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WOOD QUALITY ASSESSMENT OF RUBBERWOOD: THE EFFECT OF CLONE AND AGE ON SPECIFIC GRAVITY AND STRENGTH PROPERTIES

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ABSTRACT

Specific gravity and strength properties were determined for rubberwood (*Hevea brasiliensis*) from two clones (RRIM600 and RRIM623) and two age groups (22 years and 35 years). The specific gravity was higher for clone RRIM600 compared to clone RRIM623 and no difference between near pith and near bark. Modulus of Elasticity (MOE) and Modulus of Rupture (MOR) showed no significant difference between the two clones although clone RRIM600 exhibited higher MOE values. The Maximum Compression Strength (MCS) was higher for clone RRIM600 and Maximum Shear Strength (MSS) was higher for clone RRIM623. Among age group, the 22-year old trees exhibited higher values for both MCS and MSS. It is hoped that the values for specific gravity and strength properties derived from this study can be a beneficial guide in assessing the suitability of rubberwood for specific application.

Key words: specific gravity, Modulus of Elasticity (MOE), Modulus of Rupture (MOR), Maximum Compression Strength (MCS), Maximum Shear Strength (MSS)

INTRODUCTION

Wood quality or the behaviour of wood when applied for specific purposes can be predicted through the measurement of certain wood characteristics collectively known as quality indicators. Such indicators include specific gravity and strength properties such as static bending, compression and shear strength.

Specific gravity has proved to be the most useful index of the wood for many important uses. The pulp and paper industry has given the greatest support for the use of specific gravity and it has been shown to indicate strength properties, pulp yield and quality (Zobel and McElwee, 1958).

However, the suitability of a timber for a particular purpose depends not only upon physical properties but also upon its strength properties. Such properties, according to Haygreen and Bowyer (1982), are the primary criteria for the selection of the material for structural application. The lightness and strength of wood ensured its retention for beams in the construction of building in the early historic times (Bodig and Jayne, 1982).

This project was therefore conducted to study the specific gravity and the strength properties such as static bending (MOE and MOR), compression parallel to grain and shear parallel to grain for two clones and two age groups of rubberwood. The objective is to determine the variation of the said properties according to clone and age of the tree.

MATERIALS AND METHODS

Rubberwood (*Heavea brasiliensis*), selected from the rubber plantation area of Universiti Putra Malaysia (UPM), Serdang Selangor were obtained from two clones namely RRIM 600 and RRIM 623 at the age of 22 years and 35 years old. Three different trees representing each clone and age group were selected, felled and cut into various portions. The wood samples were stored in a freezer room to prevent from moisture loss and fungal attack.

Determination of Specific Gravity (SG)

The wood block sized 2.5 mm by 2.5 mm were cut from inner and outer part of the discs at three height levels – diameter at breast height (DBH), 50% and 80% of clear bole height. Three blocks from outer and 3 blocks from inner part were used to determine the specific gravity by the water immersion method (ASTM D-143-52(78)).

Determination of Strength Properties

Samples for mechanical testing were prepared from two portions of the tree i.e. *first portion* is 50% from the total height of the bole and *second portion* is the rest of the clear bole height and tests were conducted in accordance to the British Standard (BS 373:1957 – Method of Testing Small Clear Specimen of Timber) (Anon., 1957). The specimens were conditioned for approximately two weeks in a mechanical testing laboratory, maintained at a constant relative humidity of 67.1% ± 2% and temperature of 24°C ± 1°C before mechanical tests were conducted. The tests such as Static Bending, Compression Parallel to Grain and Shear Parallel to Grain were conducted using 'Zwick 1474 Universal Testing Machine, Installed in a controlled room condition at 12% moisture content.

RESULTS AND DISCUSSIONS

The variation of specific gravity (SG) between clones and age groups along height and radial zones is shown in Table 1. Mean SG ranged from 0.54 to 0.62 and was higher for clone RRIM600 compared to that of RRIM623. Bhatt *et al.* (1984) found that SG of rubberwood ranged from 0.43 to 0.62. The 22-year old trees showed higher higher values than the 35-year old trees. The SG was lowest at breast height (DBH). Ashaari (1980) noted that extraction significantly decreased the SG from 0.56 to 0.46.

Strength properties for rubberwood are given in Table 2 for the mean values of standard deviation (SD) and coefficient of variation (CV), Table 3 for the summary of ANOVA on clone effect, and Table 4 for the summary of ANOVA on the age effect.

Modulus of Elasticity (MOE) differed significantly among different age groups but not between different clones. The MOE values for rubberwood are higher for clone RRIM600 and the 22-year old tree showed a much higher MOE value (5615.16 N/mm^2) than the 35-year old tree (4658.67 N/mm^2). Similarly, Modulus of Rupture (MOR) exhibited significant differences among different age groups whereby the 22-year old tree gave a higher MOR value (86.60 N/mm^2) than the 35-year old tree (76.43 N/mm^2).

Compression strength parallel to grain represented by Maximum Compression Strength (MCS) and Shear strength parallel to grain represented by Maximum Shear Strength (MSS) differed significantly between different clones and among different age groups. Clone RRIM600 gave a higher MCS value (57.21 N/mm^2) but clone RRIM623 exhibited a much higher MSS value (16.25 N/mm^2). Among age groups, the 22-year old tree showed higher values for both MCS and MSS when compared to the 35-year old tree.

The results of current study when compared with previous studies revealed interesting findings as shown in Table 5, although very few studies were focused on different clones and age groups.

Table 1: Mean SG between Clones and Age Groups along Height Levels and Radial Zones.

Clone Type	Age Group (Years)	Height Level (Clear Bole Ht.)	Outer (Near Bark)	Inner (Near Pith)	Mean
RRIM623	22	DBH	0.61	0.61	0.61
		50%	0.62	0.62	0.62
		80%	0.62	0.63	0.62
		Mean	**0.62**	**0.62**	**0.62**
		SD	0.01	0.01	0.01
	35	DBH	0.53	0.52	0.53
		50%	0.55	0.53	0.54
		80%	0.57	0.55	0.56
		Mean	**0.55**	**0.54**	**0.54**
		SD	0.02	0.03	0.02
RRIM600	22	DBH	0.59	0.67	0.63
		50%	0.63	0.63	0.63
		80%	0.62	0.63	0.62
		Mean	**0.61**	**0.64**	**0.62**
		SD	0.02	0.06	0.04
	35	DBH	0.57	0.59	0.58
		50%	0.62	0.61	0.61
		80%	0.62	0.62	0.62
		Mean	**0.60**	**0.61**	**0.60**
		SD	0.02	0.03	0.02

Legends: SD = Standard Deviation; DBH = Diameter at Breast Height

Table 2: Mean and Standard Deviation Values of Strength Properties of Rubberwood

Parameters	Ages (Year)	Clones	
		RRIM600	**RRIM623**
Modulus of Elasticity (MOE)	22	5136.62	4501.01
		[551.35]	[1802.24]
		(10.74)	40.04)
	35	4815.12	4502.21
		[1645.06]	[518.16]
		(34.16)	(11.51)
Modulus of Rupture (MOR)	22	82.67	84.92
		[6.17]	[3.47]
		(7.46)	(4.08)
	35	77.92	74.94
		[10.06]	[4.74]
		(12.91)	(6.32)
Maximum Compression Strength (MCS)	22	58.39	60.51
		[2.01]	[3.77]
		(3.43)	(6.24)
	35	56.03	51.45
		[6.47]	[2.51]
		(11.55)	(4.88)
Maximum Shear Strength (MSS)	22	15.72	17.79
		[0.63]	[0.66]
		(4.01)	(3.74)
	35	14.02	14.70
		[1.34]	[0.66]
		(9.53)	(4.47)

Note: Unit = N/mm^2; [ ] = Standard Deviation; ( ) = Coefficient of Variation

Table 3: Summary of ANOVA for Strength Properties Between Different Clones

Parameters	Clones	
	RRIM600	**RRIM623**
MOE*	4975.87a	4501.61a
MOR*	80.29a	79.93a
MCS*	57.21a	55.98b
MSS*	14.87a	16.25b

Note:
Unit = N/mm^2
* = Significant Difference at $P < 0.05$
a, b = Mean with the same letter are not significantly difference

Table 4: Summary of ANOVA for Strength Properties Among Different Age Groups

Parameters	Age Groups	
	22-Year Old	35-Year Old
MOE*	5615.16a	4658.67b
MOR*	86.60a	76.43b
MCS*	57.97a	53.74b
MSS*	15.89a	14.36b

Note:
Unit = N/mm^2
* = Significant Difference at $P < 0.05$
a, b = Mean with the same letter are not significantly difference

Table 5: Comparison of Strength Properties of Rubberwood with Previous Studies

Study	Strength Properties				
	Clone (Age Group)	MOE (N/mm^2)	MOR (N/mm^2)	MCS (N/mm^2)	MSS (N/mm^2)
Current	RRIM600 (22-Year Old)	5136.62	82.67	58.39	15.72
	RRIM600 (35-Year Old)	4815.12	77.92	56.03	14.02
	RRIM623 (22-Year Old)	4501.01	84.92	60.51	17.79
	RRIM623 (35-Year Old)	4502.16	74.94	51.45	14.70
Previous	(1)	9100.00	67.00	40.00	10.30
	(2)	5950.98	57.55	32.45	9.30
	(3)	8039.22	74.12	36.67	10.56
	(4)	9200.00	66.00	32.30	11.00
	(5)	15670.00	98.35	52.73	-

Note:
MC at Test: 17.30 ± 1.43%
(1) = Keating & Bolza (1982), Indonesia
(2) = Sanyal & Dangwal (1983), India (25-30 Year Old)
(3) = Shukla & Mohan Lal (1985), India (22 Year Old)
(4) = MTIB (1989), Malaysia
(5) = Gnanaharan & Dhamodaran (1993), India (35 Year old)

It can be seen from Table 5 that the strength properties obtained from this study were slightly higher or nearly the same with the previous studies except for MOE. For MOR, the 22-year old tree from this study showed a range of 82.67 N/mm^2 to 84.92 N/mm^2, slightly higher values compared to the previous studies of 57.55 N/mm^2 (Sanyal and Dangwal, 1983) and 74.12 N/mm^2 (Shukla and Mohan Lal, 1985). However, samples from the 35-year old tree with values ranging from 74.94 N/mm^2 to 77.92 N/mm^2 showed much lower values compared to value obtained by Gnanaharan and Dhamodaran (1993). The difference in anatomical characteristics of specimens especially existence of tension wood in rubberwood could contribute to the differences. The occurance of tension wood is a common phenomenon in rubberwood (Lim and Ani Sulaiman, 1994). This study also showed higher values for MCS and MSS when compared to those values from the previous studies except for MCS value for clone RRIM623 at the age of 35 years. This clone with a value of 51.45 N/mm^2 exhibited almost similar values obtained by Gnanaharan and Dhamodaran (1993) with values of 52.73 N/mm^2. The differences might be due to environmental conditions, anatomical properties and site factors.

COMCLUSIONS

Wood from clone RRIM600 was superior in terms of higher specific gravity, greater values for Modulus of Elasticity and Maximum Compression Strength but clone RRIM623 was better in terms of Maximum Shear Strength. Age wise, the 22-year old tree gave better results for both clones than the 35-year old tree. The higher the specific gravity, the denser is the wood that is related to higher pulp yield and greater strength. The bending properties as indicated by MOE and MOR are useful when used as flexural members such as beams, joists, columns, furniture components, etc. The compression data are useful in designing of columns, posts, bearing blocks, furniture legs and some sport goods. While shear strength may provide early information in designing various industrial articles and in design of beams in construction with appropriate factor of safety.

REFERENCES

Ashaari Mohd. Amin. 1980. Variation in certain Wood Properties of Rubber Trees (*Hevea brasiliensis* Muell Agr.) Unpubl. Master's Thesis, Lousiana State University.

Anon., 1957. Method of Testing Small Clear Specimens of Timber, BS 373. British Standard Institution Incorporated by Royal Chapter, London: 32 p.