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Department of Conservation
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Wood Utilisation Research Centre

STRENGTH PROPERTIES OF REGROWTH JARRAH, KARRI AND MARRI

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SUMMARY

The major strength properties of samples of regrowth and mature timber of jarrah (*Eucalyptus marginata* Donn ex Sm.), karri (*E. diversicolor* F. Muell.) and marri (*E. calophylla* R. Br. ex Lindl.) were assessed in this study. Modulus of rupture, modulus of elasticity and maximum crushing strength were measured, using green or seasoned specimens of each of the three species. The results were compared with published strength group ratings, using Australian Standard AS2878 - 1986, and indicated that regrowth and mature karri and marri (tested green or air-dried) had strength properties similar to the published ratings of S3, SD2 for karri and S3, SD3 for marri. However, both regrowth and mature jarrah (tested green) were S3 compared with the published rating of S4, while the air-dried results were the same as the published SD4. Further testing of regrowth from the three species is required.

INTRODUCTION

The major timber species in the forested areas of the south-west of Western Australia are jarrah (*Eucalyptus marginata* Donn ex Sm.), karri (*E. diversicolor* F. Muell.) and marri (*E. calophylla* R. Br. ex Lindl.). Harvesting and regeneration from the time of European settlement have resulted in substantial areas of regrowth of these species which are now available for timber production.

The outer heartwood of jarrah is generally dark red, and it is strong and durable with air-dried density about 820 kg m^{-3} (Bootle 1983). The uses have included heavy construction with either round or sawn timber, poles, piles, sleepers, bridge and wharf construction, and house framing. The higher quality timber is well suited for manufacture of joinery and furniture.

Karri heartwood is pink to reddish brown and heavier and stronger than jarrah. Air-dried density is about 900 kg m^{-3}. A major advantage of karri timber is that long lengths of large cross-sectioned timber are available for building timbers, flooring and mining timber. Structural plywood is another major use, and forest thinnings and sawmill waste are used for wood chips used for pulp and paper manufacture.

In contrast, marri heartwood ranges from pale yellow to light brown. The strength and density properties are intermediate between the other two species, with air-dried density

of about 850 kg m^{-3}. The major problem with utilization is that sawn timber production has been restricted by the extensive occurrence of kino veins. Bootle (1983) commented on the use of marri for general construction, handles, sporting equipment, and, when preserved, for poles, piles and posts.

Timber used for structural purposes must be stress graded and branded to verify its integrity. Visual stress grading of hardwoods using AS2082 - 1979 (Standards Association of Australia 1979) uses the CSIRO system in which the structural grade based on the size and number of defects is related to the strength group for that species, and a dove-tailing chart gives the stress grade.

The strength group and stress grade system was derived by CSIRO to rationalize the previous classification of A, B, C, and D, which did not cover the full range of properties of Australian-grown species, particularly for plantation-grown pines (Kloot 1973). The system is the basis for deriving working stresses and hence design stresses in engineering design. It uses static bending tests (modulus of rupture (MOR), modulus of elasticity (MOE)), compression parallel to the grain (maximum crushing strength (MCS)) and shear (maximum shear strength).

The strength group of a species is now based on MOR, MOE, and MCS, as described in AS2878 - 1986 (Standards Association of Australia 1986). The strength group allocated is S1 to S7 for green timber, or SD1 to SD8 for seasoned timber (S1, SD1 are strongest). Where insufficient data are available, a provisional strength grouping (indicated by brackets) may be allocated from density values.

The AS2878 - 1986 gives the following strength groups for the three species being assessed:

jarrah	S4	SD4
karri	S3	SD2
marri	S3	SD3

The aim of this study was to compare MOR, MOE and MCS properties in samples of regrowth material from the above species with the corresponding properties of mature timber, and to verify the strength groups allocated in AS2878 - 1986.

METHODS

The trees sampled to provide the test specimens were randomly selected over the geographic range of each species, with one tree selected in each of five separate areas.

Logs were sawn at the Wood Utilization Research Centre at Harvey. The material produced was 55 x 55 mm cross-sections for green strength tests (based on two random

positions in the log) or 60 x 60 mm cross section for specimens to be tested after drying. The green specimens were dressed to final dimensions of 50 x 50 mm and docked to 760 mm lengths for bending strength, and 200 mm for compression tests. The specimens for assessment of strength properties in the seasoned condition were strip-stacked in a covered shed, and after drying to equilibrium moisture content at approximately 12 per cent moisture content, they were dressed to 50 x 50 mm and docked to the required lengths.

The strength testing was done under contract by Curtin University of Technology, using a 20 kN capacity Mohr and Federhaff universal testing machine in the Civil Engineering laboratories. The standard test methods described by Mack (1979) were used. Briefly, the specimens for modulus of rupture and elasticity were assessed using a 700 mm span (i.e. 14:1 span-depth ratio), with a single loading head applied at midspan and a loading rate of 2.5 mm/min. Deflection was measured using a deflectometer located on the neutral axis. The compression specimens were tested on an Avery-Denison machine with 300 kN capacity, again using the method described by Mack (1979). The rate of loading was 0.6 mm/min.

The data for the seasoned specimens were corrected where necessary to the standard of 12 per cent moisture content, using the CSIRO correction factors:

MOR = 4 per cent/per cent MC (added if MC is above 12 per cent, and subtracted if MC is below 12 per cent);

MOE = 1.5 per cent/per cent MC; and

MCS = 5 per cent/per cent MC.

The corrected data for MOR, MOE and MCS from each of the three species were then assessed using Australian Standards AS2878 - 1986 (Standards Association of Australia 1986b) to verify the strength group for both green (unseasoned) and seasoned timber. Detailed statistical analysis was not done because of the limited size of the sample, but comparisons are made with published data.

RESULTS AND DISCUSSION

The MOR, MOE and MCS values for green specimens of regrowth and mature timber are given in Table 1. The original CSIRO data based on tests of mature timber (Bolza and Kloot 1963) are used for comparison. The corresponding data for seasoned specimens are given in Table 2.

Table 1. Green strength properties of regrowth and mature jarrah, karri and marri.

Species	N	MOR (MPa)		MOE (GPa)		MCS(MPa)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Regrowth							
Jarrah	11	81.2	7.4	13.5	1.9	40.1	4.6
Karri	9	84.5	7.7	15.4	2.2	37.7	3.2
Marri	10	74.4	5.3	13.1	1.1	35.1	3.3
Mature							
Jarrah	9	77.6	10.9	12.8	2.0	39.6	5.4
Karri	10	79.1	14.5	14.1	1.2	37.1	6.7
Marri	14[a]	78.4	12.1	12.2	2.4	41.9[b]	8.7
Mature (Bolza and Kloot 1963)							
Jarrah	26	68.1	9.9	10.2	1.9	35.8[c]	4.9
Karri	26	73.1	9.1	14.3	2.4	36.2	5.9
Marri	6	77.9	14.4	13.5	3.1	40.6[c]	10.2

a. Four specimens intended for testing in the seasoned conditions were inadvertently tested green, increasing the sample size to fourteen.

b. Twelve specimens. Two excluded because results considered excessively large.

c. Seven specimens.

The results indicated that regrowth material has marginally higher strength properties than mature material.

The MOR, MOE and MCS of green specimens of jarrah, karri and marri regrowth were higher than those of mature, with the exception of mature marri which had a higher MCS than regrowth marri. The results for the mature jarrah were higher than those of Bolza and Kloot (1963), but those of mature marri were less than Bolza and Kloot's data.

Table 2. Air-dried strength properties of regrowth and mature jarrah, karri and marri[a].

Species	N	MOR (MPa)		MOE (GPa)		MCS(MPa)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Regrowth							
Jarrah	8	124.9	17.0	15.2	2.6	71.5	7.6
Karri	4	146.7	19.8[b]	21.5	6.0[b]	84.9	12.6[b]
Marri	4	115.1	2.9[b]	15.2	2.3[b]	65.6	[c]
Mature							
Jarrah	8	103.3	22.0	12.0	2.5	62.4	11.6
Karri	6	149.2	14.5	16.7	1.3	82.3	10.1
Marri	4	112.0	20.1[b]	14.5	2.9[b]	72.8	13.0[b]
Mature (Bolza and Kloot 1963)							
Jarrah	28	111.7	17.6	13.0	2.3	61.2	6.6
Karri	21	132.4	10.6	19.0	2.5	71.7	7.2
Marri	5	125.5	17.3	16.6	3.2	66.1[d]	12.4

[a] Corrected to 12 per cent moisture content

[b] Standard deviations are an indication only with 4 specimens

[c] No SD is given because 3 specimens only

[d] Seven specimens

Siamos and Siemon (1989) had reported mean values of MOR of 74.5 MPa , MOE of 11.8 MPa, and MCS of 39.7 MPa for fifteen specimens from 60-year-old jarrah from Kent Block in Harvey District. Jarrah is a very slow grown species, so material of this age is considered as regrowth.

Fewer seasoned specimens were tested owing mainly to checking and drying distortion which made some specimens unacceptable for testing, and to four marri specimens being inadvertently tested when moisture content was above 20 per cent. The trends with seasoned timber were similar to those of green timber, except that regrowth jarrah was substantially stronger in each property than mature jarrah. The regrowth and mature karri specimens had similar MOR and MCS, but the MOE was substantially higher. The marri data was similar in both regrowth and mature.

Statistical analysis was not done because of the limited sample size. However, the data were assessed using Australian Standard AS2878 - 1986 to verify whether strength groups of each species were similar to the published ratings. The major difference found was that both regrowth and mature jarrah tested green had strength properties of S3

compared with the published rating of S4. All other strength group ratings were similar to the published figures.

Further testing of regrowth material to assess these major strength properties (MOR, MOE, and MCS) would be an advantage to ensure that there are no potential problems which would adversely affect the engineering design. Tests will be carried out when staff and financial resources are available.

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