of an approved white lead-free paint.
- The ends of all sawn, hewn and round timber (except transoms), and the tops of piles shall be treated with a special mixture of petroleum jelly.
- All beds and joins to receive a thick coat of an approved white lead-free paint.
- No other timber shall be painted or tarred except in tropic high rainfall areas, where the tops of girders for one half the circumference and the top face of headstocks shall receive 3 coats of an approved white-lead free paint.
- All new piles in silled piers shall be sapped and tarred.
- In driven piers the ground shall be excavated after the piles are driven to allow the piles to be sapped and tarred from 300mm above the ground to 1000mm below the surface.
- All sapped, dressed, hewn or sawn timber below ground to receive 2 coats of an approved tar mixture."

It was also about this era that CCA treatment of new girders was introduced which allowed the sapwood to be left in place. These girders can be recognised by the distinctive "Koppers' Log" green colouring.

3.0 Tramway Bridges

The term "tramway" was a legal definition to describe railways that were operated by local authorities or private companies. In effect, only the government could own and operate a railway and all others were tramways. Many of these were built to 3'6" gauge and used ex-QGR equipment or hired QGR equipment. It would be expected that the design of the bridges in these cases would be similar to the then current QGR practice. The majority of this discussion will deal with sugar tramways or, as they are now known, cane railways.

The situation with sugar mill tramways is much more complex. Apart from the mills owned by CSR Co. Ltd -which introduced a measure of standardisation- most mills were owned by individual co-operatives or companies. This means that a lot of local practices were adopted and there was no real standardisation across the industry. With mill mergers and the formation of larger companies and co-operatives, there has been a trend towards some standardisation in more recent years.

Generally, it can be seen that the materials used in tramway bridges reflected those used in general bridge engineering. Initially, timber would have been the major material followed by steel especially for the girders and prestressed concrete from the 1960's.

3.1 Timber Tramway Bridges

Timber tramway bridge construction generally follows the practices introduced by QGR and later the Main Roads Board (later Commission, then Department). The major difference is perhaps longer spans reflecting the lighter loads and more use of piers containing two piles. Two girders per span are common and sizes are similar to those listed for QGR bridges. The use of double girder is very uncommon. Those that are used are on bridges taken over from the QGR.

I had the opportunity to do an assessment of the St Helens Creek bridge on the Farleigh Mill system north of Mackay. It was built in the 1960's for their North Coast line extending beyond Calen. It was designed for double headed Com-Eng 0-6-0 diesel locomotives each weighing 24 tonnes. Brief details of the timber section of this bridge are:

- Typical span length 9.1 metres (30 feet)
- Corbels 3.7 metres (12 feet) long
- Girders 430mm round or 460mm hexagonal
- Typically 18 transoms per span
- 3 piles per pier
- Piers greater than 4.1 metres (13'6") from ground to top of headstocks are fitted with fender and strut piles
- Piles extend above headstocks to top of girder as per MRD practice.

This bridge remains in use for 40 tonne rebuilt 73 Class and 38 tonne EIMCO locomotives.

The general trend has been towards the elimination of timber bridges however many still exist. Sugar mills are large industrial plants with access to many of the metal working trades. Many timber bridge repairs have favoured the use of steel to replace timber girders and headstocks which probably reflects the skills available within the Mill.

3.2 Steel Tramway Bridges

The Colonial Sugar Refining Company Limited owned and operated sugar mills in Northern NSW, Queensland and Fiji. The Company issued a range of standard drawings to cover their tramway practice. These included details for steel bridge girders. From these drawings and records of bridges on the Victoria Mill (Ingham) system in 1960, the following typical girder size and spans can be deduced. A 16" x 6" Rolled Steel Joist (R.S.J.) is an "I" shaped beam with an overall height of 16" (406mm) and a flange width of 6" (150mm).

Typical Steel Bridge Beams For CSR Co. Ltd "Permanent" Lines

Bridge Beam (2 per Span)	Typical Span
24" x 7½" R.S.J.	40'
20" x 7½" R.S.J.	30'
18" x 7" R.S.J.	24'
16" x 6" R.S.J.	20'
14" x 6" R.S.J.	15'
12" x 6" R.S.J.	12'

Notes: Based on CSR Co. Ltd Drawings dated 1960 & 1963
Girder typically spaced 5' to 6'6" apart and 2 girders per span
Reinforced concrete piles 15" square
R.S.J. = Rolled Steel Joist ("I" beam)

These bridges used 15" (375mm) square reinforced concrete piles and headstocks and were built in large numbers throughout the CSR mills. For example, the 1960 List of Bridges at Victoria Mill has 97 bridges shown and all but one have steel girders. The longest of these bridges was the 564 feet (172 metre) crossing of the Herbert River on the Abergowrie Line. This bridge contained 25 spans.

Queensland Railways' Bridge – North of Townsville
This bridge has been repaired by replacing the original timber girders with steel girders. Short timber corbels have been used on the original timber piers.

Fairymead Sugar Mill
A pair of ex-QGR steel bridge spans stored at the Mill in the early 1980's. On the left is a lattice truss and on the right is a plate girder.

Cane Railway Bridge.
Repairs and strengthening of a timber bridge by replacement of the headstocks and girders with steel beams. Note how the outer piles in the piers have been spliced above ground level.

3.3 Reused Bridges

Sugar mills have long been users of equipment reclaimed from state owned railways. This has largely been the case with rails. There are a number of examples where the mills have acquired the former right of way of the QGR. Some examples include, Childers to Cordalba for Isis Central Mill, Wallaville branch for Bingera Mill and Finch Hatton to Marian for the Marian Mill. The former was rebuilt many years after it was closed by the QGR and all infrastructure was replaced. The line to Finch Hatton was taken over from the QGR intact and parts were regauged for immediate use and other sections progressively replacing parallel tramways. In this case, the existing QGR bridges were reused by regauging the rails. The impressive high level steel bridge at Mirani is now used by cane trains.

One former QGR bridge in its original location is in use at Wallaville, although the major steel and timber structure has been modified as part of a road upgrade.

Other examples include complete bridges that were obtained and removed for later reuse. Most of these were steel spans removed from the QGR as their axle loads increased or made redundant by realignment works. An interesting example exists over Snake Creek on the Bingera Mill's Wallaville line where an ex-QGR turntable has been relocated for use as a bridge.

Examples also exist of the concrete piers of redundant road bridges being reused for tramway bridges.

4.0 Dual Purpose Bridges

Most bridges form more than one purpose. As well as the rail traffic for which they were built, there may be a range of other services attached to the bridge such as communication cables, water pipes etc. In a number of cases, bridges have been built to carry both road and rail traffic, and it is this type of dual purpose bridge that I will concentrate on in this discussion.

There are two basic forms of dual bridge; those where two types of traffic are separated but use a common substructure (and possibly superstructure) and those where both types of traffic share a common running lane. The QGR examples are of the former type where the railway and roadway are distinct and separated, however they both share the common structure.

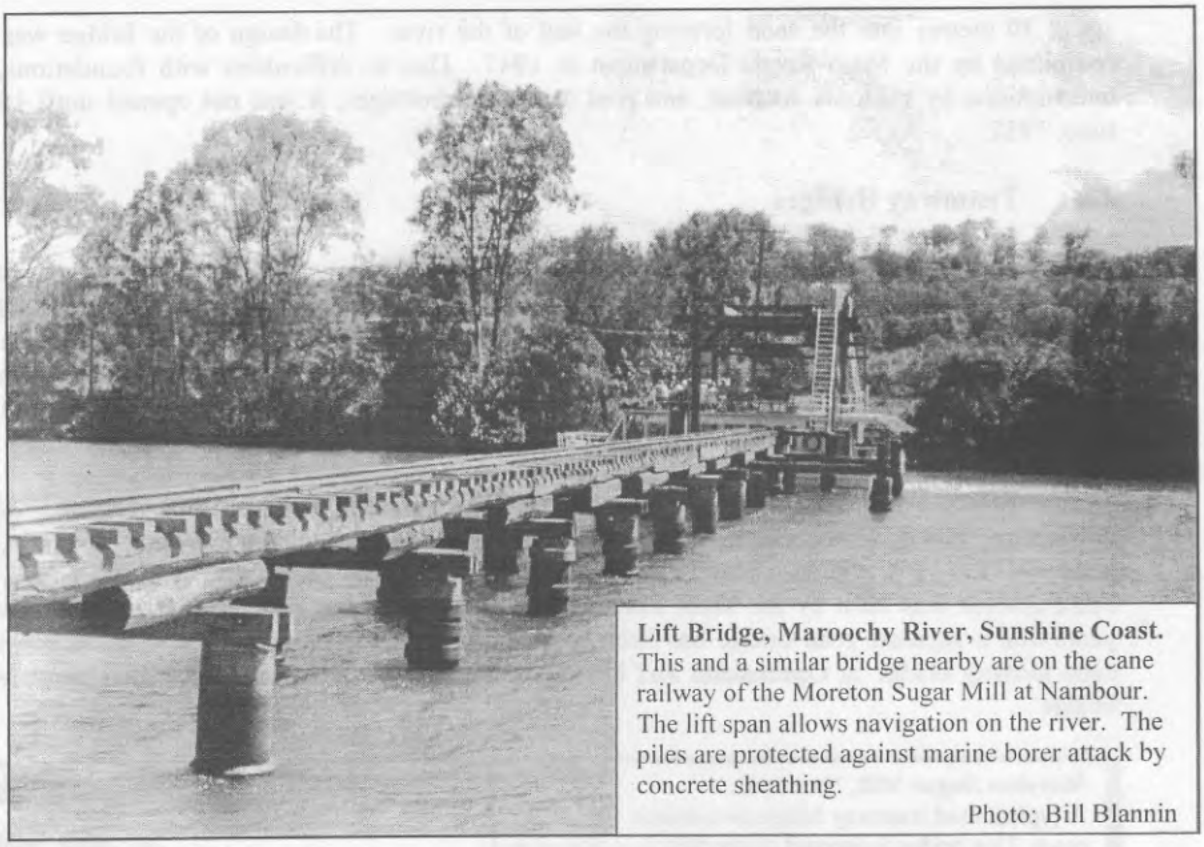
The majority of dual purpose bridges on tramways are of the latter type where the tramway and the road traffic share a common lane. Examples of separate superstructures do exist.

Queensland Government Railways

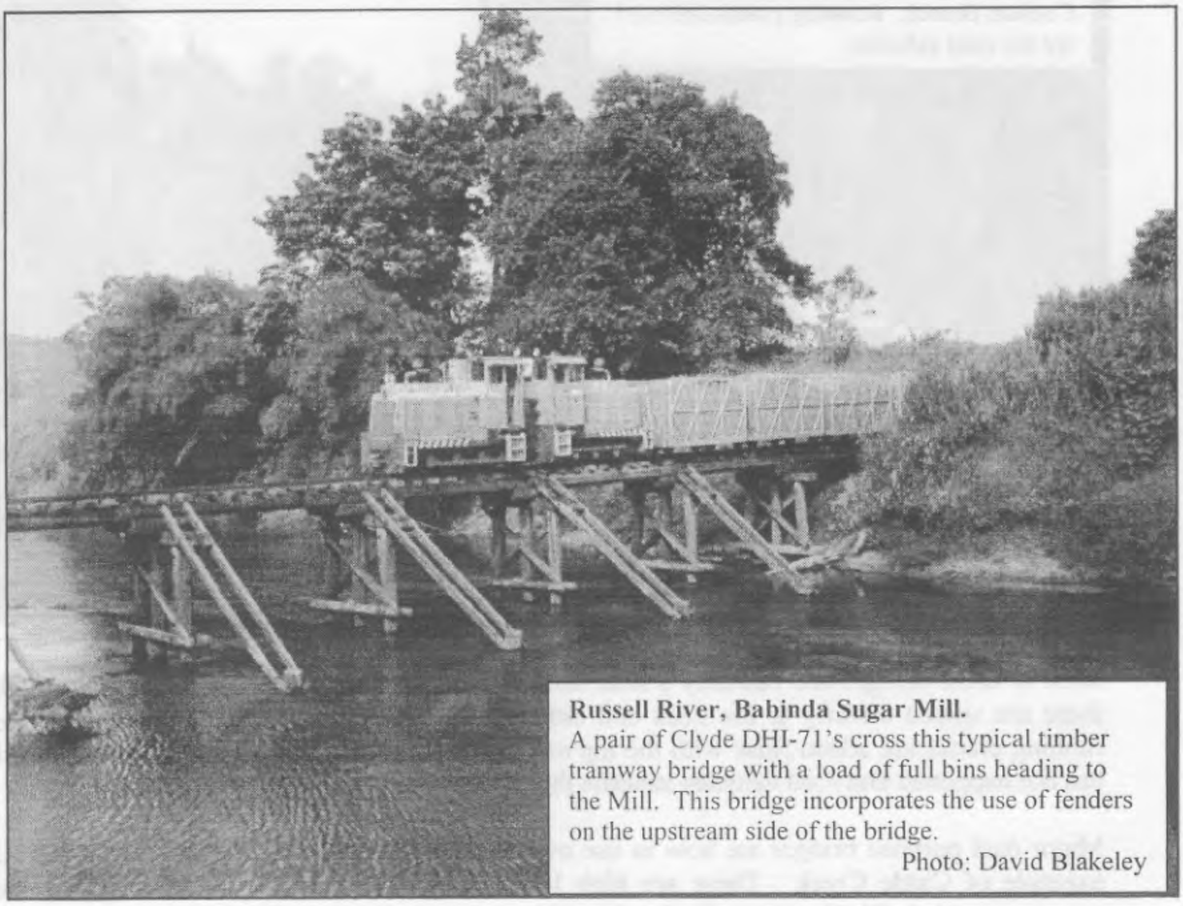
The original metal truss bridge across the Bremer River at Ipswich was originally used as a combined road and rail bridge before becoming a road bridge and has now been demolished.

There are two existing combined road/railway bridges on the QGR network. The oldest is the 1886 "Dickabram Bridge" over the Mary River at Miva on the Kingaroy Branch. It consists of a central 36.6 metre hog-back truss that is flanked by two 24.4 metre parallel chord lattice trusses. The bridge includes substantial end piers of timber and extensive timber approach spans.

The other is the "Silver Link" over the Burdekin River between Home Hill and Ayr. It has 10 major truss spans, each 250 feet (76.2 m), and is founded on massive concrete caissons sunk



Lift Bridge, Maroochy River, Sunshine Coast.
This and a similar bridge nearby are on the cane railway of the Moreton Sugar Mill at Nambour. The lift span allows navigation on the river. The piles are protected against marine borer attack by concrete sheathing.
Photo: Bill Blannin



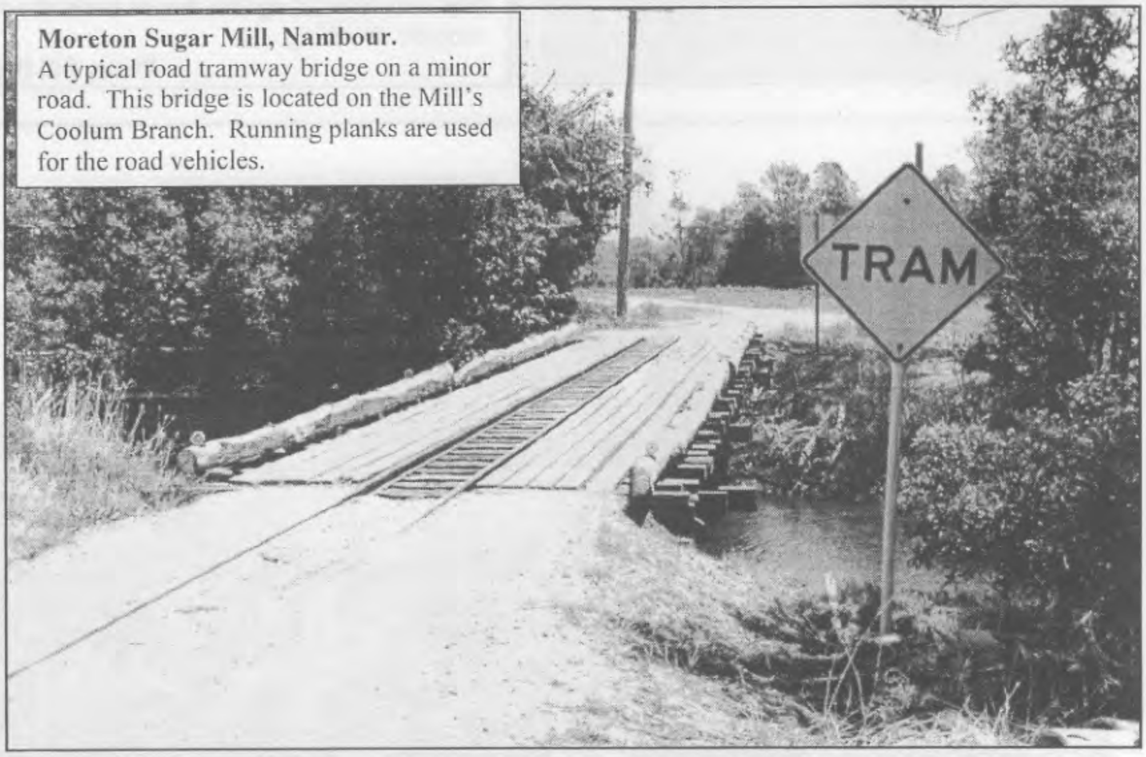
Russell River, Babinda Sugar Mill.
A pair of Clyde DHI-71's cross this typical timber tramway bridge with a load of full bins heading to the Mill. This bridge incorporates the use of fenders on the upstream side of the bridge.
Photo: David Blakeley

up to 30 metres into the sand forming the bed of the river. The design of the bridge was completed by the Main Roads Department in 1947. Due to difficulties with foundations, interruptions by cyclonic weather, and post war steel shortages, it was not opened until 15 June, 1957.

4.2 Tramway Bridges

The situation with dual purpose road tramway bridges is much more complex and is continuing to develop. One exists on the Moreton Mill (Nambour) network on the David Low Way over the Maroochy River at Bli Bli. This prestressed concrete bridge replaced a tramway ferry and was built for the local council around 1960 and was subsequently taken over by the Main Roads Department. Nambour also has two single lane timber dual purpose bridges on the Coolum Branch.

Timber dual purpose bridges are known to exist or to have existed on mill networks of Fairymead, North Eton, Cattle Creek, Farleigh, Proserpine, Kalamia, Invicta, Victoria, Babinda, Mulgrave and Mossman. The Saltwater Creek bridge on Mossman Mill's Rocky Point Branch was built by the Main Roads Department and it has only been in the last few years that a separate road bridge has been constructed. This is probably the northern most cane railway bridge in Queensland and has the distinction of being built as a dual purpose bridge.



Moreton Sugar Mill, Nambour.
A typical road tramway bridge on a minor road. This bridge is located on the Mill's Coolum Branch. Running planks are used for the road vehicles.

Most of these bridges are basically a road bridge to which rails have been added. Normally these are spiked directly to the deck and either an asphalt deck wearing surface or timber running planks are added flush with the top of the rails. A few examples do exist where this has not happened and road vehicles straddle the rails.

Major dual purpose bridges are now in use over the Pioneer River in Mackay with a further example of Cattle Creek. These are high level prestressed concrete structures. Another recent example is Elphinestone Creek near Abergowrie for the Victoria Mill.

5.0 Modelling Railway and Tramway Bridges

In the above discussion, I have attempted to give an idea of the basic sizes of materials used in bridge construction. To me, the important thing is to get the proportions right. The size of girder used is related to the span and the loading. The above tables give typical prototype values that can be used to derive the scale sizes.

For timber bridge girders, I have tended to use an appropriate size dowel for girders and corbels. Dowel is stronger and stiffer than balsa and harder to break in service. By modelling a straight bridge, a line of girders can be formed from a single piece of dowel with flattened areas at appropriate intervals for the corbels to be added. For curved bridges individual girders would need to be cut out. Steel girders can be modelled using scale "I" shapes which are available in plastic and stripwood.

Piers are best formed by prefabrication on the work bench using simple jigs. These hold the piles in location whilst the headstocks, wales and braces are attached. These can be cut from scale sized stripwood or plastic such as Evergreen. If the bridge is likely to be touched in use eg during track cleaning I would prefer to use one of the harder stripwoods rather than balsa. The completed piers can then be installed into their correct positions on the layout.

Timber bridges are bolted together and this detail is often overlooked. If the bridge is to receive close scrutiny, it's worth adding nut, bolt and washer castings. I have used castings that are made by either Kadee or Grandtline.

From the information contained on the treatment and painting of QGR bridges, the following appears to be a reasonable approximation of colours for various eras.

Typical Timber Bridge Colourings

Time Period	Typical Colours
Pre First World War	• Timber except piles Tarred (black)
First World War to Second World War	• Timber painted red oxide. Upper surface of footplanks and ends of corbels painted white
Post World War Two	• Timber generally unpainted • footplanks, escape planks, handrails, top face of girders painted white • 300 mm of piles above ground tarred (black) CCA green to girders after about 1980

On one bridge that I built I wanted a creosote finish, so I painted the timber in real creosote. Whilst the finished effect was pleasing, it is not the sort of product to use indoors and a strong creosote smell lasted for several weeks.

6.0 Conclusions

This paper has described some of the typical types of bridges that might be found on QGR branchlines and around sugar mill systems. I have included some typical prototype information to allow modellers to select appropriate materials and sizes for their bridges. I hope that this contributes in some small way to the better representation of Queensland's rich bridge heritage when bridges are next modelled.

7.0 References

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O'Conner, C., (1985), *"Spanning Two Centuries – Historic Bridges of Australia"*, University of Queensland Press, Brisbane, Australia.

Queensland Railways (1984), *"Bridgeman's Manual"*, Chief Engineer's Publication No. 18.

Queensland Railways, Standard Timber Bridge Drawings No. 1932 and 1933 of August, 1980.

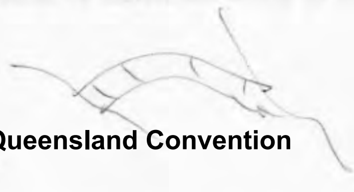
CSR Co Ltd, Drawings No. C52602 of 1958, C56105, C56106 & C56107 of 1960 and C61658 of 1963.

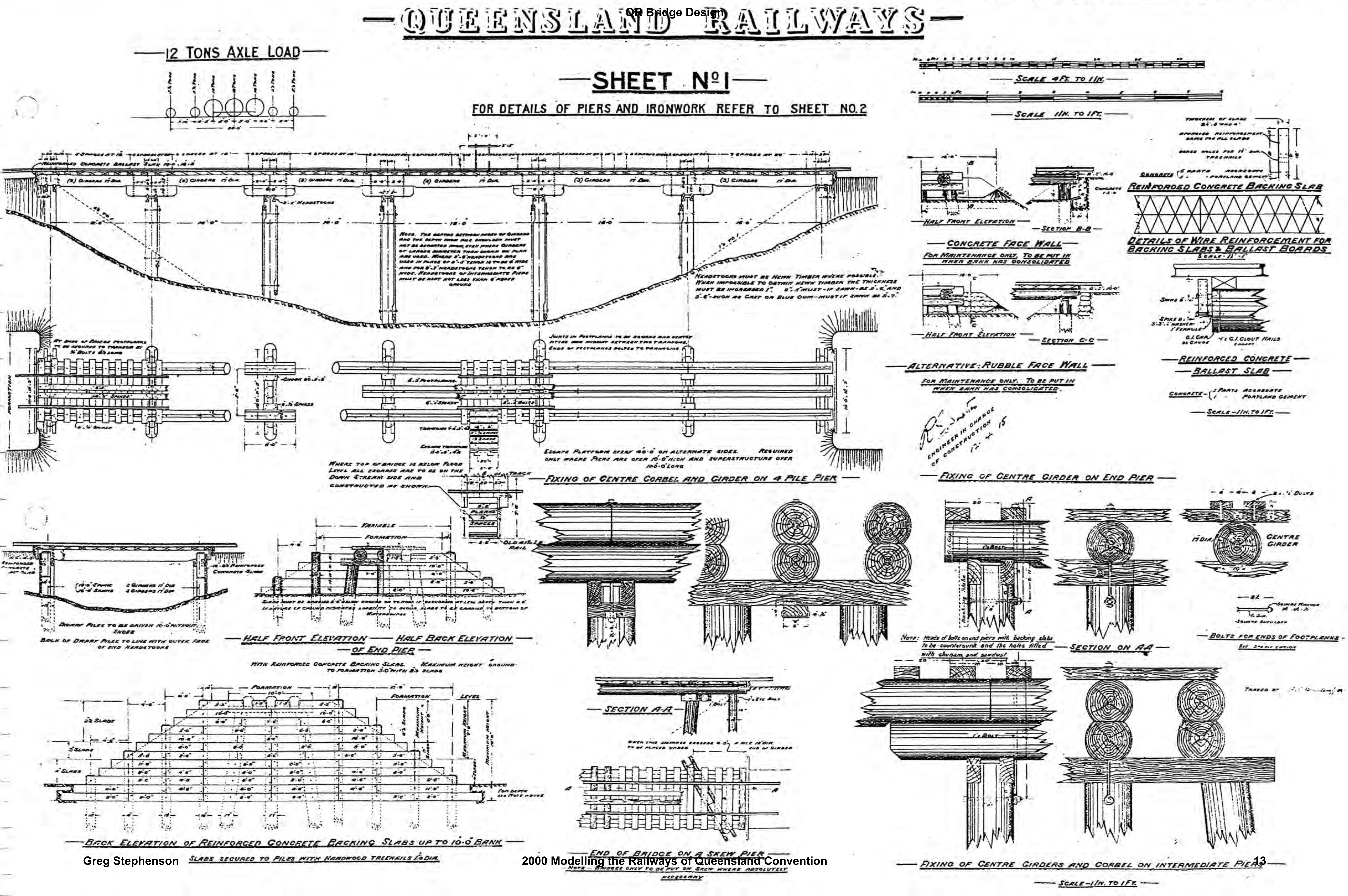
Tramway Bridge, Plane Creek Mill, Sarina
This timber bridge has been repaired by replacing the original timber girders and corbels with steel girders.

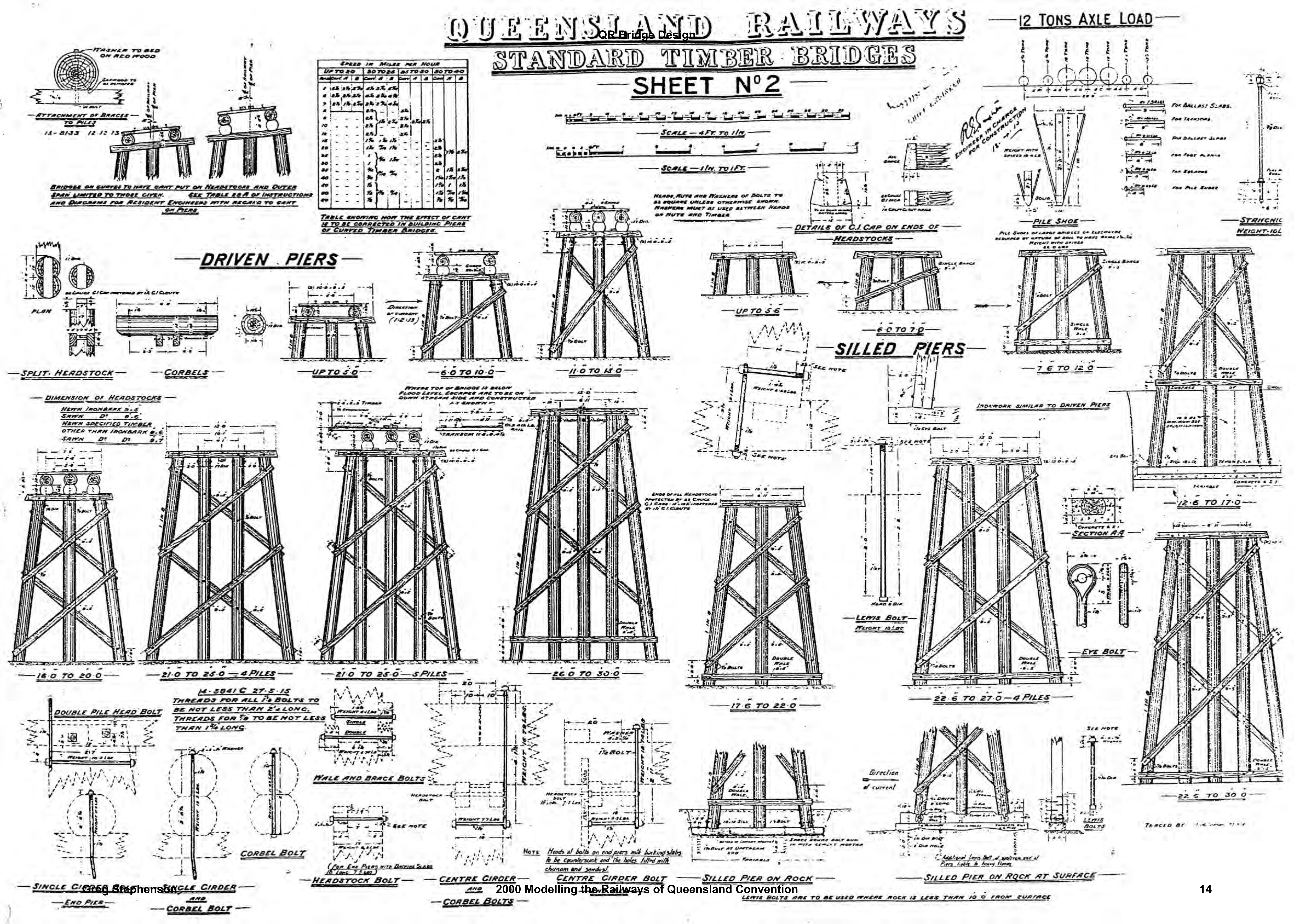
Note how multiple headstocks have been used to make up the level difference caused by eliminating the corbels.

The steel girders are painted in red oxide and the timber unpanted.

Mulgrave Mill Bridge – Long tram
Steel rail only over creek




QUEENSLAND RAILWAYS
12 TONS AXLE LOAD
SHEET No 1
FOR DETAILS OF PIERS AND IRONWORK REFER TO SHEET NO. 2
SCALE 4FT. TO 1IN.
SCALE 1IN. TO 1FT.
REINFORCED CONCRETE BACKING SLAB
DETAILS OF WIRE REINFORCEMENT FOR BACKING SLABS & BALLAST BOARDS
HALF FRONT ELEVATION
SECTION B-B
CONCRETE FACE WALL
FOR MAINTENANCE ONLY. TO BE PUT IN WHEN BANK HAS CONSOLIDATED
HALF FRONT ELEVATION
SECTION C-C
ALTERNATIVE: RUBBLE FACE WALL
FOR MAINTENANCE ONLY. TO BE PUT IN WHEN BANK HAS CONSOLIDATED
REINFORCED CONCRETE BALLAST SLAB
SCALE - 1IN. TO 1FT.
ENGINEER IN CHARGE OF CONSTRUCTION
ESCAPE PLATFORM EVERY 40-0 ON ALTERNATE SIDES. REQUIRED ONLY WHERE PIERS ARE OVER 10-0 HIGH AND SUPERSTRUCTURE OVER 100-0 LONG
FIXING OF CENTRE CORBEL AND GIRDER ON 4 PILE PIER
FIXING OF CENTRE GIRDER ON END PIER
HALF FRONT ELEVATION
HALF BACK ELEVATION
OF END PIER
WITH REINFORCED CONCRETE BACKING SLABS.
Note: Heads of bolts on end piers with backing slabs to be countersunk and the holes filled with chunam and sawdust.
SECTION ON A-A
CENTRE GIRDER
BOLTS FOR ENDS OF FOOTPLANKS
SECTION A-A
BACK ELEVATION OF REINFORCED CONCRETE BACKING SLABS UP TO 10-0 BANK
SLABS SECURED TO PILES WITH HARDWOOD TREENAILS
END OF BRIDGE ON A SKEW PIER
FIXING OF CENTRE GIRDERS AND CORBEL ON INTERMEDIATE PIERS
SCALE - 1IN. TO 1FT.


QUEENSLAND RAILWAYS
STANDARD TIMBER BRIDGES
SHEET No 2
12 TONS AXLE LOAD
SCALE — 4 FT. TO 1 IN.
SCALE — 1 IN. TO 1 FT.
ATTACHMENT OF BRACES TO PILES
BRIDGES ON CURVES TO HAVE CANT PUT ON HEADSTOCKS AND OUTER SPAN LIMITED TO THOSE GIVEN. SEE TABLE 28 A OF INSTRUCTIONS AND DIAGRAMS FOR RESIDENT ENGINEERS WITH REGARD TO CANT ON PIERS
TABLE SHOWING HOW THE EFFECT OF CANT IS TO BE CORRECTED IN BUILDING PIERS OF CURVED TIMBER BRIDGES
DETAILS OF C.I. CAP ON ENDS OF HEADSTOCKS
PILE SHOE
STANCHION
DRIVEN PIERS
SPLIT HEADSTOCK
CORBELS
UP TO 5·0
6·0 TO 10·0
11·0 TO 15·0
UP TO 5·6
6·0 TO 7·0
7·6 TO 12·0
SILLED PIERS
IRONWORK SIMILAR TO DRIVEN PIERS
DIMENSION OF HEADSTOCKS
16·0 TO 20·0
21·0 TO 25·0 — 4 PILES
21·0 TO 25·0 — 5 PILES
26·0 TO 30·0
17·6 TO 22·0
22·6 TO 27·0 — 4 PILES
12·6 TO 17·0
SECTION A.A
LEWIS BOLT
EYE BOLT
22·6 TO 30·0
THREADS FOR ALL 1⅛ BOLTS TO BE NOT LESS THAN 2¼ LONG. THREADS FOR ⅞ TO BE NOT LESS THAN 1¾ LONG.
DOUBLE PILE HEAD BOLT
WALE AND BRACE BOLTS
CORBEL BOLT
SINGLE GIRDER END PIER
SINGLE GIRDER AND CORBEL BOLT
HEADSTOCK BOLT
CENTRE GIRDER AND CORBEL BOLTS
CENTRE GIRDER BOLT
SILLED PIER ON ROCK
SILLED PIER ON ROCK AT SURFACE
LEWIS BOLTS ARE TO BE USED WHERE ROCK IS LESS THAN 10·0 FROM SURFACE