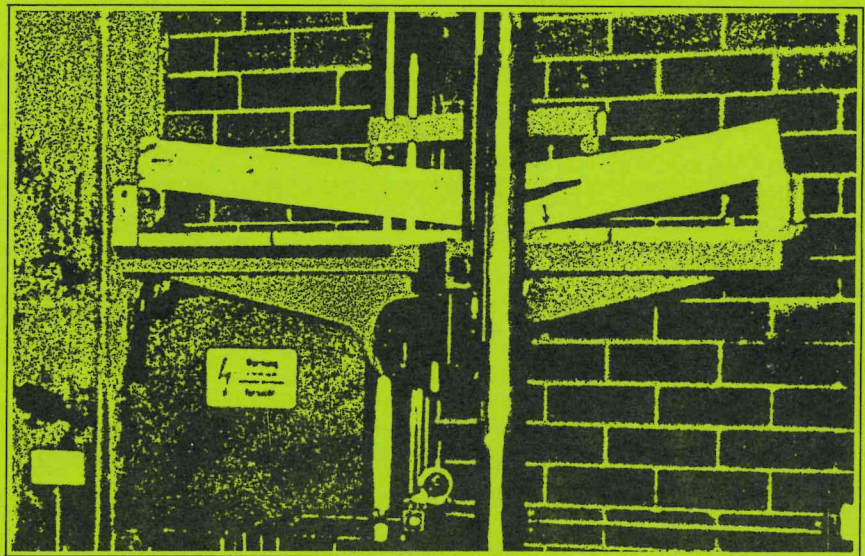

Effect of Pencilling and Furnace Oil Treatment on Strength Properties of Jarrah

L. Siamos and G.R. Siemon



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SUMMARY

Strength tests of a limited sample of jarrah (*Eucalyptus marginata* Donn ex Sm.) indicated that pencilling in the timber, which is generally associated with *Fistulina hepatica* Fr., had no significant effect on modulus of rupture, modulus of elasticity, or maximum crushing strength. Boulton conditioning, followed by pressure treatment with furnace oil, similarly had no significant effect on these strength properties. The only significant differences found in the study were in density.

INTRODUCTION

Jarrah (*Eucalyptus marginata* Donn ex Sm.) is the major timber species grown in the south-west of Western Australia. The prime jarrah area is a 30-50 km wide belt along the Darling Range from about 50 km east of Perth to the Albany region (Boland *et al.* 1984), covering about 1.5 million ha. Tree height varies from 30-40 m, to mallee size, depending on the site.

The outer heartwood of jarrah is dark red to reddish brown, strong and durable, with density of about 830 kg/m³ (Boland *et al.* 1984). Uses have included heavy construction (either round or sawn), piling, sleepers, bridge and wharf construction, as well as house framing. The better quality timber is ideally suited for manufacture of high quality furniture.

The appearance grade timber suitable for furniture manufacture regularly has 'pencilling', which is associated with the fungus *Fistulina hepatica* Fr. Pencilling shows as a dark fleck in the heartwood, due to the presence of abnormally dark kino in the fibre, vessels, ray cells and wood parenchyma of the pencilled streaks (Tamblyn 1936). Its distribution varies considerably both within the tree, between trees, and between sites. The experience in industry is that pencilled heartwood dries more evenly than normal wood being seasoned for furniture grades.

Pencilled wood has been observed also in jarrah sleepers which are treated with furnace oil at a commercial timber preservation plant near Bunbury. The sleepers are incised before treatment to improve penetration of preservative, but pencilled wood apparently absorbs more preservative than normal wood. It was not known whether strength properties were affected by these apparent increased retentions of preservative.

The major strength properties requiring study were:

- modulus of rupture - a measure of the maximum fibre stress in bending
- modulus of elasticity - a measure of resistance to bending under load and its capacity to return to its original shape and size when the load is removed
- maximum crushing strength - a measure of resistance to compression parallel to the grain.

These properties are the basis for allocation of species into strength groups (Standards Association of Australia 1986).

This study was therefore designed to compare strength properties of non-pencilled ('normal') and pencilled wood, and to assess the effect of Boulton conditioning and pressure treatment with furnace oil as a preservative. The four treatments were therefore normal untreated, normal conditioned and treated, pencilled untreated, and pencilled conditioned and treated.

MATERIALS AND METHODS

The jarrah timber used in the study came from regrowth trees about 60 years old harvested from Kent Block in Harvey District. Milling was done by the Department of CALM's Wood Utilisation Research Centre in Harvey. Logs were sawn to produce 55 x 55 mm cross sections from which a total of 30 normal and 30 pencilled specimens were randomly selected, from at least 10 trees. These specimens were dressed to final dimensions of 50 x 50 mm, and docked to 760 mm length. The thirty pieces of each treatment were then subdivided randomly to give 15 pieces for preservative treatment and 15 to be left untreated. Each piece was marked for identification. The untreated specimens were wrapped in plastic to restrict moisture loss before strength testing.

The specimens for preservative treatment were included with a commercial cylinder charge of railway sleepers at Koppers Ltd, Picton, conditioned by 'Boultonising' (heating the timber in oil under vacuum for 10 hours, with temperature increasing from 90 to 105°C, to expel water before preservative is taken up), and then pressure treated at 1350 kPa for one hour to give a minimum retention of 65 kg/m³. The specimens are subsequently referred to as 'treated'.

The strength testing was done using a 20 kN capacity Mohr and Federhaff universal testing machine in the Civil Engineering laboratories at the Curtin University of Technology. The static bending parameters of modulus of rupture and modulus of elasticity were determined using the standard methods described by Mack (1979). Briefly, the specimens were tested over a 700 mm span, with a single loading head applied at midspan and a loading rate of 2.5 mm/min. A deflectionometer located on the neutral axis was used to measure deflection.

After static bending tests were completed, a 200 mm section was cut from the end of each specimen for compression tests to determine maximum crushing strength. These sections were tested in an Avery-Denison machine with 300 kN capacity, again using the method described by Mack (1979).

Density estimates were made from sections cut from the residual lengths of static bending specimens, and moisture contents of both untreated and treated specimens were checked using the requirements of AS1080 (Standards Association of Australia 1972).

Data were analysed using analysis of variance to compare the four treatments in each property i.e. modulus of rupture, modulus of elasticity, maximum crushing strength and density. The standard SPSS - X computer package was used.

RESULTS

The test results were as follows (Table 1).

Table 1.
Strength properties and density of normal or pencilled jarrah,
either untreated or furnace oil treated.

Property(a)		Normal untreated	Normal treated	Pencilled untreated	Pencilled treated
MOR (MPa)	Mean	74.5	74.0	73.0	72.5
	SD	11.0	7.9	11.5	16.7
MOE (MPa)	Mean	11820	11390	12545	12720
	SD	2040	1450	2190	2440
MCS (MPa)	Mean	39.7	36.7	38.9	34.6
	SD	4.8	4.6	4.7	6.5
D (kg/m ³)	Mean	1129	1083	1097	1091
	SD	36	43	66	39

- (a) MOR = modulus of rupture
MOE = modulus of elasticity
MCS = maximum crushing strength
D = density

The analysis of variance produced the results shown in Table 2.

Table 2.
Analysis of variance of strength properties and density.

Property(a)	Source of Variation	F-ratio	Significance	
MOR	Main effects	0.12	0.885	ns
	- Pencilling	0.22	0.640	ns
	- Treatment	0.02	0.879	ns
	Two way interaction	0.00	0.996	ns
MOE	Main effects	1.89	0.160	ns
	- Pencilling	3.73	0.058	ns
	- Treatment	0.06	0.814	ns
	Two way interaction	0.33	0.571	ns
MCS	Main effects	1.68	0.195	ns
	- Pencilling	0.01	0.937	ns
	- Treatment	3.36	0.072	ns
	Two way interaction	0.78	0.382	ns
D	Main effects	2.80	0.069	ns
	- Pencilling	1.00	0.322	ns
	- Treatment	4.61	0.036	*
	Two way interaction	2.50	0.120	ns

(a) MOR = modulus of rupture
 MOE = modulus of elasticity
 MCS = maximum crushing strength
 D = density

DISCUSSION

The strength properties of normal untreated jarrah (Table 1) were marginally higher than Bolza and Kloot's (1963) values for green specimens of 68.1 MPa for modulus of rupture, 10 205 MPa for modulus of elasticity, and 35.8 MPa for maximum crushing strength. Moisture contents were checked to verify that the specimens were green. It should be taken into consideration that the specimens in the present study came from a single logging area.

The results of the trial, given in Tables 1 and 2, indicated that neither pencilling nor treatment with furnace oil preservative to give an envelope of treated wood had affected strength properties of jarrah. There were no significant differences ($p < 0.05$) between treatments in modulus of rupture, modulus of elasticity, or maximum crushing strength, and there was no interaction between pencilling and preservative treatment.

Aufsess (1973) had found that while *Fistulina hepatica* caused reddish-brown heartwood discoloration in oak (*Quercus* spp), the density and strength properties were not affected. In comparison, he found that white rots (eg. *Polyporus dryophilus* and *Fomes robustus*) and brown rots (eg. *P. sulphureus*) caused rapid breakdown of cell walls in laboratory tests, and hence reduction in density and strength.

The effect on strength properties of preservative treatment by boultonising was discussed by Thompson (1980), who reviewed the literature on this subject. The authors quoted found reductions in modulus of rupture of 4 to 18 per cent, depending on the duration and temperature of the conditioning process, the species, and the dimensions of the timber. Thompson also stated that strength reductions associated with oil-type or oil-borne preservatives were attributable to conditioning effects and not to the preservatives themselves.

In comparison, the results of the present study indicated that the effects of the furnace oil treatment are comparatively mild. However, the Boulton conditioning and pressure treatment with furnace oil gave a 3 - 4 mm thick envelope of preservative around the circumference of each specimen, which resulted in only 24 - 30 per cent of the cross-section being treated.

While inspections of the sections docked for the maximum crushing strength tests indicated the uniform envelope of furnace oil, there was no evidence of improved penetration in the pencilled specimens following the Boultonising, and the pressure treatment at 1350 kPa. It was assumed that chemical tests would produce a similar result.

From the results of this study it is also assumed that the increased retention of preservative in treated jarrah sleepers was due to other fungi i.e. wood-destroying species. The increased uptake would then indicate reductions in strength values. While *Fistulina* can be associated with the pencilling on the surface of the sleeper, its occurrence is generally irregular, and recognition of attack by other fungi is also difficult. It is not feasible to sort sleepers before treatment to separate out the ones which would normally have a higher retention of preservative, and treat them with a different schedule to reduce uptake.

The statistically significant differences in density were due to preservative treatment rather than pencilling (Table 2). Untreated specimens had a significantly higher density than treated, and the data indicated that this was due to larger mass with a constant volume being maintained.

In summary, this study indicated that pencilling in jarrah does not have a significant effect on strength properties, and that preservative treatment with furnace oil does not affect strength, in a cross-section which has up to 30 per cent penetration.

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