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THE TRANSVERSE STRENGTH OF AUSTRALIAN TIMBERS.

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IN Mr. Maiden's valuable and interesting paper which was read at the last meeting of the Association, entitled, "Notes on some N.S.W. Timbers," the subject was treated as a branch of economic botany. The common and botanical names of the various timbers considered were given, as well as a considerable amount of useful information as to their application in Engineering, Architecture, and for other purposes.

References were also made to the results of experiments made by various persons from time to time, having for their object the determination of strength and elasticity.

It is proposed in the present paper to publish the results obtained by means of the apparatus in use in the author's laboratory for testing the strength and elasticity of materials. These consist of a series of experiments on the transverse strength of Australian timbers, which have been made during the last three years, and which are still in progress.

The compressive, tensile, and shearing tests will be but briefly referred to in this paper, partly because they have been recorded as far as they have been completed in a pamphlet entitled, "The Strength and Elasticity of New South Wales Timbers of Commercial Value," published by the Government Printer in 1887, and partly because the whole subject is far too large to include in a single paper.

There is no doubt that it is most desirable that an uniform system should be adopted in the testing of Australian timbers, and it was the first subject which the author devoted himself to in 1885, when the testing machine was put down in the Engineering Laboratory.

The first twelve months were principally occupied in ascertaining the influence of the size, form, and proportions of the specimens tested, and the various methods of holding them in the machine during the test, and accurately determining the strains whether of deflection, elongation, compression, or shearing. He was able to derive some important results by operating upon the sound portions of a large timber beam of ironbark which had been tested to destruction by the Railway Bridges Inquiry Commission, by supporting it on trestles 28 feet 6 inches in the clear, and gradually loading it in the centre until it broke.

The deflections were measured by means of multiplying levers, and were also read directly by means of a level. In fact, the whole of the experiments made by the Commission above referred to, have been repeated on a smaller scale several times by the author. It was then decided that future tests on Australian timbers should be made upon specimens of the following sizes :—

Description.	Length.		Breadth.	Thickness.
Transverse tests ...	4ft.	6in.	6in.	4in.
Compressive ,, ...	6	0	3	3
,, ,, ...	4	0	3	3
,, ,, ...	2	0	3	3
,, ,, ...	1	0	3	3
Shearing ,, ...	0	6	2¼	2¼

For tensile tests, pieces 3 feet long 2¼" x 2¼" were turned in a lathe and held in clips.

On August 11th, 1888, a letter was sent to the Under-Secretary for Mines requesting to be supplied with specimens of the various timbers of the colony of commercial value of the sizes specified in the foregoing table, and further that the specimens should be accompanied in every case with a schedule of particulars of the timbers sent. This request was complied with and a number of specimens were sent, the first lot arriving in January, 1887.

Since the Forestry Branch is now attached to the Lands Department, specimens are now received from the latter department. Letters were also written to the Forestry Branches and Departments of Public Works of Western and Southern Australia, Victoria, Queensland, and New Zealand, and all but the specimens promised from Queensland and New Zealand have been tested for transverse strength. The compressive, tensile, and shearing tests have yet to be made.

The necessity for the particulars given in the foregoing schedules is now generally admitted by every one who is competent to express an opinion on this subject, and the omission of these particulars in connection with the earlier experiments would alone have considerably reduced their value, even if the testing had been conducted in a scientific manner.

The experts in the Forestry Branches in the various colonies from which specimens have been received, have taken great care to obtain the true botanical names from the leaves, seeds, and flowers (and it has been necessary to wait in some cases six months before this point could be determined), so that in the future there will be no difficulty in the identification of the trees to which the tests refer.

The strength and durability of timber depends to a great extent upon the locality in which the trees are grown. Timber, for example, of the same name and presenting the same general characteristics, but grown under different conditions with regard to temperature, geological formation of soil, the amount and distribution of rainfall as to a period of time, whether grown on mountain ridges, or in swampy low-lying ground, differs widely in quality. Granite country does not appear to produce good timber in any part of Australia.

The Victorian Carriage Timber Board state in their report that: "Mountain Ash grown on the heights of Narbethong, and Blue

Gum from Corner Inlet, showed excellent results under the tests as compared with timber of the same description grown in other localities, under other and less favourable conditions." The quality and, therefore, the value of timber is so much affected by local conditions, that it is all important in treating of any particular description, that they be taken into account.

"Hardwood timber grown in swampy low-lying ground is generally deficient in tenacity of fibre compared with the same timber grown at higher elevations and where the geological formation is favourable. Hence, Blackwood grown on low-lying land is spongy, soon decays, and in power of resistance is inferior to Red Deal. Grown on mountain ranges or elevated land displaying rock of the mesozoic period, it attains its maximum strength, quality and value." The chief objections to the use of timber in constructing works in this colony are its liability to decay from dry rot, and to the attacks of the white ant. Where timber is used in marine work unprotected it is liable to the attacks of the teredo.

The durability of timber depends to a large extent upon the time when the tree was felled.

If a tree be cut down when in full sap, it is very probable that in twelve months time dry rot will be found to exist in it.

Timber in this colony is unfortunately cut down at any time during the year when it is required, and consequently there is considerable uncertainty in the time which a timber structure may be supposed to last. Mr. Wright, Railway Engineer of the Bluff River district, showed the author last year a large number of specimens of timbers grown in the New England district, with the object of proving that the durability of a timber could be determined by a careful comparative examination of the annular rings and sap tubes. He says for example, "Place a cube of iron-bark and stringy-bark together and examine the ends with a glass magnifying from eight to ten diameters, and it will be found that the sap-tubes in the iron-bark are small and well formed, regular, and evenly distributed over the whole area under view, their surface appearance being quite bright or dark and shining."

"The annular rings will be found to be small, clearly defined, and in most instances not perforated by the sap-tubes to such an extent as to break their continuity.

"The stringy-bark on the other hand will be found to be more irregular in its transverse section, the cells or tubes being larger in diameter, the annular rings being more pronounced and perforated unevenly by the sap-tubes.

"Compare also the longitudinal sections, taking care to place them together either in the direction of the annular rings or cutting them, and it will be seen that the difference is very marked, the iron-bark being much finer and more even than the stringy-bark. Again examine the specimens singly on the four sides, and it will be found that there is very little difference in the size of the grain of the iron-bark on either side; but the difference will be found to be very marked in the stringy-bark.

"This difference was found to be more and more decided with timbers possessing less and less durability."

The conclusions arrived at by Mr. Wright are worthy of full consideration, for if they are found to be general in their application it will be possible to decide as to the durability of a particular kind of timber for bridges, sleepers, etc., without reference to the botanical name or to other considerations referred to.

The results of testing the transverse strength and elasticity of the various kinds of timbers described in the foregoing schedules, are recorded in tables I., II., III., and IV. The specimens of timbers were prepared for testing at the Government Works, Redfern, under the direction of Mr. W. Shellshear, District Engineer. They were planed square on four sides so that they could be accurately measured; three specimens were then placed on a small weighing machine and the weight recorded was divided by the number of cubic feet in the three specimens, which gave the weight per cubic foot. In this way the column in the tables has been obtained.

The specific gravities of five kinds of timber were determined by Mr. A. Helms, M.A.Ph.D. (Berlin) late demonstrator in chemistry at the University of Sydney, in the following manner:

The specimens were prepared as one inch cubes, and were kept five days in open air at a temperature of from 15 to 19 degrees C; they were then dried three hours in a water bath at a temperature of 96 degrees C, varnished and dried one hour in a water bath and kept again three days in the open air at from 15 to 19 degrees C. The specific gravity was taken in each case at a temperature of 17 degrees C.

The results are given in the following tables :—

Name of Timber.	Weight in air.	Weight in water.	Difference.	Specific Gravity.
Grey Ironbark	20.0610	3 0714	16.9896	1.1807
Red Ironbark	20.0510	2.6620	17.3890	1.1531
Spotted Gum	15.1715	1.6790	16.8505	0.9003
Black Butt	16.0265	0.1410	16.1675	0.9912
Woolly Butt	15.7605	0.5200	16.2805	0.9680

The weights per cubic foot have been deduced from the results given in the above, and compared with the results obtained by direct weighing and measuring in the following table :—

Name of Timber.	Weight per cubic foot deduced from experiments made by Dr. Helms, in lbs.	Weight per cubic foot obtained by direct measuring and weighing in lbs.
Grey Ironbark	73.79375	73.854
Red Ironbark	72.06870	76.522
Spotted Gum	56.2687	62.195
Black Butt	61.9500	65.539
Woolly Butt	60.5000	63.895

Both Dr. Helms and the author consider that the results obtained by direct weighing and measuring are at least as satisfactory as those obtained from the specific gravities, as the want of delicacy in the former method is compensated for by the fact that a better average of the timber is obtained from the large scantlings than from the 1 inch cubical specimens; and it was, therefore, not considered necessary to find the specific gravity of the remaining specimens.

The results are recorded in the tables of transverse tests.

It was decided to calculate the modulus of rupture in every case in preference to any constant, such as the specific strength used by the Victorian Carriage Timber Board and others. As the modulus of rupture is much more convenient in practically applying the results of testing, and is equally simple; but it may be as well to show the relationship between them, so that one may be converted into the other if it is ever considered desirable to do so. It is well known that when a beam is subject to transverse stress it deflects, and the upper fibres are compressed, and the lower fibres extended. The intensity of stress on the extreme upper or lower layer of fibres is greater than that on any intermediate layer; and since at some intermediate layer tension must change to compression, the direct stresses must vanish at this layer, which is called the neutral layer. And the intensity of stress at any layer above or below this neutral layer will be proportional to its distance from the neutral layer; and the moment of resistance of any layer is the product of its area into its distance from the neutral layer, into the resistance of the layer in question to the stresses developed along it, and the sum of all such products is the moment of resistance of the section.

Let I denote the moment of inertia of the section with reference to an axis passing through its centre of gravity. Let y denote the distance from the neutral layer to the extreme top or bottom fibres. Let f denote the modulus of rupture. Then the moment of resistance (Mt R) $= \frac{f\,I}{y}$ For rectangular sections $I = \frac{1}{12}\,b\,d^3$ where b denotes the breadth, and d the depth of the beam.

$$\text{Mt R} = \frac{f\,I}{y} = \frac{\frac{1}{12}\,b\,d^3\,f}{\frac{d}{2}} = \frac{b\,d^2\,f}{6}$$

The bending moment developing the direct tensile, and compression stresses in the beam must equal the moment of resistance, and since the load was applied in the centre in the experiments referred to, the bending moment $= \frac{W\,l}{4}$ Where W = weight applied, and l = span or distance between the centres of the knife edges upon which the beam was supported.

$$\frac{W\,l}{4} = \frac{b\,d^2\,f}{6} \quad \therefore \quad f = \frac{6\,W\,l}{4\,b\,d^2}$$

Now, in the Victorian Carriage Timber experiments the constant of specific strength is denoted by—

$$S = \frac{W\,l}{4\,b\,d^2} \qquad \text{Hence } f = 6\,S$$

The modulus of rupture is, therefore, six times as great as this constant of specific strength, so that one can readily be converted into the other.

The advantages of the modulus of rupture are seen immediately it is required to calculate the strength of a beam loaded with concentrated loads, or with partially distributed loads, as it is only necessary to calculate the bending moment for the loading in question and to equate this with the moment of resistance from which W is readily found.

The modulus of elasticity does not appear in any of the results of testing Australian timbers by other experimentors, although it is obviously necessary to know its value when it is required to calculate the deflection of a beam under a given load. In the experiments made by Col. Ward, at the Sydney Mint, the smallest deflections given appear to have been measured in many cases beyond the elastic limit of the material, and are, consequently, not applicable to cases occurring in properly designed structures, and moreover, the modulus of elasticity could not be calculated from the data given.

The records of the Victorian Carriage Timber Board are equally unsatisfactory in this respect. In tables I., II., III., and IV., before referred to, a series of deflections have been recorded, with the loads producing them, for each specimen tested, both within and beyond the elastic limit, but the modulus has been calculated with a load of from 2,500 to 5,000 pounds, which is well within the point where the deflections cease to be proportional to the loads producing them in all the specimens tested. Again, the autographic stress-strain diagram, which was obtained in every case, clearly defines the load which produces a deflection which is sensibly greater than that which is proportional to the load. The deflection which occurs at fracture, is not a quantity which can be made use of in calculations which have for their object the determination of the deflections or stiffness of beams. The modulus of elasticity for the deflection of beams (more correctly called Modulus of Transverse Elasticity) and the various formula for calculating their stiffness may be derived as follows :—

Let R denote the radius of curvature, let M denote the bending moment, let I denote the moment of inertia, let E denote the modulus of elasticity, let V denote the deflection produced by a load, W within the elastic limit of the material.

Then it can be proved that $\frac{1}{r} = \frac{M}{E\,I} = \frac{d_2\,v}{d\,x_2}$ nearly. If i denotes the circular measure of the slope at a distance X from the origin of co-ordinates, since $i = \tan i = \frac{d\,v}{d\,x}$ nearly, we have :—

$$\frac{d^2\,v}{d\,x_2} = \frac{M}{E\,I}$$

$$i = \frac{d\,v}{d\,x} = \int \frac{M}{E\,I}\,d\,x^2$$

$$V = \iint \frac{M}{E\,I}\,d\,x^2$$

Since E and I are constant in a beam of uniform section, we may write,—

$$i = \frac{1}{E\,I} \int M\,d\,x; \quad V = \frac{1}{E\,I} \iint M\,d\,x_2$$

In the case of a beam supported at each end, and loaded in the centre, as in the experiments referred to, assume the origin at the left hand support, then we have,—

$M = \frac{W\,x}{2}$ if x is taken to the left of the centre of the beam, and—

$M = \frac{W\,(l-x)}{2}$ if x is taken to the right of the centre of the beam,

Therefore we obtain by integrating $\frac{1}{E\,I}\left(\frac{W\,x}{2}\right)$ the equation for slope.

$$i = \frac{W}{2\,E\,I} \int x\,d\,x = \frac{W}{2\,E\,I}\left(\frac{x^2}{2}\right) + C$$

When $x = \frac{l}{2}$ then $i = O$, and C becomes equal

$$\text{to} -\frac{W\, l_2}{16\, E\, I}$$

$$\therefore i = \frac{W}{4\, E\, I}\left(\frac{x^2\, l^2}{4}\right)$$

$$V = \frac{W}{4\, E\, I}\int\left(x^2 - \frac{l^2}{4}\right) d\,x = \frac{W}{4\, E\, I}\left(\frac{x_3}{3} - \frac{l_2\, x}{4}\right) + C$$

But when x = O, V = O, ∴ C = O.

$$\therefore V = \frac{W}{4\,E\,I}\left(\frac{x^2}{3} - \frac{l^2\, x}{4}\right)$$

The slope is greatest when x = O

$$\therefore i_o = \frac{W\, l^2}{6\, E\, I}$$

The deflection is greatest when x = ½

$$\therefore V = \frac{W\, l^3}{48\, E\, I}$$

For rectangular sections we have by substituting I for its value, viz., $\frac{1}{12}$ bd³,—

$$I = \frac{3\, W\, l^2}{4\, E\, b\, d^3} = \text{greatest slope.}$$

$$V = \frac{W\, l^3}{4\, E\, b\, d^3} = \text{greatest deflection.}$$

$$\therefore E = \frac{W\, l^3}{4\, v\, b\, d^3}$$

The modulus of elasticity in tables I., II., III., and IV., has been calculated from the latter formula.

The results of testing the 249 specimens of timber recorded in tables I., II., III., and IV., have been arranged in the most convenient form for future reference. In table I., which is the most extensive, and which refers to N.S.W. Timbers, it will be seen how the weights per cubic foot and the moduli of rupture and elasticity differ, even for the same timber, when the conditions under which the timber has been grown, and the seasoning differ.

The total number of specimens tested up to date, are as follows:—Transverse, 249; Compression, 224; Tension, 56; Shear, 56; Total, 585.

When all the specimens in the author's possession, and those promised are tested, the number will exceed 2,000. It may be stated that the Senate of the University of Sydney has allowed all tests made on the Australian Timbers to be made without payment of the usual fees, as it was considered to be a matter of national importance. Each tested specimen will have a card attached to it with the particulars of the test, and the specimens will be ultimately arranged for reference in the Macleay Museum.

SCHEDULE OF PARTICULARS OF VICTORIAN, SOUTH AUSTRALIAN, AND WESTERN AUSTRALIAN TIMBERS SENT WITH THE SPECIMENS FOR TESTING.

VICTORIAN TIMBERS.

Local Name.	Mark.	Number.	Date when tree was felled.	Date when tree was cut.	Height of tree.	Diameter of tree.	Number of Rings.	Average ht. of trees in locality	Average dia. of trees in locality.	Locality whence obtained.	Formation and kind of soil.	Botanical Name.
					about	about	about	feet	inches.			
Blue Gum	M	1	12-4-88	7-6-88	150 feet	49 in. at bot. 32 ,, at top	160	160	60	Yaugher.	Light black.	Eucalyptus Globulus.
Mountain Ash	M	2	5-6-88	26-6-88	No. 1, 245 ,, No. 2, 240 ,,	42 ins. 38 ,,	112 98	250	16 to 18 ft.	Mt. Monda, Victoria Forest.	Granite porphyry, plutonic rocks, soil decomposed vegetation.	Eucalyptus Amygdalina.
Red Gum	M	3	19-6-88	21-6-88	129 ,,	32 ,,	...	136	36	Barmah and Yielima State Forest in the Parish of Picola.	Tertiary, soil, clay.	Eucalyptus rostrata.
Blackwood	B.V.		1-88	12-88	40 ,,	39 ,,	20	40	36 to 48	Lakes Entrance, Gippsland.	Sandy.	
Mahogany	M.V.		1-88	12-88	45 ,,	48 ,,	35	40 to 60	48 to 60	Snowy River, Gippsland.	Rich.	

SOUTH AUSTRALIAN TIMBERS.

Local Name.	Mark.	Number.	Date when tree was felled.	Date when tree was cut.	Height of tree.	Diameter of tree.	Number of Rings.	Average ht. of trees in locality	Average dia. of trees in locality.	Locality whence obtained.	Formation and kind of soil.	Botanical Name.
								feet.				
Sugar Gum	S.A.	1	5-5-87	5-88	104 feet	34 ins.	100	110	......	Wirrabara Forest, South Australia.	Sandstone formation, varying to granite, granitic sandstone [and also quartz.	Eucalyptus Corynocalyx.
Box Gum	S.A.	2	4-87	4-88	50 ,,	16 ,,	52	50 to 80	......	do do	Mixed formation sandstone and granite.	Eucalyptus Hemipholia.
do.	S.A.	2 A	4-88	5-88	66 ,,	24 ,,	69	50 to 80	......	do do	do do	do. do.
Blue Gum	S.A.	3	3-87	4-88	72 ,,	30 ,,	72	60 to 80	......	do do	do do	Excalyptus Leucoxylon.
do.	S.A.	3 A	1-87	4-88	83 ,,	22 ,,	80	60 to 80	......	do do	do do	do do
Red Gum	S.A.	4	5-87	5-88	87 ,,	66 ,,	93	80 to 100	......	do do	do do	Eucalyptus Rostrata.
do.	S.A.	4 A	5-87	5-88	74 ,,	46 ,,	130	70 to 100	......	do do		do do

WESTERN AUSTRALIAN TIMBERS.

Local Name.	Mark.	Number.	Date when tree was felled.	Date when tree was cut.	Height of tree.	Diameter of tree.	Number of Rings.	Average ht. of trees in locality	Average dia. of trees in locality.	Locality whence obtained.	Formation and kind of soil.	Botanical Name.
								feet				
Jarrah	M.C.D	1	27-3-88	2-4-88	130 feet *	60 ins.	In Jarrah rings are not clearly defi'd	120 to 130	......	Karridale Saw Mills, 15 miles N.W. of Cape Leeuwin and [190 miles south of Perth.	Red Ironstone rock and gravel (the worse the soil the better [the timber.)	Eucalyptus Marginata.
Jarrah	...	2	11-87	10-88	60 ,, †	36 ,,		75	......	Darling ranges.	Ironstone ridges	do. do.
Red Gum	M.C.D	...	27-3-88	2-4-88	175 ,, ‡	72 ,,	......	175	......	Karridale Saw Mills, 15 miles N.W. of Cape Leeuwin and [190 miles south of Perth	Black loam, (Red gum land is considered best agricultural land [in southern districts of W.A.)	Eucalyptus Calaphylla.
Karri	M.C.D	...	1-5-88	4-5-88	275 ,, ¶	108 ,,	......	200	......	do do do	Limestone outcrop; red loam	Eucalyptus Divisicolor.

* 50 feet to first branch. † 32 feet to first branch. ‡ 70 feet to first branch. ¶ 125 feet to first branch.

TRANSVERSE STRENGTH AND ELASTICITY OF VICTORIAN, SOUTH AUSTRALIAN, AND WESTERN AUSTRALIAN TIMBERS.

VICTORIAN TIMBERS.

TABLE II.

Local Name.	Distinguishing letter and number.	Size of Specimens. Length.	Width	Depth	Weight in Pounds per cubic foot.	Breaking Load in Pounds.	Modulus of Rupture in pounds per sq. inch.	Modulus of Elasticity in pounds per sq. inch.	Number of days in Seasoning.	Deflections. 2,500 lbs	5,000 lbs	7,500 lbs	10,000 „	12,500 „	15,000 „	Remarks.
		′ ″	″	″						inches	inches	inches	inches	inches	inches	
Blue Gum	M 1, 1	4 4·20	5·34	3·54	...	12,500	13,449	1,716,345		·155	·34	·475	·678	...	...	
,,	M 1, 2	4 4·20	5·30	3·54	60·645	12,500	13,550	1,896,645	369	·15	·31	·44	·605	...	...	
,,	M 1, 3	4 4·0	5·28	3·58	...	12,000	12,768	1,630,358		·18	·35	·515	·7	...	...	
Mountain Ash ...	M 2, 1	4 4·25	5·48	3·71	...	14,500	13.841	2,058,340		·113	·24	·34	·46	...	...	
,,	M 2, 2	4 5·125	5·25	3·59	43·804	11,500	12.237	1.897.100	315	·15	·3	·448	·664	...	...	
,,	M 2, 3	4 8·625	5·59	3·70	...	14,300	15.305	2,122,700		·11	·23	·33	·445	...	...	
Red Gum	M 3, 1	4 4·625	5·80	3·75	...	12,500	11,034	1,329,300		·17	·34	·5	·648	...	...	Split before testing
,,	M 3, 2	4 4·50	5·90	3·70	65·76	11,750	10,236	1,321,626	160	·175	·35	·535	·73	...	...	
,,	M 3. 3	4 4·50	5·80	3·74	...	14.120	12,531	1,469,706		·155	·31	·445	·66	...	...	
Blackwood	B.V, 1	4 6·50	5·74	3·70	...	13,100	12,003	1,434,700		·165	·33	·49	...	...	...	
,,	B.V, 2	4 6·30	5·63	3·75	43·475	9,750	8,867	1.258,436	471	·18	·37	·55	...	...	...	
,,	B.V, 3	4 5·40	5·68	3·80	...	12,370	10,859	1.167,215		·195	·38	·55	...	...	...	
Mahogany	M.V, 1	4 6·10	5·80	3·88	...	16,000	13,194	1,854,800		·11	·22	·34	·45	·58	...	
,,	M.V, 2	4 6·10	5·82	3·82	60·443	14,600	12,347	1,775,560	471	·12	·24	·356	·475	...	...	Knot in specimen
,,	M.V, 3	4 6.00	5·84	3.70	...	8,850	7,971	881,740		·22	·53	·8	...	...	...	

SOUTH AUSTRALIAN TIMBERS.

TABLE III.

Local Name.	Distinguishing letter and number.	Length	Width	Depth	Weight in Pounds per cubic foot.	Breaking Load in Pounds.	Modulus of Rupture in pounds per sq. inch.	Modulus of Elasticity in pounds per sq. inch.	Number of days in Seasoning.	2,500 lbs	5,000 lbs	7,500 lbs	10,000 „	12,500 „	15,000 „	Remarks.
Sugar Gum	S.A1, 1	4 4·5	5·937	3·812	...	11,300	9,432	...		...	...	...	...	...	...	
,,	S.A1, 2	4 5·125	5·812	3·75	69·611	14,750	12,983	2,022,600	691	·12	·223	·34	·459	·62	...	
,,	S.A1, 3	4 4·375	5·75	3·75	...	9,500	8,460	1,232,300		·178	·37	·64	...	...	...	
Box Gum	S.A2, 1	4 4·75	5·781	3·687	...	14,000	12,848	2,030,200	727	·12	·235	·361	·486	·645	...	
,,	S.A2, A.2	4 1·125	5·812	3·75	71·835	16,750	12,884	2,819,000	362	·08	·16	·251	·34	·44	·54	
,,	S.A2, 3	4 8·50	5·343	3 812	...	16,500	13,393	2,800,100	727	·085	·165	·255	·354	·465	·CC5	
Blue Gum	S.A3, A.1	4 5·5	5·687	3·812	...	14,800	12,880	1,994,600	817	·126	·22	·349	·47	...	...	
,,	S.A3, A.2	4 5·25	5·75	3·875	66·379	14,500	12,123	2,025,400	817	·11	·204	·325	·5	...	...	
,,	S.A3, 3	4 5·375	5·875	3·812	...	15,500	13,091	1,774,000	730	·135	·24	373	·51	·68	...	
Red Gum	S.A4. 1	4 5·0	5·812	3·812	...	9,000	7,672	810,610		·28	·53	...	...	...	...	
,,	S.A4, 2	4 4·875	5·937	3·75	56·394	10,000	8,624	958,460	697	·3	·58	...	...	...	...	
,,	S.A4, 3	4 4·75	5·906	3·812	...	4,625	3,880	918,590		·23	...	...	...	...	...	

WESTERN AUSTRALIAN TIMBERS.

TABLE IV.

Local Name.	Distinguishing letter and number.	Length	Width	Depth	Weight in Pounds per cubic foot.	Breaking Load in Pounds.	Modulus of Rupture in pounds per sq. inch.	Modulus of Elasticity in pounds per sq. inch.	Number of days in Seasoning.	2,500 lbs	5,000 lbs	7,500 lbs	10,000 „	12,500 „	15,000 „	Remarks.
Jarrah	MGD, 1	4 6·30	5·76	3·94	...	14,125	11,374	1,307,990		·15	·315	·478	·66	...	...	
,,	MGD, 2	4 6·20	5·82	3·85	56·24	12,060	10,065	1,261,211	388	·165	·298	·43	·59	...	...	
,,	MGD, 3	4 6·00	5·86	3·80	...	12.687	10,795	1,333,125		·165	·325	·495	·67	...	...	
,,	1	4 6·00	5·62	3·80	...	15,775	13.998	1,949,027		·115	·22	·338	·46	·655	...	
,,	2	4 6·75	5·70	4·11	67·796	16,625	12,432	1,746,640	474	·11	·19	·285	·385	·502	647	
,,	3	4 6·00	5·78	3·71	...	14,500	13,123	2,129,833		·1	·225	·342	·467	..	...	
Red Gum	MGD, 1	4 6·25	5·80	3·92	...	14.518	11,728	1,884,210		·105	·208	·304	·418	·54	...	Resembling Jarrah both
,,	MGD, 2	4 6·25	5·80	3·77	66·24	16.000	13,975	2,341,145	388	·095	·18	·27	·365	...	...	in appearance & weight.
,,	MGD, 3	4 6·20	5·74	3·80	...	7,500	6,515	912,283		·24	·468	·75	...	...	...	Like Red Gum of N.S.W.
Karri	MGD, 1	4 6·25	5·84	3·80	...	11.622	9,946	1,725,560		·125	·25	·378	·57	...	...	[and Victoria.
,,	MGD, 2	4 6·25	5·85	3·78	59·912	10,875	9,387	1,750,100	346	·125	·25	·385	·65	...	...	
,,	MGD, 3	4 6·20	5·84	3·86	...	13,500	11,117	1,646,318		·125	·23	·345	·49	...	...	