Department of Conservation
and Land Management

Wood Utilisation Research Centre

BASIC AND AIR-DRIED DENSITY AND LOG MOISTURE CONTENT SURVEY OF REGROWTH JARRAH AND KARRI

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August 1991
W.U.R.C. Technical Report No. 28

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SUMMARY

Basic density and air-dried density data from Departmental studies of regrowth and mature jarrah (*Eucalyptus marginata* Donn ex Sm.) and karri (*E. diversicolor* F. Muell.) are summarised in this Technical Report. The mean basic density values for regrowth and mature wood were 633 kg/m^3 and 624 kg/m^3 (jarrah), and 641 kg/m^3 and 632 kg/m^3 (karri). Air-dried density values for regrowth and mature wood were 801 kg/m^3 and 777 kg/m^3 (jarrah), and 872 kg/m^3 and 824 kg/m^3 (karri).

The mean moisture content (MC) percentages for regrowth and mature logs were 73 per cent and 80 per cent (jarrah), and 77 per cent and 85 per cent (karri). Linear regression equations relating MC per cent to distance from the log perimeter for each of the four categories showed significant correlations for each set of data except for mature jarrah.

INTRODUCTION

Density is the major physical property of wood because of its link with most mechanical properties, including those of structural importance (Bootle 1983). There is a significant correlation between density and strength, based on test data from small defect-free specimens. In practice the correlation between density and strength is complicated by factors such as growth defects. In addition, young trees have a significant volume of juvenile wood in their central core which is of lower density than mature wood of the same species.

Considerable variation in density occurs between and within trees. Density increases more with increasing cambial age or distance from the pith, at a given height in the tree, than it does with increasing height in wood of the same age from the pith. The mean wood density for a tree may sometimes be influenced by growth rate (Hillis 1978). The wood density in a particular tree is controlled more by a combination of environmental and genetic factors than it is by growth rate.

The most common density values determined for timber are basic density and air-dried density. Basic density is a measure of the amount of actual wood substance present, and is determined from the oven-dried mass and the green volume. Air-dried density is determined when the moisture content of the test piece is at the equilibrium moisture content, and is normally based on a standard moisture content of 12 per cent.

Understanding the distribution of moisture in logs, and hence the variation likely in sawn timber, is important in timber drying, because moisture content ranges and drying times can be estimated. Some data on moisture contents of regrowth jarrah from Kent Block, Harvey District and Banksiadale Road, Dwellingup District were given in Brennan *et al.* (1990a).

This report summarises the variation in basic and air-dried densities of samples of regrowth jarrah and karri, and compares them with samples of mature wood of the same species as well as discussing moisture contents in regrowth jarrah and karri logs.

MATERIALS AND METHODS

Basic and air-dried densities

Basic and air-dried densities were assessed in samples of mature and regrowth jarrah and karri using methods outlined by the Standards Association of Australia (1981). The regrowth jarrah (48 to 58-years-old) came from coppice in a stand in Arklow Block, Collie District. This stand was heavily cut in the 1930s and the resulting regrowth was subsequently thinned in 1988. Mature jarrah from Arklow Block was estimated to be 300-years-old. The regrowth karri (52-years-old) and mature karri (approximately 100-years-old) came from a two-tiered stand in Treen Brook Block, Pemberton District. The regrowth karri trees resulted from natural regeneration in the 1930s.

The karri logs were stockpiled under waterspray for approximately five months and the jarrah logs four months before the assessments were made.

For assessing basic density, 140 x 40 x 50 mm defect-free specimens were cut 0.7 m from the end of 2.4 m boards used in seasoning experiments (Brennan *et al.* 1990b). Green dimensions were measured with vernier calipers and the volume of each specimen calculated. The pieces were oven-dried at 103°C to constant weight. Basic density (B.D.) was calculated using the formula:

$$\text{B.D.} = \frac{\text{oven-dried mass}}{\text{green volume}} \quad (\text{kg/m}^3)$$

In the air-dried density survey, boards 140 x 40 mm and approximately 1 m long were dried to 12 per cent moisture content in an experimental high temperature kiln. No reconditioning treatment was used. Air-dried volume was assessed by measuring the width and thickness of each board with vernier calipers, and the length with a lineal tape measure. Mass was determined using digital scales to an accuracy of 0.01 g. Air-dried density (A.D.D.) was calculated using the formula:

$$\text{A.D.D.} = \frac{\text{air-dried mass}}{\text{air-dried volume}} \quad (\text{kg/m}^3)$$

Log moisture content profiles

Sixteen mature and 30 regrowth jarrah logs were assessed for moisture content profiles within a week of felling. Twenty mature karri logs were assessed after they had been stockpiled under waterspray for five days, and 31 regrowth karri after similar storage for two days. All karri logs had been stockpiled within two days of felling.

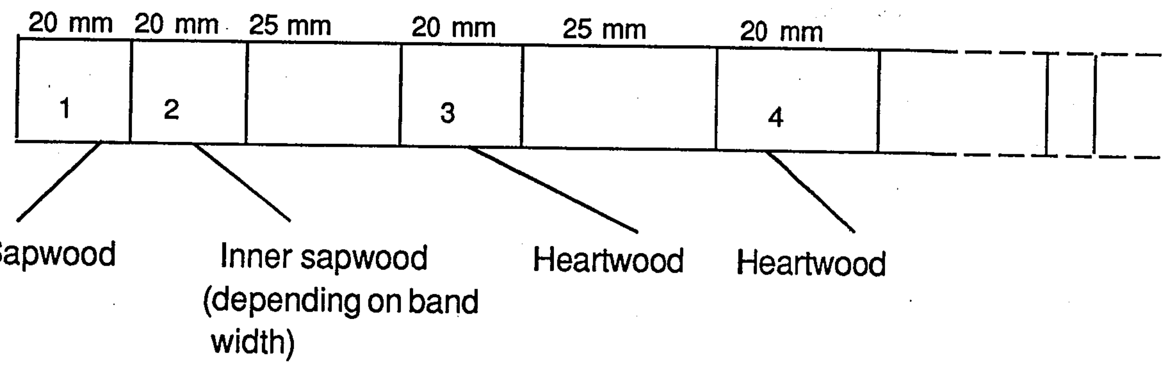
The following method was used to prepare specimens to measure moisture contents:

(i) discs 50 mm thick were cut 300 mm from the butt end of each log

(ii) 100 mm wide sections were cut radially from sapwood to sapwood

(ii) small sections 20 x 50 mm were cut from the sapwood and immediately inside the sapwood/transition wood/heartwood boundary at both ends of the cross sections. Smaller width specimens were taken when the sapwood width was less than 20 mm.

(iv) Further 20 x 50 mm samples were cut at 45 mm intervals from the heartwood (the remainder of the cross section), using the method below.



(v) moisture contents of these samples were determined using the oven-dried method (Standards Association of Australia 1972).

Means and standard deviations were calculated, and regression analysis used to relate moisture content to distance from the log perimeter.

RESULTS AND DISCUSSION

Basic and air-dried densities

Mean values, standard deviations and ranges for the basic and air-dried densities assessed are given below (Table 1).

Table 1
Basic and air-dried densities for regrowth and mature jarrah and karri

	Basic density (kg/m^3)				Air-dried density (kg/m^3)			
	Mean	S.D.	Range	N	Mean	S.D.	Range	N
Mature jarrah	624	61	536 - 885	21	777	59	674 - 899	42
Regrowth jarrah	633	60	438 - 789	21	801	65	552 - 901	43
Mature karri	632	44	528 - 729	21	824	50	717 - 933	44
Regrowth karri	641	46	549 - 777	21	872	70	746 - 1047	42

The mean basic densities of both mature jarrah and karri were similar to those of regrowth, with all means less than the figures published by Kingston and Risdon (1961). Standard deviations and ranges indicated a large variation in basic density, which is consistent with the results of Kingston and Risdon (1961), who estimated the mean basic density for mature jarrah as 658 kg/m^3 (S.D. 41 kg/m^3), ranging from 553 to 758 kg/m^3. For mature karri they estimated the mean basic density as 695 kg/m^3 (S.D. 27 kg/m^3), ranging from 634 to 754 kg/m^3.

The mean air-dried densities are consistent with the data in Kingston and Risdon (1961). They reported the mean air-dried density before reconditioning for mature jarrah as 823 kg/m^3 (S.D. 71 kg/m^3) and range 686 to 1019 kg/m^3.
For mature karri they reported the mean air-dried density as 905 kg/m^3 (S.D. 40 kg/m^3) and range 814 to 1000 kg/m^3. The means for the mature material are less than those of the regrowth.

There was a fairly consistent increase in density from the pith outwards, which would account for regrowth karri in the study having a lower mean density than the published figures. In this report the age of karri classified as mature was approximately 100 years old, and younger than the large mature trees available for harvesting.

Jarrah came from a stand that had been silviculturally treated in the 1930s, resulting in release of jarrah saplings. There is a possibility that the regrowth harvested included suppressed mature trees, and this factor could explain the similar mean densities.

Mean basic and air-dried densities of the regrowth were higher than the densities of mature material. Factors other than age influence density, for example the amount of earlywood and latewood, the amount of defect, and the number of samples with a high proportion of sapwood. No defective wood was included in the density assessment.

Log moisture contents

The mean moisture contents for jarrah and karri are listed in Table 2. As stated previously, these logs were extracted from the forest within a week of felling.

Table 2
Mean moisture contents for jarrah and karri logs

	Mean	S.D.	Range	N
Mature jarrah	80	14	55 - 153	16
Regrowth jarrah	73	15	33 -124	30
Mature karri	85	17	52 - 126	20
Regrowth karri	77	18	41 - 121	31

Note: In the range, the low moisture contents are for sapwood and high moisture contents for the heartwood.

The mean moistures (Table 2) showed little difference between regrowth and mature logs, but standard deviations and ranges in all categories indicated a wide spread of moisture contents throughout the log. The low moisture contents of the sapwood suggested that drying had occurred on the outside of the logs, and these moisture contents were considerably lower than the sapwood moisture contents reported by Brennan *et al.* (1990).

Regression analyses

The regression equations relating MC per cent and distance from the log perimeter for each species and age class were:

Mature jarrah	M.C. %	=	-0.011 x + 80.44	(N.S.)
Regrowth jarrah	M.C. %	=	-0.25 x + 61.9	(p<.01)
Mature karri	M.C. %	=	-0.087 x + 72.8	(p<.05)
Regrowth karri	M.C. %	=	-0.22 x + 62.8	(p<.01)

where M.C. = moisture content (%)

x = distance from the log perimeter (mm)

The regression analysis for regrowth jarrah and mature and regrowth karri gave good correlations, showing increasing moisture contents with increasing distance from the log perimeter. Mature jarrah gave no correlation of moisture content with distance from the log perimeter.

The advantage of the data is that the density and log moisture content values can be used as a guide by kiln operators in determining drying schedules and times when seasoning jarrah and karri.

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