

Timber Bridges in Australia

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Abstract

This paper presents an overview of the history of timber bridges in Australia and examines applications of timber technology related to transportation structures and the implementation of technology in Australia.

Keywords: Timber, Bridges, Australia

Introduction

European presence on the Australian mainland has only existed in a permanent format for approximately 200 years. Prior to this, the indigenous aboriginal population lived in harmony with the often harsh environment.

Australia's significant timber resources are located in the coastal zones of the South West, Eastern and South Eastern regions of the continent. The remainder of the continent is semi arid to arid with little to or no significant commercial timber resource.

The Indigenous population had little commercial interest in the forests other than to provide a refuge and environment in which they and their food resource resided.

Europeans had a different perspective on the forest resource. Australian forests provided them with an untouched natural resource which provided materials of strength, size and durability.

Unlike the Indigenous population, Europeans had little understanding of the environmental management issues in this new continent which would enable a sustainable commercial use for the forest resource.

It took more than a century for Europeans to realise that the timber was a finite resource unless managed.

Australia now has a well managed hardwood and softwood forest management strategy in practice. Native Eucalyptus forests are managed on a sustainable basis with specific management practices developed for the different species and environments. Hardwood plantations are being developed to supplement the managed native forest resource.

Commercial softwood plantations, mainly Radiata Pine, have been planted over the previous 70 odd years. Softwoods have provided the economical alternative resource for the value added side to the timber industry.

History of Timber Bridges in Australia

The earliest recorded timber bridge built in Australia was the Bridge Street bridge over the Tank Stream in Sydney constructed in 1788 but was washed away soon after construction. The Stream rapidly became a polluted drain as Sydney developed and was finally fully covered as part of Sydney's expansion by 1870.

Professor Colin O'Connor, in his book "Historical Bridges of Australia" records that by 1805, there were 10 timber bridges on the Sydney to Paramatta Road constructed of Iron bark or Blue Gum timber stingers and decking.

As the Colony developed bridges were constructed, many using timber superstructures and masonry piers. None of

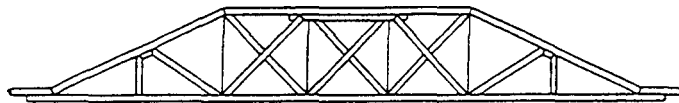
these early bridges remain.

There are few records of the actual numbers of timber bridges constructed during the early years in the Colonies.

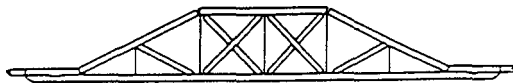
As the Colonies expanded, and the need to transport people and commodities increased, there was a need to build bridges with larger spans and greater load capacity.

The timber truss is generally considered as an American innovation. During the early and mid period of the nineteenth century, many consider that, as a result of the Gold rushes and rapid movement of people, this technology was transferred internationally.

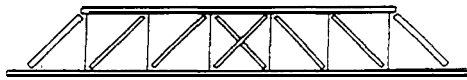
New South Wales was the Australian leader in the use of timber truss bridges to overcome the span requirements. Professor O'Connor indicates the development of truss bridges in Australia can be classified into so called old type trusses prior to 1886, McDonald trusses 1889-1894, Allan trusses 1893 to approximately 1920 and the de Burgh composite steel and timber and Dare composite trusses in the period 1900 to 1912.



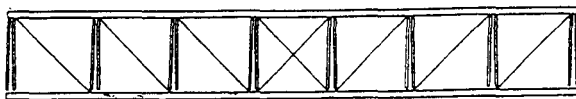
Old Style Truss (Public Works Department)



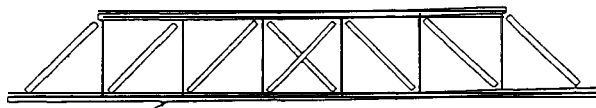
McDonald Truss



Allan Truss



De Burgh Truss



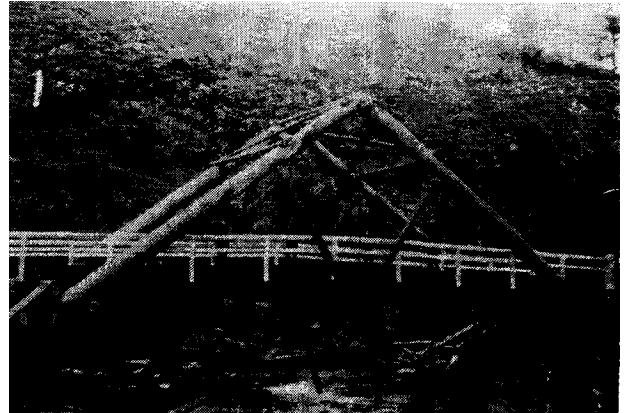
Dare Truss

**Timber Truss Types for Bridges
Constructed 1860-1912**

One of the oldest type timber truss bridges still in existence is the Karuah River bridge at Monkerai which was built about 1877.

Laminated Bow Staring arch bridges were constructed in the period 1870 to 1900, but many developed problems as a result of separation of laminates due to the large amount of shrinkage of Australian hardwoods. The shrinkage created gaps that enabled fungal and termite attach in these areas. Replacement of individual laminates was not possible.

The larger and more impressive truss structures attract the attention of the general public.

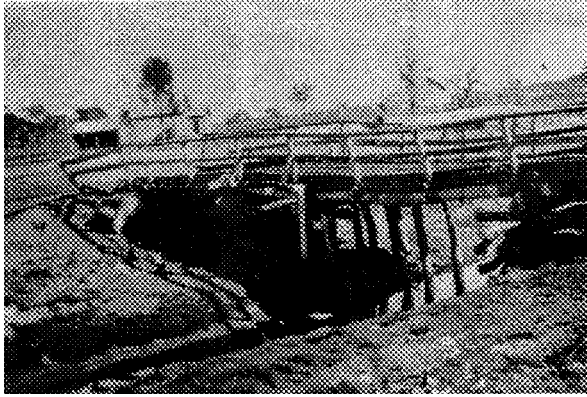


**Livingston Road Bridge
Morwell River, Victoria**

Many of the innovations in timber bridge technology were developed through necessity with the expansion of the railway network and the requirement for greater load capacity

It was not these structures that provided the significant tool to the development of the infrastructure network, but rather the humble timber stringer beam bridge with timber trestle substructure. These simple structures with spans in the range 5 to 12 metres provided the backbone to the road and rail network. Timber for these structures was sourced and milled locally and bridges constructed by the local communities.

Timber bridge construction was overtaken by more modern materials and technologies in the early portion of this century. Timber appeared to have lost the appeal to designers and those managing the road network.



Old Timber Bridge - Eastern Victoria

Materials

Durability is perceived by many to be the down side to using timber in significant infrastructure projects.

An understanding of the materials is essential to the correct utilisation of the material, whether timber, concrete or steel or combination of all in composite structures.

Australia was fortunate in that it had many readily available hardwood species suitable for structural applications. The most notable are the Eucalyptus species of which many provided both durability and strength.

Much of the old growth Eucalyptus species were large trees and very suitable for bridge construction applications. Today in Tasmania, the Southern most state of Australia, it is not difficult to obtain clear round logs in excess of 1.2m diameter and 15m plus length.

The availability of this timber is reducing rapidly as the community appreciates the old growth mature forest for its heritage and environmental values.

Many of the Australian Eucalypts have been high strengths with round logs from varieties such as Grey Box, Black Butt and Iron Bark being classified in strength groups of F27 and high durability classifications. These timber species enabled early bridge builders to construct basic bridges easily, cheaply with the benefit of strength and long life. Many of these basic bridges are in service on minor roads today, with little or no maintenance and in excess of 80 years service.

Designers of bridges in Australia today cannot economically obtain old growth mature forest sawn timber in sizes necessary to construct bridges.

Technology has enabled plantation timbers to be utilised through the manufacture of structural timber sections such as Glu-Laminated beams. Preservative treatment of lower durability timbers, both hardwood and softwood, have enabled previously undesirable species to find application in bridge building.

Manufactured structural section with appropriate durabilities are available for bridge building. The imagination of the designer will be the limitation to the application of these products in the competitive market place.

Perceptions of Timber Bridges

Timber bridge construction effectively ceased in the early 1950s due to availability of suitable timber sizes, perceived durability and the advances in steel and reinforced concrete technologies.

Concrete in particular was perceived as providing long term maintenance free structures similar to many old and existing masonry structures. Advances in steel technology provided opportunities for longer span structures with increased load capacities.

Timber bridge technology had not advanced beyond the trusses of the late nineteenth century. Construction and maintenance of these bridges was becoming a problem particularly where the ratio of material cost to labour cost was altering with labour cost proportions increasing over material costs.

The timber bridge was seen as a solution on low traffic volume, small span and remote location sites where there was a local material source.



**New Timber Stringer Bridge
Savage River - Tasmania**

Poor detailing on many of the short span timber stringer with timber trestle substructures combined with low durability local resourced timber, resulted in the perception

of timber bridges being short term solutions to bridging problems. This perception is still held by many Engineers practicing today.

The timber bridge was being delegated to the boutique market scene where cost was not the driving consideration. This effectively excluded timber bridges from the arterial road networks, with targeted programs to replace existing timber bridge stock.

Timber bridges are delegated to a solution for small pedestrian bridges and low load capacity vehicle structures on the likes of golf courses and private rural farm properties.

The timber supply industry concentrated on the rapidly growing residential scantling market where large volumes of repetitious section sizes would be utilised.

Timber was not seen as exciting in the context of materials available in the market. The result was stagnation in the advancement of technologies which would enhance the use of nature's most friendly renewable resources in transport infrastructure projects.

Advancements in Technology

During the 1970s, the extent of the timber bridge asset was being appreciated, not through an appreciation of its functionality, but rather through the cost of maintaining it. Neglect of the asset over decades had resulted in this situation. Replacement of the timber bridge asset was prohibitive in the short term.

The necessity to prolong the serviceability of these assets was required. Like so many progressions in technology, necessity for a solution progressed the cause.

The residential and commercial building market with the potential for large volume turnover lead to the development of manufactured timber products such as Glu-Lam and Laminated Veneer Lumber structural sections.

Developments in preservative treatment of timber products opened the field for use of timber products to previously hostile environments.

Innovation by practitioners in the maintenance field resulted in a better appreciation of the detailing requirements for timber bridges.

Advancements such as "stress laminated timber decks utilising preservative treated or high durability sawn timber has provided a new and exciting tool to maintain existing bridge structures while also increasing their load capacity through. The Canadian initiated "Stress Laminated bridge system has been successfully further developed in the

United States to provide a tool to practitioners maintaining and building timber bridges.

Through the generous contribution of the United States Forest Industry, the technology associated with stress laminated timber bridges has been shared with Australia.

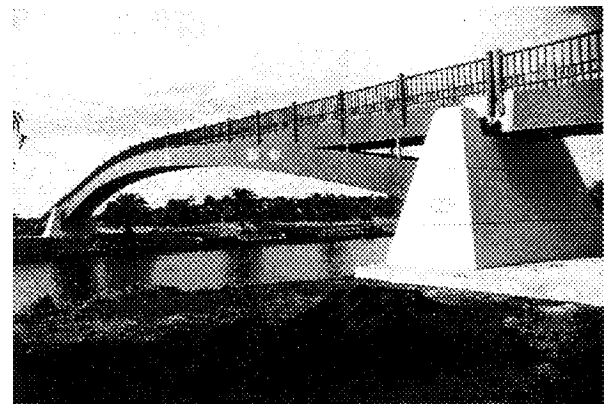
The Road and Traffic Authority of New South Wales in association with the University of Technology, Sydney, have worked in adapting this technology to Australian conditions. The timber industry have been supportive of the research.

Advancements in the development of stress laminated technology to new structures is being carried out by the Road and Traffic Authority of NSW and the University of Technology, Sydney. Consultation and technology transfer during the project is occurring between the Australian project personnel and the US Forest products laboratory.

The use of laminated timber beams has been used successfully in Australia to construct pedestrian bridges. These bridges range from single span stringer beam through to large arch structures.

The Maribyrnong River pedestrian bridge is a two-pinned arch restrained by continuous off ramps. The clear span of the arch is 66 metres.

Interest in timber bridges technology in Australia has led to innovation in small span bridge design utilising composite timber stringer and concrete decks, cable stayed stress laminated pedestrian bridges and stress laminated cellular deck structures.



**Timber Arch Pedestrian Bridge
Manbyrnong River - Victoria**

Conclusion

The future use of timber in bridges in Australia will ultimately be driven by economics. The solutions

developed by designers to satisfy client requirements will generally be cost driven. The market in volume terms is relatively small when compared to other commercial uses. The small span bridge market is very competitive with solutions using alternative materials such as concrete and steel being perceived by many as providing the more appropriate economic and durable solution.

For timber bridges to achieve success in this competitive market will require the persistence of the dedicated, commitment of suppliers and an appreciation by the consumer of the benefits of using nature's most friendly renewable resource.

Timber will not be the appropriate solution for all situations.

With the appropriate commitment from all shareholders in the timber technology community, timber will remain a key resource material for bridge designers and managers of the road network infrastructure asset.

References

(Book) SPANNING TWO CENTURIES - Historic Bridges of Australia. Colin O'Connor 1985.

(Book) TIMBER TRUSS BRIDGES - Maintenance handbook - Department of Main Roads, New South Wales.

(Proceedings Paper) PTEC. Conference 1994, H Carlin-Smith, P Slavich Design of Maribyrnong River Footbridge.

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In: Ritter, M.A.; Duwadi, S.R.; Lee, P.D.H., ed(s). National conference on wood transportation structures; 1996 October 23-25; Madison, WI. Gen. Tech. Rep. FPL- GTR-94. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.