Small Eucalypt Processing

Shrinkage, Collapse and Dimensional Recovery of Regrowth Jarrah

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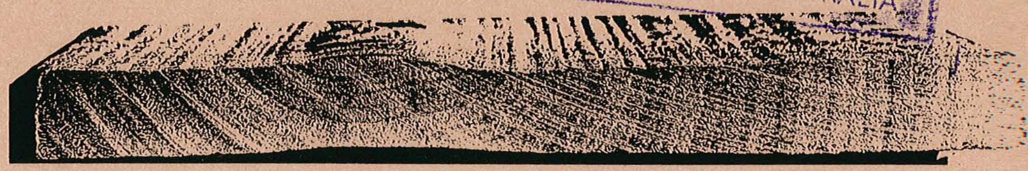

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SUMMARY

This study of regrowth jarrah (*Eucalyptus marginata* Donn ex Sm.) assessed shrinkage, collapse, and dimensional recovery by steam reconditioning in seasoned sawn timber.

Collapse was evident in 140 x 40 mm board samples, but a steam reconditioning at 100°C gave better collapse recovery when timber was at 11-15 per cent moisture content, than when the timber was at 16-25 per cent or 8-10 per cent. The reconditioning at 100°C was more effective than at 70° or 90°C in any moisture content range. The 100°C reconditioning treatment (at 11-15 per cent) reduced overall shrinkage by 3.1 per cent (tangential) and 2.4 per cent (radial), compared with non-reconditioned controls.

INTRODUCTION

As green timber dries, it initially loses free water from the cell cavities, and then loses bound water from the cell walls and begins to shrink. True shrinkage in cells begins at fibre saturation point (approximately 30 per cent moisture content), and continues until the equilibrium moisture content (EMC) is reached. To produce dimensioned timber for use in a seasoned condition, allowances for shrinkage and dressing must be made in determining the required cutting sizes for the green timber. Shrinkage values for most commercial species are well documented in publications such as Kingston and Risdon (1961) and Bootle (1983).

As well as true shrinkage due to loss of combined moisture from the cell walls, some eucalypt timber exhibits abnormally high shrinkage, termed collapse, while the moisture content is still above fibre saturation point. In the Eastern States, collapse is commonly associated with the ash-type eucalypts, which show a corrugating or caving-in of the surface of the timber and/or internal checking or honeycombing. Collapse can generally be reversed by a reconditioning treatment which consists of steaming the timber in saturated conditions at 100°C when moisture contents are below fibre saturation point (Kauman 1964).

In Western Australia, observations in sawmills suggest that sawn regrowth jarrah (*Eucalyptus marginata* Donn ex Sm.) timber has greater shrinkage than mature jarrah, and undulating corrugated surfaces have been observed on dry regrowth jarrah boards. The present study examined the shrinkage rates of regrowth jarrah timber, the possibility of collapse occurring, and the effect of various steam reconditioning treatments at different moisture contents during the drying process.

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METHODS

Milling
Fourteen regrowth jarrah logs (about 60 years old) from the Harris River Dam site, Harvey District, were sawn at the Wood Utilisation Research Centre. Logs had been harvested during the previous summer and were stockpiled under water sprinklers for three to four months. The logs were milled into 140 x 40 mm backsawn sections, using a twin-edged circular saw with overhead beam feed, and a narrow kerf vertical band re-saw. One hundred and twenty pieces of higher quality suitable for appearance grade were randomly selected, and a 1.2 m length docked and its ends sealed using a petroleum-based sealant. Lines were permanently marked at three points along the length (0.3, 0.6, and 0.9 m), and width and thickness at these positions were measured to 0.1 mm accuracy using dial calipers. These samples were then strip-stacked for drying.

A 20 mm long section for moisture content determination by the oven dry method was taken directly adjacent to the 1.2 m sample.

Seasoning of Boards
The sample boards were allowed to air-dry to approximately 50-60 per cent moisture content (MC). They were then placed in an experimental kiln and dried using the schedule given in Table 1, as suggested for jarrah by CSIRO (Campbell 1980). When the charge had reached 16-25 per cent MC, 30 samples were removed for reconditioning treatment. Another 30 samples were removed for reconditioning treatment when the MC reached 11-15 per cent, and the next thirty for reconditioning at the end of the kiln cycle when the MC was between 8-10 per cent. As a control, the final 30 samples were kiln dried to between 8-10 per cent without reconditioning.

Table 1.
CSIRO kiln schedule used to dry samples in an experimental kiln (Campbell 1980).

Moisture Content (%)	Dry Bulb Temperature (°C)	Wet Bulb Temperature (°C)
60	40	37
40	45	41
35	45	41
30	50	45
25	50	42
20	55	45
15	60	45
10	60	45

Reconditioning

Reconditioning treatment was given at three different temperatures (70, 90 or 100°C) in each of the three MC ranges. Reconditioning took place in a separate chamber with steam fed from an electric boiler, and conditions were monitored with wet and dry bulb resistance temperature diodes ($\pm$2°C accuracy). Dimensions of the boards were measured prior to the reconditioning treatment, which lasted 5-6 hours. At the end of treatment boards were allowed to cool towards ambient temperature for 2-3 hours, and dimensions remeasured.

Results of dimensional increases following reconditioning of the samples were expressed as per cent difference before and after reconditioning, in the moisture content range in which they occurred. As the samples were not perfectly backsawn, the results were given in terms of width and thickness of the board rather than as tangential and radial directions.

All reconditioned boards were further dried in the kiln to below 10 per cent MC using the CSIRO schedule, and were again measured.

Data Analysis

Inspection of the data indicated that they were not distributed normally, and because of the large range of values with extreme outlying data, the non-parametric Kruskal-Wallis Test was used to assess differences between treatments at $p<05$.

RESULTS

Reconditioning

In each reconditioning treatment there were no obvious differences in dimensional increases between means or standard deviations, but there was a wide variation in maximum and minimum values (Table 2). Some samples actually decreased in dimensions as a result of reconditioning. Consequently, statistical analysis based on ranking individual values within each treatment showed differences between treatments.

Table 2.

Width and thickness of ten backsawn regrowth jarrah sample boards in each of three different moisture content classes, before and after steam reconditioning at three different temperatures.

MC Class	Recondit. Temp(°C)	Dimensional change (%) 70		90		100	
		W	T	W	T	W	T
16 - 25 %							
Mean		1.2	1.5	1.7	1.9	1.1	1.2
S.D.		0.7	1.5	1.9	1.1	0.9	1.4
Minimum		0.6	-0.5	-20	0.0	-2.2	-4.7
Maximum		6.2	2.7	6.2	4.5	1.9	3.4
11 - 15 %							
Mean		2.0	1.7	2.6	2.2	2.2	2.4
S.D.		2.3	0.8	1.1	1.5	2.2	2.4
Minimum		0.5	0.3	1.2	1.5	-3.3	0.5
Maximum		8.5	4.2	4.9	5.8	5.2	6.3
8 - 10 %							
Mean		0.5	0.6	1.1	0.7	1.7	1.4
S.D.		1.6	0.4	0.5	0.5	0.4	0.9
Minimum		-6.5	0.0	-0.1	-0.2	1.0	-1.5
Maximum		4.1	1.2	1.9	2.0	2.5	3.2
Mean		1.3	1.2	1.8	1.6	1.6	1.9

Most increase in width occurred in the 11-15 per cent MC class, followed by the 16-25 per cent MC class and then the 8-10 per cent MC class. Reconditioning temperatures of 90°C and 100°C resulted in greater increases in width than 70°C did, but all differences were significantly different at p<0.5.

Thickness recovery in the 16-25 per cent MC class was larger than the 11-15 per cent MC class, and these treatments gave greater overall dimensional increases than the 8-10 per cent class. Thickness recovery was largest at 100°C in the 11-15 per cent moisture class, followed by 90°C, with 70°C giving the smallest increase in dimensions. All differences were significant at p.<05.

Overall Dimensional Loss to 8-10 per cent MC

Mean dimensional loss to 8-10 per cent MC for all reconditioned samples was 4.2 per cent in thickness and 4.9 per cent in width (Table 3). Although the standard deviation for each was small (1.5 per cent for thickness and 1.4 per cent for width), the range of shrinkage was quite wide, varying from 0.3 to 16.1 per cent for thickness and 0 to 10.8 per cent for width.

The non-reconditioned control samples had mean dimension loss of 5.9 per cent for thickness and 7.5 per cent for width. The standard deviation was again quite small and the range of shrinkages, although quite wide, was smaller than that of the reconditioned samples (Table 3).

Table 3.

Overall percentage loss in width and thickness of backsawn regrowth jarrah boards, either reconditioned at one of three different temperatures and moisture contents, or not reconditioned, before drying to 8-10 per cent MC.

MC class	Reconditioning Temperature (°C)					
%	70		90		100	
	W	T	W	T	W	T
16-25						
Mean	4.9	3.5	5.4	3.9	4.8	3.4
S.D.	0.6	0.7	1.4	0.7	1.5	1.3
Minimum	3.2	0.3	3.3	2.6	3.7	2.1
Maximum	8.5	5.6	8.0	5.0	6.0	4.6
11-15						
Mean	5.9	6.1	4.6	4.2	4.4	3.5
S.D.	2.4	3.8	0.7	0.7	1.3	2.7
Minimum	2.8	2.9	2.9	3.2	0.0	0.3
Maximum	9.7	16.1	6.4	6.1	5.8	15.3
8-10						
Mean	6.7	5.1	5.6	4.4	5.0	3.9
S.D.	2.4	2.0	1.3	0.8	0.7	0.7
Minimum	3.2	1.4	1.3	2.7	3.5	2.9
Maximum	10.8	9.7	7.5	5.7	10.6	7.6
Non-reconditioned control samples						
Mean	7.5	5.9				
S.D.	2.5	1.3				
Minimum	3.2	2.6				
Maximum	10.6	7.6				

DISCUSSION

This trial was designed to assess shrinkage in regrowth jarrah, the possibility of collapse occurring, and the need for subsequent dimensional recovery.

The samples were subject to a 'dimensional change' rather than a change due only to true shrinkage. Where they occurred, bow, spring, twist and cup caused distortion of the samples, which may have resulted in a change in dimensions additional to shrinkage and any collapse. The effects that knots, kino, fungi, epicormics and surface checks have on shrinkage in board samples are unknown. Because of the above factors, it was decided that 'dimensional change' would be a more appropriate term than 'shrinkage'. Similarly 'dimensional recovery' rather than 'collapse recovery' could be considered to occur during steam reconditioning.

Effect of Reconditioning Treatment on Wood Quality

Steam reconditioning resulted in a dark brown staining on the surface of the samples. This staining was on the surface only and was easily removed during processing. It is presumably associated with the release and/or breakdown of extractives due to the high temperatures. Reconditioning also caused epicormics to open, and surface checks to appear or increase in size. These surface checks may have already existed for steaming to reopen them, or else steaming induced them.

Observations indicated that reconditioning affected bow, spring, twist and cup in various ways. Deflection increased in some samples and decreased in others, while in some there was no change. However, it was observed that cup was generally decreased by reconditioning. Weight restraint is applied to pine timber during high temperature drying, including the reconditioning, and therefore may also be advantageous when reconditioning regrowth jarrah. This should be assessed in future research.

Kingston and Risdon (1961), using 100 x 25 x 25 mm specimens, reported mean shrinkage values for jarrah of 7.4 per cent (tangential) and 4.8 per cent (radial) before reconditioning. In comparison, the present study gave mean shrinkage values for the non-reconditioned controls (Table 3) that were 0.1 per cent larger for tangential shrinkage and 1.1 per cent larger for radial. The reconditioned samples (Table 3) had mean dimensional loss less than the values of 6.7 per cent (tangential) and 4.6 per cent (radial) quoted by Kingston and Risdon.

The differences in mean shrinkage and the wide range of shrinkage values raise some issues. Kingston and Risdon (1961) used samples from trees that were presumably mature (at least 100 years old), whereas the present study used 60-year-old regrowth jarrah. The indications are that higher shrinkage rates occur in regrowth timber, but dimensional recovery is also larger. In addition, the dimensions of the samples used in each study were different. Both studies found a wide range of shrinkage or, rather, dimensional loss due to a decrease in moisture content in jarrah.

Greenhill (1938) found that optimum collapse recovery in *E. regnans* occurred at steam temperatures of 100°C when the MC of the timber was between 15-20 per cent. He used 100 x 25 x 25 mm samples, and based his conclusions on recovery of the collapse, standardised to 12 per cent MC. The results in Table 3 verified Greenhill's conclusions that reconditioning has a greater effect on dimensional recovery when the timber is above EMC than when it is completely dry, and that steaming at higher temperatures gives better results than steaming at lower temperatures.

In summary, the results of this study indicated that as well as true shrinkage (i.e. decrease in dimensions due to loss of moisture from the cell walls) as it dries, regrowth jarrah is subject to a dimensional loss affected by factors such as collapse, and restraint resulting from differential shrinkage and distortion. It is difficult to determine what is true shrinkage, what is collapse, and what dimensional loss is due to other factors. In the study, most dimensional recovery was achieved by steam reconditioning treatment at 90-100°C when the moisture content was about 11-25 per cent.

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