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Department of Conservation
and Land Management

Wood Utilisation Research Centre

STRENGTH PROPERTIES OF LAMINATED JARRAH AND KARRI CROSSARMS

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W.U.R.C. Technical Report No. 33

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SUMMARY

The VALWOOD® process developed by the Department of CALM's Wood Utilisation Research Centre has application for structural products as well as furniture material. This trial assessed the bending strength properties of thirty jarrah (*Eucalyptus marginata* Donn ex Sm.) and thirty karri (*E. diversicolor* F. Muell.) 100 x 100 mm cros sarms.

The mean Modulus of Rupture (MOR) and Modulus of Elasticity (MOE) for jarrah were 99.3 MPa and 15 750 MPa respectively, and for karri 127.3 MPa and 20 705 MPa respectively. The small standard deviations indicated a very uniform product. The MOR for each species could be predicted from MOE using the equation:

$$MOR = -879 + 101 \ln MOE \quad (r^2 = 68.6\%).$$

The strength values were substantially higher than those from a small sample of solid jarrah crossarms. The major advantage of laminated crossarms is that they can be produced in a few weeks, compared with the two years usually needed to dry solid timber crossarms.

INTRODUCTION

Since 1986 the Department of Conservation and Land Management has conducted a major project to assess value-added products from regrowth eucalypt thinnings. The research has been concentrated at the Department's Wood Utilisation Research Centre at Harvey, and has been funded jointly by the Commonwealth Government, State Government, and the W.A. timber industry.

A major achievement has been the development of the VALWOOD® process, in which, thin dried dressed boards are edge- and face-glued into blanks (panels). The research commenced when a need was seen for increased volumes of furniture grade timber to supplement existing supplies.

However, the VALWOOD® process can be applied in manufacturing structural products, including laminated crossarms suitable for power and transmission poles. The solid timber crossarms in current use take at least two years to dry, with the risk of degrade during drying which makes the quality unacceptable.

This trial assessed the strength properties (Modulus of Rupture (MOR) and Modulus of Elasticity (MOE)) of 2.1 m long 100 x 100 mm cross-sections manufactured from boards of regrowth jarrah (*Eucalyptus marginata* Donn ex Sm.) and karri (*E. diversicolor* F. Muell.). A minor aim was to consider the relationship between MOR and MOE in the two species when used in laminated crossarms.

METHODS

The regrowth jarrah and karri material used in this study was standard VALWOOD® material stock at Harvey, and included characteristics such as small intergrown knots.

Thirty crossarms of 100 x 100 mm cross-section were produced by laminating ten 10 mm thick boards, using resorcinol formaldehyde adhesive to provide a waterproof bond. The crossarms were processed in an `Orma' commercial glue press, with oil-heated platens at 90°C, a pressure of 1500 kPa, and pressing time of about 20 min.

The strength tests were done under contract by the Department of Civil Engineering at the Curtin University of Technology. An 18 mm diameter hole was drilled in the centre of the crossarm at right angles to the laminae, to simulate service conditions where the crossarm would be bolted to a power pole. The crossarms were supported on a span of 1435 mm, on 100 mm bearings allowing rotation, and a centre load of 75 mm width was applied with the laminae horizontal.

The load was applied at a constant rate, taking regular load and deflection readings. It was held constant at 17.2 kN for 1 min, and the residual deflections at zero load were assessed. The load was then increased until failure and the maximum load and type of failure noted.

Specimens were subsequently taken from near the failure point for assessment of moisture content using the oven-dried method (Standards Association of Australia 1972), to confirm that the moisture levels in the timber were constant.
The Modulus of Rupture was calculated using the following equation:

$$M = \frac{wl}{4}$$

where
- M = bending moment
- μ = maximum load (N)
- l = span (mm)

and $M = fZ$

where
- f = modulus of rupture or maximum fibre stress (MPa)
- Z = section modulus ($\frac{1}{6} bd^2$)
- b = breadth (mm)
- d = depth (mm)

hence

$$f = \frac{M}{Z}$$

Modulus of elasticity was calculated from:

$$y = \frac{Wl^3}{48EI}$$

where

- y = change in deflection (mm)
- W = change in load (N)
- l = span (mm)
- E = modulus of elasticity (MPa)
- I = moment of inertia (bd^3)
- b = breadth (mm)
- d = depth (mm)

$$\text{Hence MOE} = \frac{Wl^3}{48\,yI}$$

$$= \frac{Wl^3}{48\,y \quad bd^3}$$

$$= \frac{Wl^3}{4\,y \quad bd^3}$$

The sample data were analysed by regression methods to assess the relationship between MOR and MOE in the two species.

RESULTS AND DISCUSSION

The mean values and standard deviations for the two Moduli were (Table1):

Table 1
Means and standard deviations of MOR and MOE of laminated crossarms from regrowth jarrah and karri (sample size = 30)

Species		MOR (MPa)	MOE (MPa)
Jarrah	Mean	99.3	15750
	S.D.	13.0	760
Karri	Mean	127.3	20705
	S.D.	9.4	1328

The coefficients of variation for laminated jarrah crossarms were 13.1 per cent for MOR but only 4.9 per cent for MOE. The corresponding coefficients for karri were 7.4 per cent for MOR, and 6.4 per cent for MOE, which indicates that the product has the advantage of being very uniform.

The moisture contents of the samples varied between 8 and 10 per cent, which is below the average equilibrium moisture content of 12 per cent for the Perth area. Analysis indicated that the relationship between MOR and MOE was similar in both species, but the range of MOE values for jarrah was separate from the range for karri (Fig. 1).

The regression equation developed for the relationship was:

$$MOR = -879 + 101 \ln MOE \quad (r^2 = 68.6\%)$$

The design stresses for solid jarrah crossarms used by the SECWA are based on a MOR of 68 MPa, and currently a 100 x 125 mm crossarm is used (Palfrey, personal communication[1]). The equation for calculating MOR can be used to predict the increased strength needed by a 100 x 100 mm laminated crossarm of either species to take the same load as the solid jarrah crossarm with its larger cross-section. The estimated strength is 106 MPa.

The data from the present study of 100 x 100 mm laminated jarrah crossarms showed a mean value of 99.3 MPa indicating that half of the jarrah crossarms would perform better than the design requirements for the standard 100 x 125 mm solid jarrah crossarms. However, it is doubtful whether solid jarrah crossarms would conform with the design requirements, because the 68 MPa apparently is based on test results from small defect-free specimens given by Bolza and Kloot (1963). Limited data from tests on solid jarrah crossarms with 100 x 125 mm cross-sections indicated a mean MOR of 75.5 MPa (Karpinski, personal communication[2]). The larger cross-section of the solid jarrah crossarms would take less load than the smaller laminated sections in the present study. All laminated karri crossarms performed better than the design requirments of the standard solid jarrah crossarms.

The laminated crossarms made by the VALWOOD® process have considerable potential because the principle can be applied to eucalypts other than jarrah and karri. A major advantage is the very fast processing time in producing VALWOOD® in comparison with the two years needed to dry solid timber crossarms, with quality not being assured because of the risk of degrade during the long drying period. Weathering tests of VALWOOD® crossarm sections are in progress at the Australian National University.

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[2] Mr J. Karpinski, Curtin University of Technology, Bentley 6102.

ACKNOWLEDGEMENTS

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