Melbourne’s three bridge timber gluelams

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ABSTRACT

Prior to 1997 Melbourne bridge engineers wishing to use glue-laminated timber have had only two materials from which to choose, namely, radiata pine and jarrah. The radiata pine required pressure treatment with copper chrome arsenate (CCA) or similar to protect it from rot and termite attack. Painting of both jarrah and the treated pine was highly desirable to assist in the prevention of surface checking and cracking.

During 1997 a new gluelaminated timber product became available in white Cypress pine. The latter was more durable than jarrah but was classified as a softwood. This paper compares the three materials, some bridges designed and constructed in Melbourne using these timbers and explains why beams from two of the materials are fabricated offshore mainland Australia.

INTRODUCTION

The author is the Managing Director of BSC Consulting Engineers Pty Ltd (BSC). BSC has been designing bridges in Melbourne since 1973 in steel, concrete and timber. The timber structures have all been pedestrian bridges with principal beams in glue-laminated timber. Timber has been selected by clients on the basis of:

- price
- aesthetic appearance
- durability
- constructability
- minimal maintenance, and,
- public acceptance of a natural material

In contrast it is interesting to note the more desirable features of bridge materials as perceived by bridge engineers:

Design Information - That the materials specified have sufficient published information available to enable design of the structure for serviceability, strength and vibration,
Manufacturer Reliability - That the materials/products specified are those actually supplied,
Availability - That the materials specified are readily available along with their fabrication.
Sustainability - That use of the materials is geologically and environmentally sound.
Durability - That the materials used in bridge construction are most durable being resistant to insect and fungal attacks, ultra violet degradation and are resistant to the elements.
Stability - That the materials used do not excessively expand, shrink, warp, twist or deform in any way over time.
Workability - That the materials specified are easy to work with and have a high strength to weight ratio.

The purpose of this paper is to introduce the new bridge gluelam material, cypress pine, after reviewing briefly two completed structures in alternative materials.

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RADIATA PINE

*Pinus radiata* plantations abound in every State and Territory of Australia (fig.1). This plentiful and renewable softwood resource is used in kiln dried form for housing frames, roof trusses, polished flooring and with CCA treatment for a range of landscaping features.

In late 1974 BSC investigated alternative road overcrossing techniques. One consideration was the possibility of using a lightweight timber overpass in lieu of the heavier reinforced/prestressed concrete overpasses. A timber design prototype was developed (fig. 2) which was used as the basis for the Greensborough Footbridge - a design-construct project developed in 1975. [1] [2] [3] This was a three pinned parabolic arch spanning 50 metres with a clear footway width of 1.8 metres. The rise at the centre of the bridge was 5 metres pin to pin.

The main arch members were fabricated as CCA treated radiata pine glue-laminated beams 1015mm deep and 155mm wide. The select timber had a stress grade of F11 and a waterproof resorcinol glue was used. The gluelam beams were fabricated in Western Australia and railed the 3200 kilometres from Perth to Melbourne.
The Greensborough Bridge was one of the first uses of CCA treated pine gluelam bridges in Australia and is believed to be the largest span of its type. It is used daily by hundreds of commuters, is in structurally good condition but requires some maintenance work on its beam faces.

Unfortunately there was some delamination of the main arches and the beams were stitch bolted at one metre intervals as a precaution. Since that time no further large section glue-laminating of CCA treated pine has been carried out in Australia. All such beams must now be imported from New Zealand.

**JARRAH**

Jarrah (*eucalyptus marginata*) is a hardwood found only in the forests and in the south western corner of West Australia. It is a hard, dense timber, close grained with a mahogany-red colour. Being exposure resistant to earth, sea and air, it is commonly used for railway sleepers, retaining walls, piles and external staircases. Polished it is used for furniture and flooring. Its natural resistance to the elements make it an ideal untreated gluelam timber for bridges.

The Jarrah forests of Western Australia are managed by the state Department of Conservation and Land Management (CAML) which controls the annual yield and re-afforestation. Thus jarrah is considered to be a renewable resource in a managed forest environment.

During the 1980’s BSC designed several jarrah glue laminated bridges [5] [6] [7] and in 1994 was requested to design a low profile jarrah laminated footbridge over the Maribyrnong River at Essendon, Melbourne. This has been well reported [9]-[12] and was essentially a 68 metre span, restrained, two-pinned arch. The main timber sections were 1.2 metre deep and 120mm wide and steel channels were inserted in the off-ramps to ensure lateral stiffness. The Maribyrnong River footbridge is believed to be the longest span bridge of its type.

The Maribyrnong footbridge was erected in 1995 and carries considerable recreation traffic including walkers, walking groups, runners and families out for a stroll along the River. The author even saw a horse being led over the bridge! The jarrah was rated and designed as an F17 timber but this was recently amended to F14 for future structures.

At the time of design jarrah was rated as Durability Class 2 timber which did not require treatment or protection from fungal or insect attack. However, to help prevent checking and splitting of the timber it was stained and had a two coat clear polymer resin painted over the stain. This was to act as an anti-graffiti coating as well as an ultra-violet light inhibitor. At the time of writing the bridge is withstanding the harsh Melbourne conditions quite well with some minor checks and splits. The Durability of jarrah has recently been downgraded to Class 3 and for normal design its stress grade is now F14.

The Maribyrnong bridge sections were fabricated in Western Australia and transported by road to Melbourne.

**CYPRESS PINE**

In 1997 BSC was requested to design a footbridge spanning 21 metres over Moonee Ponds Creek in the suburb of Westmeadows, Melbourne. This bridge was to be a shared cycle/footway quite remote from the nearest residences and was to be user friendly and aesthetically pleasing. More importantly it had to blend into the environment of native grassland and shrubs. The client was keen on a timber structure but was reticent about using timber from the jarrah forests and preferred an Australian product to one from New Zealand.

These constraints virtually eliminated the known timber products of jarrah and treated radiata pine, and BSC was forced to cast around for an alternative. The answer came in the form of White Cypress pine (*Callitris glaucephylla*) which had recently been developed in glue-laminated form.

White Cypress pine is a conifer indigenous to Australia and is classified as a softwood. The species is distributed throughout Australia but predominantly in New South Wales (NSW) and Queensland (fig.3).
The main commercial forests in NSW and Queensland occur where annual rainfall is between 450mm to 700mm. Here the species reach heights of up to 25 metres with a diameter at breast height of 250mm to 300mm in about a 100 year rotation.

White Cypress pine has been available in the green or air dried state for decades and is well known for its resistance to termite and fungal attack. It has commonly been used in external situations such as posts where it has been placed in the ground without treatment. White Cypress pine has a durability rating of Class 1. The heartwood represents about 70% of the cross-section of logs in the 250mm to 300mm diameter category.

In comparison to pinus radiata Cypress pine is very slow growing and log sizes are smaller. For this and other reasons the species has never been considered seriously for plantation development. However it is the second highest commercial native species cut in NSW and nationally some 300,000 cubic metres are extracted annually from forests with about 67 per cent coming from Queensland. The major commercial Cypress forests in NSW have received on-going silvicultural treatment since the 1920’s and forest assessments confirm the sustainability of the current level of harvesting.

For various reasons the Cypress saw milling sector lagged behind other industry sectors in the area of value added product. Until about ten years ago all the Cypress was sold green or air dried. In the past decade some progressive companies installed driers and high speed planers so that high quality kiln dried boards became available.

During this period a Melbourne based company, Laminated Timber Supplies (LTS), carried out research and development on glue-laminating of Cypress pine heartwood - a procedure which was patented by that company. Strength testing of LTS glue laminated cypress beams was carried out at Monash University Timber Engineering Laboratories resulting in a grading of GLIO to the Glued Laminated Timber Association Natural Strength Standard. The results of this work came on stream about the time BSC required the new product!

The larger sizes and curved shapes for bridges required LTS to have the fabrication carried out in Tasmania at Tasmanian Timber Engineering and then transported by ship to Melbourne. The two main beams were 22 metres long, 1015mm high and 115mm wide. Laminated diaphragms were spaced at 3 metre intervals with pre-routed holes in them for long bolts from one side of the bridge to the other. Diagonal wind bracing and brackets were located beneath the deck along with
laminated deck stringers. Striated cypress pine decking was screwed to the stringers. The handrail posts were shaped from solid kiln dried cypress pine and the handrails were glue-laminated to match the curvature of the bridge.

The bridge was assembled in the LTS factory and transported by road in complete form to the site. Weighing eight tonne it was lifted into position and bolted down on the same day (fig.4). To protect the timber, the contractor, AG Wallace, firstly applied a water repellent wood preservative called CD50 to form a base for an anti-grafitti coating. The latter, called Duracoat MCL was applied in three coats to form an aliphatic polyurethane prepolymer cover to the timber. grafitti is simply wiped from this coating. Both the base and anti-grafitti coats were clear leaving the natural brown heartwood timber with some creamy streaks (sapwood) to the delight of the client.

![Fig. 4 Transport of completed bridge.](image)

**SUMMARY**

The author has described the three timbers currently obtainable in Melbourne for glue-laminated bridge manufacture. None of the fabrication of large curved section sizes is performed in Melbourne. The nearest fabricator for cypress pine is in Tasmania. Treated radiata sections are only fabricated in large sizes in New Zealand and jarrah in West Australia.

The new bridge gluelam, cypress pine, is durability Class 1, white ant resistant, free of chemical treatments, seasoned, dimensionally stable with variations in ambient moisture content and is extracted from a sustainable managed resource.

A comparison of the three materials discussed in this paper is presented as Table 1. It is interesting to note that cypress pine, although a softwood, is nearly as heavy as hardwood. It also has the least strength properties of the three materials.
Table 1. Available timbers for glue-laminated bridge construction in Australia.

<table>
<thead>
<tr>
<th>TIMBER (Kiln Dried)</th>
<th>COMMON NAME</th>
<th>BOTANICAL NAME</th>
<th>COLOUR</th>
<th>AIR DRY DENSITY Kg/m³</th>
<th>STRESS GRADE</th>
<th>CHEMICAL TREATMENT</th>
<th>DURABILITY CLASS</th>
<th>WHERE FABRICATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiata Pine (p,s)</td>
<td>Pinus Radiata</td>
<td>White</td>
<td>500</td>
<td>F11</td>
<td>CCA</td>
<td>VACSOL</td>
<td>1</td>
<td>New Zealand</td>
</tr>
<tr>
<td>Jarrah (NF,H)</td>
<td>Eucalyptus Marginata</td>
<td>Red</td>
<td>800</td>
<td>F14</td>
<td>Nil</td>
<td>3</td>
<td>West Australia</td>
<td></td>
</tr>
<tr>
<td>Cypress Pine</td>
<td>Callitrus (NF,S) Glaucophylla</td>
<td>Browny-Cream</td>
<td>680</td>
<td>F8</td>
<td>Nil</td>
<td>1</td>
<td>Tasmania</td>
<td></td>
</tr>
</tbody>
</table>

P = plantation        NF = native forests        S = softwood        H = hardwood

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REFERENCES


