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THE STRENGTH, ELASTICITY, AND OTHER PROPERTIES OF NEW SOUTH WALES HARDWOOD TIMBERS.

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In this paper will be given the results of tests commenced in 1907, and continued up to December, 1910; these include the following:—

1. Tests of cubes in compression, cut from sections in the tree at various heights from the ground, in order to determine any variation in strength depending on the height above the ground.
2. The strength and elasticity of large and small timber beams.
3. The strength and elasticity of long and short columns of timber subjected to compression.
4. The shearing strength of timber.
5. The tensile strength of timber.
6. The compressive strength across the fibre.
7. Hardness tests.
8. Torsion tests.
9. Resistance to wear in floors and street pavements.

The tests have been planned, as far as possible, having regard to our special conditions, in accordance with the systems elaborated by Professor W. Kendrick Hatt, of the Bureau of Forestry, United States Department of Agriculture, and by Professor Rudeloff in Berlin, adopted by the International Society for Testing Materials.

SELECTION OF TREES AND TEST-PIECES.

The trees were selected for testing by the experts in the State Forestry Department, from the North and South Coast districts, and represent average specimens of normal growth in the localities from which they were obtained. The particulars of the various trees tested, and the method of cutting the test-pieces from different heights in the tree are clearly indicated on Plate II. It will be observed from the diagram, Plate II., and Figs. 1, 2, and 3, that the specimens for testing have, in every case, been cut from a definite portion of the tree trunk, and that particulars have been furnished as follows:—

1. The common name.
2. The dates of felling of the tree, and cutting it up into specimens in the manner indicated in Plate II.
3. The height and diameter of the tree, as compared with the average height and diameter of similar trees in the same locality.
4. The formation and kind of soil.

The selection of the height of the tree trunk from the base, at which specimens were cut, is in conformity with the purposes of the investigation. A section at the highest level, in the tree trunk, from which it was considered that useful timber may be obtained, is denoted by A, 1 foot thick, Fig. 1, Plate II., and cubes of 4 inches side, also square prisms 4 inches side, and 8 inches long, were cut from this section and prepared for testing in compression to determine the crushing strength. Similar pieces for testing in a similar manner were obtained from the four sections, each 1 foot thick, denoted by C, E, G, and I, at heights from the base of the trunk, 39, 29, 15, and 5 feet respectively. To secure uniformity in the conditions of the test in each section, one half the number of specimens were prepared with two faces, as nearly as possible tangential to the annual rings, denoted by *a*, Fig. 1; the remaining half were prepared with the diagonal of the square pressure surface radial to the trunk section, denoted by *b*, Fig. 1. The results obtained from specimens, *a*, Fig. 1, show the influence of the age of the timber on the strength, while those from *b*, Fig. 1, represent the average strength of the timber. The influence of the height above the ground on the timber is indicated by comparing the results obtained from the five sections, A, C, E, G, and I, see diagram, Plate II.

The samples for ascertaining the strength of beams of timbers have been selected from the portions of the trunk denoted by F, between the levels 16 and 29 feet measured from the base, and these have been cut and prepared, as far as possible, with two faces tangential to the annual rings in half the number of specimens, and with a diagonal of the square cross section radial to the trunk section in the other half of the specimens, as indicated in Fig. 3, Plate II. The size of the beams cut in this manner are 12 feet long by 10 by 10 inches in cross-section, and they have been tested on a span of 10 feet centres, loaded at two points dividing the length of the beam into three parts.

KEY TO SPECIMENS.

For the determination of the strength and stiffness of long columns of timber when subjected to compressive stress, applied along the axis of the column, samples were selected from the portions denoted by D, and H, diagram, Plate II., situated above and below the portion F, and prepared for testing in the following manner:—The ends in contact with the compression plates of the testing machine were accurately prepared in parallel planes at right angles to the axis of the column; one half of the specimens were cut having a square cross-section; and the other half were prepared in a lathe to a circular cross-section. The sizes are approximately 8 feet long by 4 inches side or diameter. After every test, sections were cut as near as possible to the most strained portions to ascertain the percentage of moisture contained in the timber at the time of testing, in order to determine the effect of moisture on the strength and elasticity. The sound portions of the timber remaining after the test have been used for other tests; the large beams were cut up into smaller beams of similar geometrical form and tested at intervals in order to determine the effect of seasoning on moisture, and the effect of the latter on the strength; also the columns after testing, furnished sound timber for preparing into tension, torsion, and shearing test-pieces.

The various tests will now be discussed in detail.

THE TESTS OF CUBES CUT FROM SECTIONS OF THE TREE AT VARIOUS HEIGHTS FROM THE GROUND.

The object of these tests was to determine whether the timber from a section of the tree near the base was stronger than near the top of the trunk or at any intermediate level. All authorities on timber-testing agree in that the best and most convenient test of the quality of timber is by compression of cubes or short prisms.

For each tree 6 cubes 4 inches wide were cut from each of the five sections denoted by A, C, E, G, I, in the diagram on Plate II., or 30 cubes per tree. The specimens tested were fairly sound, but large and small cracks developed in the process of seasoning, gum-veins and knots occurred in some of the pieces, but such defects, unless decided, did not appear to affect the crushing strength to any extent, excepting in the case of large dead knots, which caused a considerable reduction in strength.

All the specimens were accurately prepared to true parallel planes, in contact with the compression plates of the machine; they were measured to the nearest 0.05 inch, and tested with one spherical bearing under the lower compression plate. The individual timbers tested will now be considered:—

1. *Blackbutt, North Coast.*—The results were somewhat irregular, in consequence of the presence of gum-veins; the planes of failure are well-defined, but the strength, as shown in Table I, decreases very rapidly with increase in moisture. With 10 per cent. moisture the strength is 9,500 pounds per square inch; with 25 per cent. moisture, the strength is only 7,400 pounds per square inch.

2. *Tallow-wood, North Coast.*—This timber decreases in strength much more slowly with increase of moisture than Blackbutt, the strength, with 10 per cent. and 40 per cent. moisture, being 9,400 and 7,700 pounds per square inch respectively. The specimens were almost free from defects, but some opened out in cracks during seasoning, and these coincided with the lines of failure in testing, which were oblique to the natural plane of failure.

3. *Grey Gum, North Coast.*—This timber is stronger than Blackbutt or Tallow-wood. The specimens were, however, faulty in many cases, showing knots and gum-veins. The planes of failure were single almost without exception.

4. *Grey Ironbark, North Coast.*—The results of testing this timber by compression of cubes, although showing remarkably even results, great strength, and toughness, do not place it relatively in the high position experience and testing, in the form of beams and columns, have assigned to it. The moisture strength curve shows that it is inferior to Grey Box. The cross-section showed wavy annual rings, and the planes of failure were single, or double, in parallel or oblique.

5. No specimens of Red Ironbark were received.

6. *Blue Gum, North Coast.*—This timber showed an even grain, free from defects. The planes of failure were well-defined, with a multiplicity of branches.

7. *Brush Box, North Coast.*—The timber showed a close and even grain, but the results were somewhat irregular.

8. *Turpentine, North Coast.*—This timber was fairly sound, but in a few instances showed season cracks. The planes of failure were not well-defined, generally single, but sometimes branched. Although not a strong timber, it is much better than the timber of the same name obtained from the South Coast. It has two serious defects, viz., warping out of all proportion, and developing large cracks in seasoning.

9. *Red Mahogany, North Coast.*—The specimens of this timber showed the presence of sapwood, and some had large gum-veins; otherwise the timber was fairly sound. The results obtained in testing were irregular, and the timber is rather brittle.

10. *White Mahogany, North Coast.*—This timber is inferior in strength to the red variety, but less brittle. The planes of failure were always branched, and not well-defined. The timber has an even grain, but develops season cracks.

11. *Colonial Teak, North Coast.*—This timber was straight and even-grained at the top and the middle of the

trunk, but curly at the bottom. It was largely affected by season cracks, and is slightly brittle. The planes of failure were well-defined, but were always duplicate or branched. The results were irregular.

12. *Grey Box, South Coast.*—This timber gave the second highest results obtained in the series. It somewhat resembles grey ironbark in appearance, weight, and behaviour under test. The specimens were free from defects, excepting season cracks, and the planes of failure well-defined, in most cases single. The results were regular. Experience has shown that this timber is much inferior to Ironbark in durability.

13. *Woollybutt, South Coast.*—This timber was fairly free from defects, of even grain, but the strength decreases very rapidly with increase in moisture. The planes of failure were generally single.

14. *Spotted Gum, South Coast.*—The specimens were generally good, with the exception of slight season cracks, and the timber was of medium strength. The specimens were all of the same moisture approximately.

15. *Turpentine, South Coast.*—This timber is inferior to the North Coast timber of the same name; it yielded considerably under pressure before failure. The season cracks occurred in every case across the direction of the annual rings, and caused stepped and irregular planes of failure.

16. *Blackbutt, South Coast.*—These specimens were defective, having gum-veins, season cracks, and worm-holes. They failed for the most part along one plane more or less stepped. Notwithstanding defects, this timber gave the highest results, but as the pieces were well-seasoned, and approximately of the same moisture, only one result is given in Table I.

18. *White Stringybark, South Coast.*—The specimens of this timber contained season cracks, gum-veins, and worm-holes; also, in many cases warped on the sides. The planes of failure were irregular. There is no curve in this case also, as all the specimens were approximately of the same moisture.

SUMMARY OF THE RESULTS OF TESTING CUBES.

The following Table I. summarises the results, and arranges the timbers approximately in order of strength as found. In the case of Blackbutt, it is probable that at larger percentages of moisture than 15, the strength would fall rapidly.

A timber may be stronger at a small percentage of moisture than another timber, but weaker for a larger percentage of moisture, and it will be observed that there is a large decrease in strength for increase in moisture for Brush Box, Turpentine, and Woollybutt, as compared with Grey Gum, Ironbark, and Tallow-wood, which diminish much less in strength with increased percentage of moisture.

Table 1.—Results of Compression Tests of Cubes.

Order of Strength Approximately.	Local Name.	Locality. North or South Coast (N or S).	Strength at—per cent. Moisture.		
			15	25	35
1	Blackbutt	S ..	10,650	..	..
2	Grey Box	S ..	9,950	9,300	9,150
3	Grey Ironbark	N ..	9,500	8,550	8,200
4	Grey Gum	N ..	9,350	8,400	7,950
5	Woollybutt	S ..	9,750	8,000	7,250
6	White Stringybark	S ..	9,650	..	..
7	Tallow-wood	N ..	8,850	8,100	7,750
8	Red Mahogany	N ..	9,050	8,000	7,300
9	Brush Box	N ..	9,550	7,200	6,750
10	Spotted Gum	S ..	8,850	..	..
11	Blackbutt	N ..	8,600	7,400	7,050
12	Colonial Teak	N ..	7,500	7,050	6,950
13	Blue Gum	N ..	7,600	6,800	6.450
14	Turpentine	N ..	8,450	6,250	5,700
15	White Mahogany	N ..	7,400	6,400	5,850
16	Turpentine	S ..	7,350	5,950	5,300

CONCLUSIONS ON THE RESULTS OF TESTING CUBES.

A careful consideration of the results obtained from the tests of cubes taken from the five sections of the tree, having regard to the percentage of moisture present in each case, show that the timber cut from the highest section, denoted by A in the diagram, Plate II., is slightly stronger than that cut from the other four sections; but the difference is so slight that the timber may all be considered of approximately equal strength throughout the length of the tree trunk.

A comparison of the various timbers tested in this series shows that each timber has a characteristic strength moisture curve. It will also be observed that after a certain percentage of moisture is reached, additional moisture does not seriously reduce the strength, while on the other hand the diminution of moisture produces an important increase in strength which is much greater in some timbers than in others. The results obtained illustrate the importance of seasoning on the strength of timber, and they indicate that some timber exposed to the weather may become considerably reduced in strength in consequence of the absorption of moisture, as in the case of Woollybutt, Brush Box, and Turpentine, and to a less extent in Grey Box, Ironbark, Grey Gum, and Tallow-wood. One feature of these tests should be noted, that is, failure always occurred by shearing along planes parallel to the annual rings. The photographs of the cubes taken after testing show clearly the mode of failure. Fig. 4 represents Blackbutt.

COMPRESSION TESTS OF SHORT, MEDIUM, AND LONG COLUMNS.

The compressive tests of timber columns were made on short, medium, and long columns. The short columns were 12 inches long, and the long columns 8 feet long, of circular and square cross section. The medium columns were 3 feet long of square cross-section only. The cross-sections were, approximately, 4 inches in diameter, or 4 inches square. The results obtained in the various tests are recorded in Plate III., which gives a summary of the principal results obtained in testing the various columns.

The meaning of the headings to the various columns of figures in the above tables is sufficiently clear in nearly every case:—l, denotes the length of the column in inches; d, the diameter of the circular cross-section, or the side of the square, in the square cross-section in inches. The expression $\frac{l}{d}$ denotes the ratio of the length to the diameter, or side of the square. The short columns failed by direct compressive stress, as will be seen by the photograph of

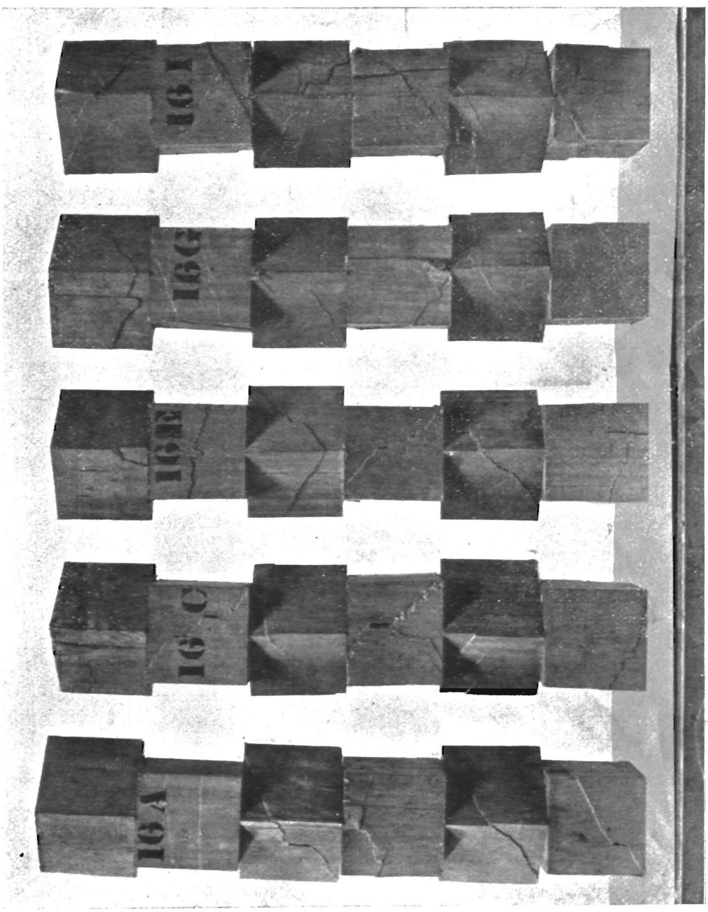


FIG. 4.

the tested specimens Fig. 5; but the long columns failed with a lower stress per unit of area, and deflected laterally, producing unequal distribution of stress over the cross-section, as in every case of failure by long-column action in any material.

In a short column, where lateral flexure may be neglected, the failure is due to the compressive resistance of the material. The plane of failure is generally oblique to the axis of the column, and is actually a shear, but the compressive strength is usually expressed as follows:—

$$\sigma_c = \frac{P}{A}$$

Where σ_c denotes the compressive strength per square inch, P the total load applied, and A the area of the cross-section. In the tables of results σ^c is expressed in lbs. per square inch.

In the case of the long columns the failure is more or less influenced by the lateral flexure, and the stress, found by dividing the total load applied by the area of the cross-section, is always lower than in the case of a short column of the same material and cross-section, and any formulae for expressing the stress producing failure must be of the well-known Euler, Rankine, Fidler, or Moncrieff type, or the strength may be expressed approximately by means of formulae of the straight-line type.

This latter type of formula may be safely adopted for timber columns, provided that it is never used outside the limits of the ratio of the length to the least lateral dimension, $\frac{l}{d}$, included in the experiments.

The tables of tests are much more valuable than any formula, as they clearly indicate the percentage of moisture, degree of seasoning, and other conditions which affect the strength and stiffness; but it is sometimes very convenient in connection with the determination of the cross-sectional area of columns of a given length intended to carry a definite load, to be able to arrive at the ultimate load causing failure, or the safe working stress in pounds per square inch of the area of the cross-section. For this purpose the straight line formulae will now be established for Ironbark, 4 D and 4 H, Grey Gum 3 D and 3 H, and Spotted Gum

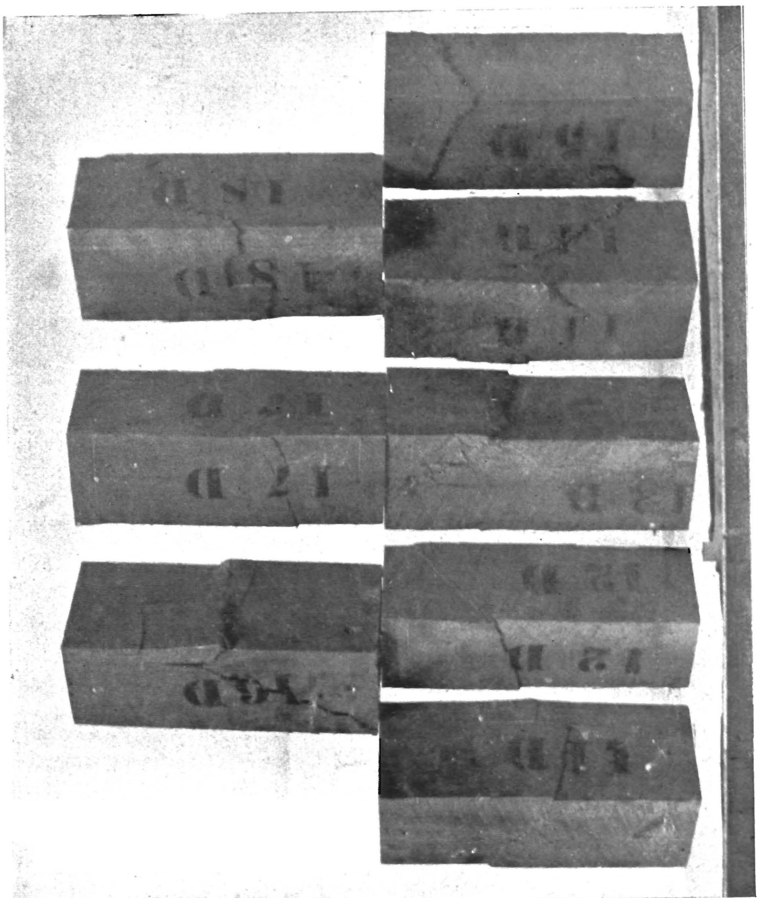


FIG. 5.

Short columns of square cross-section after testing.

14 D and 14 H, and the results of the tests on these timbers in the form of the long columns and the short columns will be average, also the values of $\frac{l}{d}$ in the long columns. The strength in the three timbers dealt with for the purpose of illustrating the method of deriving the formulae has been taken at 15 per cent. moisture from Plate III.

In the case of Ironbark timber, the average results obtained from tests on ten pieces 8 feet long are:—

$$\frac{l}{d} = 22.2, \ \sigma = 7{,}965$$

on four pieces 12 inches long:—

$$\frac{l}{d} = 2.94, \ \sigma = 10{,}367.$$

The following formula expresses the strength of any column of Ironbark timber of the kind tested between and including the proportions $\frac{l}{d} = 22.2$ to 2.94.

$$\sigma = 10{,}733 - 124 \frac{l}{d}.$$

Tests were also made on columns 3 feet long of the same sectional area, termed medium columns, and the results obtained were:—

$$\frac{l}{d} = 9.02. \quad \sigma = 9{,}620.$$

According to the above formula, we should have:—

$$\sigma = 10{,}733 - 124 \times 9.02 = 9{,}613.$$

So that the equation gives a result that agrees within 7 lb. per square inch with the experiments made on the 3-feet columns.

In a similar manner we can average the ratios $\frac{l}{d}$ and σ, for any of the timbers tested, using the results summarised in Plate III., and obtain formulae which express the strengths of the timbers tested in compression, thus:—

For Grey Gum $\sigma = 9{,}902 - 119 \frac{l}{d}$

For Spotted Gum $\sigma = 7{,}797 - 67 \frac{l}{d}$.

The value of σ obtained in the manner described, or from the tests themselves, must be divided by a factor of safety which, in the judgment of the engineer, will make due allowance for the conditions under which the timber is used.

The percentage of moisture present in the short columns show that the timber was fairly well seasoned at the time of testing, as in very few cases it exceeded 15 per cent., the standard dryness, and some were below this percentage.

METHODS OF FAILURE OF SHORT, MEDIUM, AND LONG COLUMNS.

The method of failure will be best understood by a study of the photographs obtained after the columns had been tested.

Fig. 6 shows characteristic failures of the short columns, 12 inches long.

Fig. 7 shows the failure of columns of medium length, 3 feet long.

Fig. 8 shows one of the long columns in the testing machine, after the deformations had been determined, just before failure.

On the right hand of the machine may be seen a column of tallow-wood timber, 40 inches long x 9.9 inches x 9.95 inches, which failed under a compressive load of 766,000 lb. equal to 342 tons, or 7,770 lb. per square inch.

Fig. 9 shows a photograph of portions of the long columns after failure about the region of fracture. It will be observed that the method of fracture is largely influenced by the lateral flexure of the column, and differs essentially from the method of fracture seen in the photographs of the short 12-inch columns. The sound portions at the ends of the long columns were sawn off, for use in other tests.

The figures and letters on the photographs of the specimens, in every case, are the distinguishing marks for the identification of the timbers, and correspond with those used in the tables of results, and in Plate II.

TRANSVERSE TESTS OF BEAMS.

The Determination of the Constants of Strength and Elasticity.

The tests of large beams approximately 10 in. by 10 in. cross-section on a span of 10 feet, were made on a 100-ton testing machine, illustrated in Plate IV., and the results obtained are recorded in Tables 2 and 3.

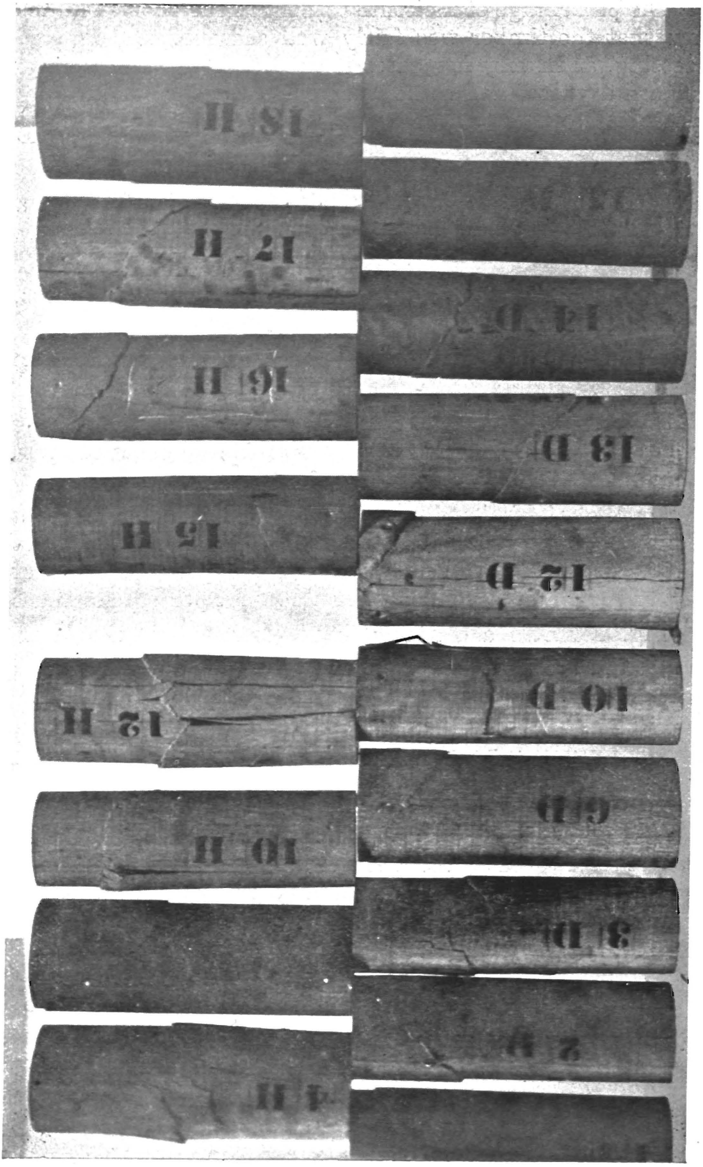


FIG. 6.
Short columns of circular cross-section after testing,

FIG. 7.
Columns of medium length after testing.

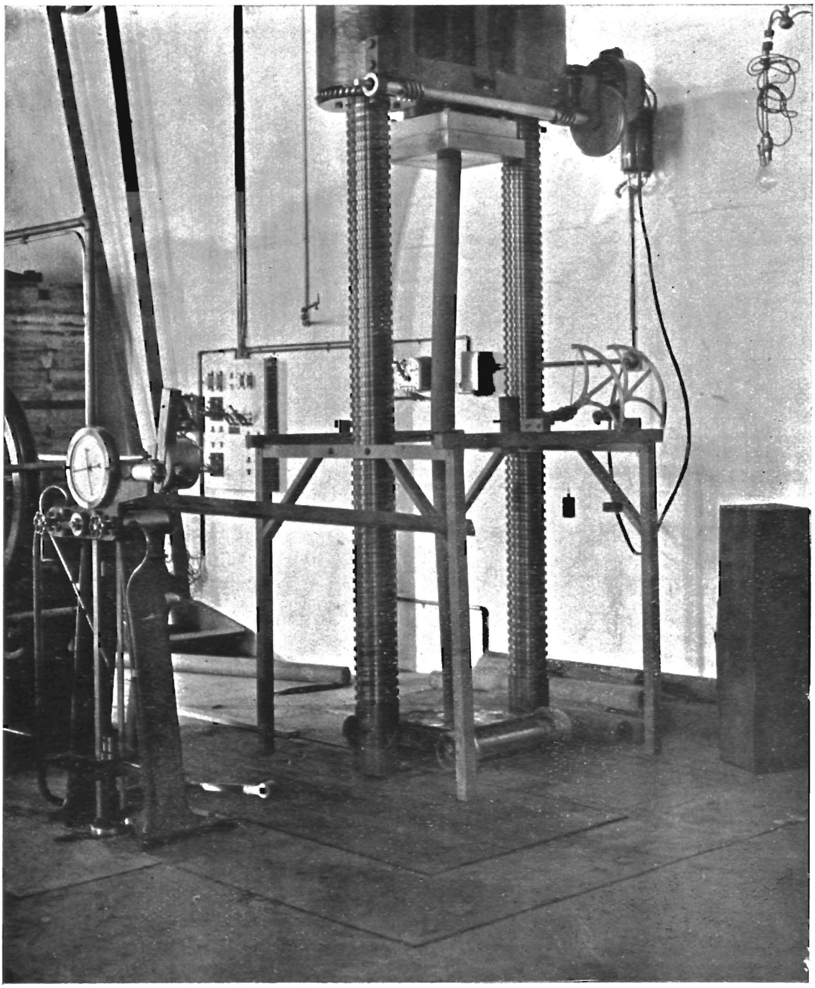


FIG. 8.

Shows long column, round section, in position in machine, after elastic readings have been taken, Special short column of Tallow-wood on right of picture. Dimensions, 9·9 in. x 95 in. x 40 in.; breaking load, 766,000 lb.

The capacity of this machine is 1,000,000 pounds. Maximum length of test piece, 12 feet.

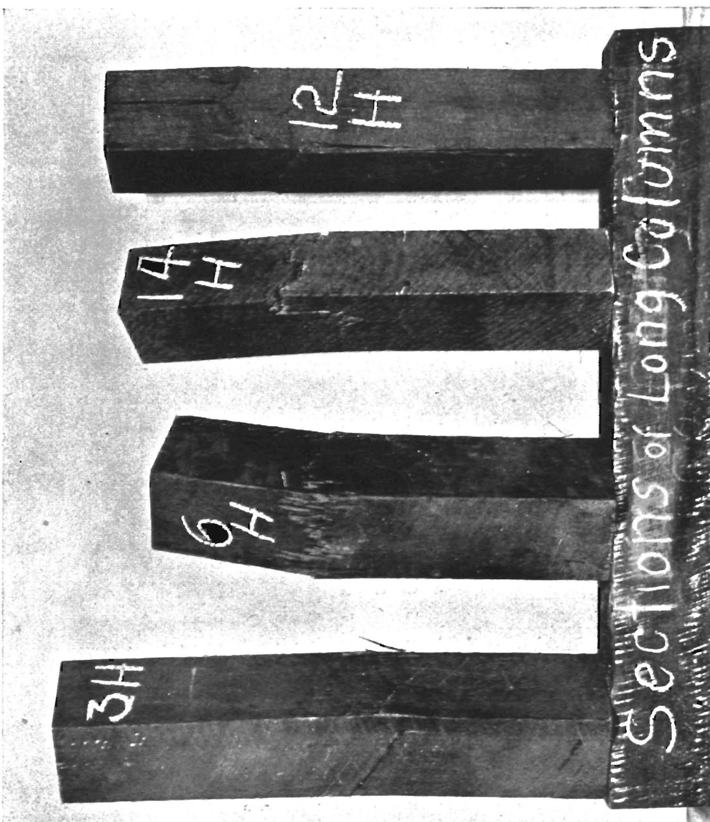


FIG. 9.

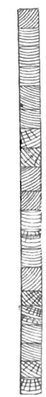
Portions sawn from long columns of square cross-section.

Table 2.—New South Wales Timbers. (North Coast.)

Transverse Tests.

Local Name.	Number and Letter.	Size.		Weight in lbs. per cubic foot.	Number of Days Seasoning.	Weight in lbs. per cubic foot at Standard Moisture.	Moisture percentage on Dry Weight.	Breaking Load in Tons.	Modulus of Rupture in lbs. per square in.	Horizontal Shear Stress in lbs. square inch (ultimate).	Apparent Limit of Proportionality.	Moment of Resilience in inch lbs. per cubic inch.	Modulus of Elasticity in lbs per square inch.		Deflection in Inches.						Position of Annual Rings.	Extension of Extreme Fibre in Inches.					Apparent Limit of Elasticity in lbs.
		Breadth. Inches.	Thickness. Inches.										From Deflection.	From Extension.	2 Tons.	6 Tons.	10 Tons.	14 Tons.	18 Tons.	22 Tons.		2 Tons.	10 Tons.	18 Tons.	26 Tons.	34 Tons.	
Blackbutt	1 F (1)*	9.8	9.9	60.7	558	53.0	31.7	18	5,060	312	(not reached)	..	2,200,000	1,375,000	..	.165	.287	.451	.595	..		..	.069	.127	..	..	..
	1 F (2)*	9.9	10.0	58.6	564	51.6	30.6	22.5	6,000	383	(not reached)	..	2,240,000	1,813,000	.050	.192	.335	.475	.630	.782		.004	.058	.113	..	..	..
	1 F (3)*	9.9	10.1	59.7	565	52.2	31.6	20	5,300	340	(not reached)	..	2,400,000	1,500,000	.065	.202	.335	.480	.610	..		.013	.069	.128	..	..	..
	1 F (4)	9.95	9.95	57.3	1,090	51	29.5	17.7	6,010	300	(not reached)	..	2,360,000	1,390,000	.080	.236	.402	.566	..	..		.009	.048	..	..	..	..
Tallow-wood	2 F (1)*	9.9	10.0	70.4	575	61.2	32.2	46.1	13,300	780	22	1.18	2,780,000	1,780,000	.060	.176	.298	.420	.532	.650		.013	.063	.117	.168	.220	9,500
	2 F (2)*	10	10.0	72.4	576	60.7	37.1	41	11,000	689	20	1.91	2,942,000	1,880,000	.045	.158	.270	.390	.495	.620		.012	.056	.102	.149	.196	5,000
	2 F (3)	10.45	10.05	66.8	1,089	59.6	29.0	35.6	11,400	570	27	1.90	2,660,000	1,590,000	.072	.190	.316	.456	..	..		.007	.039	.072	..	..	8,680
Grey Gum	3 F (1)*	9.9	10.0	76.9	550	63.8	38.7	40	11,600	689	19	1.00	2,450,000	1,623,000	.063	.195	.335	.470	.610	.750		.012	.069	.127	.194	.270	4,800
	3 F (2)*	9.0	9.0	74.6	535	61.7	39.1	15.4	5,800	320	(not reached)	..	2,370,000	1,476,000	.105	.313	.555	.893	..	..		.020	.090	..	..	..	..
	3 F (3)	9.05	9.15	67.8	1,051	61.7	26.6	18.5	8,210	375	10	0.48	2,540,000	1,160,000	.104	.308	..	..	..	..		013	.078	..	..	..	4,450
	3 F (4)	9.00	9.05	69.4	1,089	61.9	29.0	23.5	10,700	485	18	1.80	2,410,000	1,360,000	.120	.348	..	..	..	..		.013	.076	..	..	..	8,210
Grey Ironbark	4 F (1)*	9.9	10.0	70.4	559	65.0	24.5	40	11,000	680	20	0.97	2,922,000	1,923,000	.055	.170	.290	.403	.525	.648		.010	.057	.103	.153	.202	6.500
	4 F (2)	9.9	9.8	72.4	586	67.0	24.4	34	12,000	590	20	1.30	2,880,000	1,770,000	.060	.202	.345	.490	.625	.790		.008	.042	.077	.117	.164	6,400
	4 F (3)	9.85	9.95	68 0	1,072	63.1	23.9	41.5	14,300	705	32	1.81	2,910,000	1,290,000	.064	.200	.328	.460	.594	..		.008	.041	.079	..	..	11,000
Blue Gum	6 F (1)*	9.7	9.8	62.3	563	54.3	31.9	37	10,700	647	18	1.01	2,475,000	1,515,000	.060	.213	.365	.520	.683	.863		.013	.076	.133	.209	.314	5,000
	6 F (2)	9.7	9.8	62.0	580	54.5	30.8	32	11,950	570	22	2.00	2,240,000	1,450,000	.088	.262	.442	.625	.828	1.070		.013	.049	.091	.157	..	8,000
	6 F (3)	9.29	9.70	62.2	1,064	57.6	24.0	38.1	14,600	709	28	3.25	2,200,000	1,260,000	.094	.264	..	.630	.814	..		.011	.060	.139	..	..	10,700
	6 F (4)	9.70	9.60	61.6	1,074	56.6	25.1	35.8	13,500	348	22	1.76	2,390,000	1,680,000	.092	.268	.452	.618	.810	..		.009	.048	.087	..	..	8,290

Table 2.—*continued.*

Local Name	Number and Letter.	Size. Breadth. Inches.	Size. Thickness. Inches.	Weight in lbs. per cubic foot.	Number of Days Seasoning.	Weight in lbs. per cubic foot at Standard Moisture	Moisture percentage on Dry Weight.	Breaking Load in Tons.	Modulus of Rupture in lbs. per square in.	Horizontal Shear Stress in lbs. square inch (ultimate).	Apparent Limit of Proportionality.	Moment of Resilience in inch lbs. per cubic inch.	Modulus of Elasticity in lbs per square inch From Deflection.	Modulus of Elasticity From Extension.	Deflection in Inches. 2 Tons.	6 Tons.	10 Tons.	14 Tons.	18 Tons.	22 Tons.	Position of Annual Rings.	Extension of Extreme Fibre of Inches. 2 Tons	10 Tons.	18 Tons.	26 Tons.	34 Tons.	Apparent Limit of Elasticity in lbs.
Brush Box	7 F (1)*	9.7	9.8	60.9	559	49.2	42.3	39.5	8,700	700	18	1.03	2,310,000	1,450,000	.065	.220	.377	.540	.696	.870		.016	.080	.148	.220	..	5,000
	7 F (2)	8.7	8.9	62.6	604	56.3	27.8	22	10,700	645	(not reached)	..	2,340,000	1,770,000	.120	.370	.630	.915	1.225	1.680		.012	.057	.100	..	..	..
	7 F (3)	9.45	9.60	62.9	1,074	57.5	25.8	32.8	12,700	609	20	1.35	2,720,000	1,420,000	.080	.260	.442	.640	..	..		.011	.057	..	..	..	7,740
	7 F (4)	8.40	8.80	62.0	1,075	57.1	24.9	27.8	14,200	631	21	2.83	2,530,000	1,430,000	.118	.374	.632	..	..	..		.013	.077	..	..	..	10,700
Turpentine	8 F (1)	9.6	9.8	66.0	579	55.4	37.0	30	10,900	537	(not reached)	..	2,182,000	1,456,000	.080	.268	.458	.655	.860	..		009	.049	.089	..	..	..
	8 F (2)	9.8	9.9	66.3	586	56.9	33.9	22	7,700	380	20	2.18	1,760,000	1,080,000	.100	.315	.550	.785	1.032	..		.011	.063	.119	..	..	7,000
	8 F (3)	9.05	9.50	66.1	1,073	61.3	23.9	32.7	13,400	638	15	0.69	2,260,000	1,600,000	.092	.304	.548	.780	..	..		006	.042	..	..	..	6,150
	8 F (4)	9.40	9.50	62.7	1,071	55.7	29.7	30.8	12,200	500	..	..	1,920,000	1,270,000	.086	.320	.484	..	..	..		.011	.062	..	..	..	..
Red Mahogany	9 F (1)	9.9	9.8	63.3	562	55.1	32.0	27.4	9,700	474	(not reached)	..	2,405,000	1,573,000	.075	.248	.420	.655	..	..		.009	.043	..	..	..	..
	9 F (2)	9.9	10.0	63.0	574	53.5	35.5	29.7	10,200	500	22	1.90	2,300,000	1,510,000	.075	.232	.400	.565	745	.948		.009	.046	.084	.139	..	7,500
	9 F (3)	9.80	9.85	60.5	1,045	54.3	28.3	29.9	10,600	522	..	..	2,490,000	1,760,000	.080	.238	.398	.560	..	..		.009	.042	.075	..	..	..
	9 F (4)	9.70	9.85	61.0	1,047	53.8	30.3	28.3	10,100	497	..	..	2,560,000	1,530,000	.080	.236	.394	.552	..	..		.010	.046	..	..	..	..
White Mahogany	10 F (1)*	10.1	10.2	67.2	527	53.9	43.5	42	11,100	685	22	1.34	2,290,000	1,510,000	.068	.208	.340	.483	.628	.773		.013	.069	.128	.187	.254	6,700
	10 F (2)*	10.1	10.1	69.2	530	54.4	46.2	31.9	8,400	525	18	1.02	2,470,000	1,600,000	.075	.228	.390	.538	.710	.930		.012	.064	.104	.172	..	4,700
	10 F (3)†	10.1	10.1	69.7	533	52.0	54.0	23.1	9,030	380	20	..	2,000,000	1,600,000	.083	.273	.465	.665	.870	1.175		.018	.098	.186	..	..	7,800
	10 F (4)	10.0	9.75	66.7	1,053	57.3	34.0	28.7	10,100	495	26	2.18	2,390,000	1,470,000	.080	.244	.412	.580	.760	..		.009	.047	..	..	..	9,150
Colonial Teak	11 F (1)	10.1	10.1	59.1	524	53.4	27.2	24.1	7,860	398	22	2.74	1,487,000	932,000	.100	.370	.578	.840	1.073	1.408		.011	.065	.127	..	..	7,000
	11 F (2)	10.0	10.1	59.6	538	54.4	26.1	18	6,060	306	(not reached)	..	1,550,000	1,225,000	.101	.330	.580	.840	..	..		012	.047	..	..	..	..
	11 F (3)	10.0	10.05	56.6	1,019	52.5	24.2	22.9	7,600	382	20	2.02	1,390,000	920,000	.113	.322	..	..	..	..		.015	.074	..	..	..	6,630
	11 F (4)	10.0	10.2	57.3	1,031	54.2	21.6	21.5	6,950	354	..	..	1,790,000	1,050,000	.097	.290	.486	..	..	..		.012	.061	..	..	..	..

* Tested with Central Span of 40 Inches. † Tested on one support. All Test pieces 11 feet long.

Table 3.—New South Wales Timbers. (South Coast).
Transverse Tests.

Local Name.	Number and Letter.	Size.		Weight in lbs. per cubic foot.	Number of Days Seasoning.	Weight in lbs. per cubic foot at Standard Moisture.	Moisture percentage on Dry Weight.	Breaking Load in Tons.	Modulus of Rupture in lbs. per square in.	Horizontal Shear Stress in lbs. square inch (ultimate).	Apparent Limit of Proportionality.	Moment of Resilience in inch lbs. per cubic inch.	Modulus of Elasticity in lbs. per square inch.		Deflection in Inches.						Position of Annual Rings.	Extension of Extreme Fibre in Inches.					Apparent Limit of Elasticity in lbs.
		Breadth.	Thickness.										From Deflection.	From Extension.	2 Tons.	6 Tons.	10 Tons.	14 Tons.	18 Tons.	22 Tons.		2 Tons.	10 Tons.	18 Tons.	26 Tons.	34 Tons.	
Grey Box	12 F (1)	10	10	77.7	353	66.0	35.3	36.2	12,230	608	22	1.40	2,910,000	1,894,000	.060	.185	.310	.445	.580	.710		.006	.035	.066	.095	.130	7,460
	12 F (2)	10.1	10	70.2	354	61.1	32.1	36.0	12,000	600	22	1.52	2,660,000	1,660,000	.058	.185	.340	.480	.620	.770		.008	.039	.073	.108	.159	7,340
	12 F (3)	9.85	10.0	68.7	849	63.9	24.2	23.7	8,080	404	..	..	2,860,000	1,800,000	.064	.196	.324	.462	.596	..		.008	.040	.069	..	..	..
	12 F (4)	9.9	10.05	70.0	853	63.0	28.1	28.3	9,510	478	..	..	2,830,000	1,610,000	.064	.194	.332	..	..	..		.008	.042	..	..	..	..
Woolly-butt	13 F (1)	10	10.1	70.0	242	57.7	39.5	26.3	9,000	450	22	1.55	2,570,000	1,500,000	.061	.205	.350	.490	.635	.790		.008	.043	.080	.117	..	7,510
	13 F (2)	10	10.1	70.0	242	53.2	51.2	23.7	8,000	400	20	1.33	2,460,000	1,680,000	.065	.220	.360	.510	.668	.825		.008	.043	.076	..	..	10,000
	13 F (3)	9.85	10.1	63.7	832	54.8	34.0	36.5	12,100	608	28	3.31	2,390,000	1,310,000	.078	.220	.376	.530	.684	..		.009	.046	..	..	..	9,320
	13 F (4)	9.95	10.1	65.3	820	55.4	35.3	24.3	8,160	412	20	1.74	1,830,000	1,470,000	..	.230	.390	..	..	..		..	.051	.091	..	..	6,700
Spotted Gum	14 F (1)	10	10	72.3	321	55.7	49.4	32.2	10,815	542	22	2.39	2,022,000	1,211,000	.078	.260	470	.680	.928	1.205		.009	.057	.114	.180	..	7,400
	14 F (2)	9.9	10	69.8	328	54.6	47.0	30.0	10,170	510	20	1.85	1,918,000	1,232,000	.090	.280	.475	.685	.890	1.170		.011	.055	.104	.225	..	6,800
	14 F (3)	9.7	9.8	66.3	819	56.6	34.8	31.8	11,500	557	22	2.45	1,970,000	1,290,000	.100	.300	.500	.720	..	..		.011	.056	..	..	..	8,040
	14 F (4)	9.85	9.95	71.0	832	60.0	36.1	27.2	11,500	513	23	2.33	2,090,000	1,200.000	.100	.336	..	..	..	..		.013	..	..	..	..	9,730
Turpen-tine	15 F (1)	9.8	9.9	65.2	325	48.7	54.0	22.0	7,700	381	(not reached)	..	2,122,000	1,400,000	.075	.278	.548	.833	1,215	1,930		.009	.050	.087	..	..	..
	15 F (2)	9.9	10	64.4	327	46.7	58.7	16.0	5,450	272	(not reached)	..	1,770,000	1,130,000	.105	.313	.538	.776	..	..		.011	.059	..	..	..	..
	15 F (3)	9.3	9.7	63.8	814	56.8	29.1	24.1	9,250	459	(not reached)	..	2,290,000	1,300,000	.100	.292	..	..	..	..		.012	..	..	..	..	..
	15 F (4)	9.2	9.2	64.5	815	55.6	33.2	24.8	10,700	494	(not reached)	..	2,210,000	1,220,000	.102	.360	.554	.844	..	..		.013	.068	..	..	..	..
Blackbutt	16 F (1)	10	10.1	69.4	329	56.8	40.5	28.0	9,250	465	22	1.75	2,400,000	1,690,000	.080	.242	.390	.550	.720	.892		.007	.039	.072	.109	..	7,250
	16 F (2)	9.9	10.1	68.6	337	56.8	42.5	26.0	8,660	435	20	1.39	2,333,000	1,480,000	.068	.225	.380	.535	.690	.850		.008	.043	.079	.117	..	6,650
	16 F (3)	8.6	8.9	60.5	815	53.6	29.8	24.1	11,800	528	22	2.62	2,710,000	1,480,000	.108	.332	.552	..	..	..		.013	.065	..	..	..	10,800
	16 F (4)	9.55	9.95	66.2	817	59.6	27.9	32.9	11,700	583	27	2.17	2,640,000	1,630,000	.080	.222	.382	..	..	..		.009	.042	..	..	..	9,600
Mountain Ash	*17 F (1)	10.1	10.1	65.9	342	52.8	43.4	30.0	7,300	462	24	1.80	2,360,000	1,300,000	.065	.198	.338	.475	.610	.763		.014	.074	.131	.206	..	5,900
	17 F (2)	10.1	9.9	66.7	355	53.3	43.9	33.4	11,300	560	24	2.17	2,340,000	1,500,000	.075	.238	.403	.568	.753	.923		.008	.046	.083	.124	..	8,100
	17 F (3)	8.7	9.0	62.0	860	57.7	23.4	20.7	9,880	444	16	1.44	2,360,000	1,200,000	.118	.350	..	..	..	..		.013	.074	..	..	..	7,650
	17 F (4)	9.75	9.9	62.5	860	57.8	24.0	23.6	8,290	412	20	1.14	2,650,000	1,710,000	.074	.214	.366	.512	..	..		.009	.040	..	..	..	7,050
White Stringy-bark	18 F (1)	10	10	67.0	355	51.4	50.0	32.0	10,700	540	24	2.25	2,200,000	1,344,000	.075	.248	.416	.568	.758	.938		.009	.049	.089	.135	..	7,500
	18 F (2)	10	10	66.2	355	52.1	46.1	30.0	10,000	505	24	2.16	2,180,000	1,390,000	.080	240	.410	.576	.738	.914		.009	.047	.088	.132	..	8,000
	18 F (3)	9.9	9.9	61.3	830	52.4	34.4	23.6	8,170	405	(not reached)	..	2,160,000	1,310,000	.084	.256	432	.624	.784	..		.010	.050	.091	..	..	..
	18 F (4)	10.05	9.75	61.0	842	56.5	24.2	29.2	10,200	490	(not reached)	..	2,270,000	1,300,000	.088	.260	.432	.606	.788	..		.010	.051	.098	..	..	..

* Tested with Central Span of 40 Inches.