MECHANICAL PROPERTIES OF RUBBERWOOD FROM A 35-YEAR-OLD PLANTATION IN CENTRAL KERALA, INDIA*

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GNANAHARAN, R. & DHAMODARAN, T. K. 1993. Mechanical properties of rubberwood from a 35-y-old plantation in central Kerala, India. The mechanical properties of air-dried rubberwood (*Hevea brasiliensis*) from a 35-y-old plantation in the central region of Kerala were determined. It was found that the mechanical properties tested, namely, modulus of rupture (MOR), modulus of elasticity (MOE) and maximum compressive stress (MCS) were higher for the 35-y-old material than for lower age material reported in the literature. These properties were comparable with those of other conventional timbers grown in Kerala. The study showed that rubberwood possesses medium strength properties.

Key words: Rubberwood - strength properties

GNANAHARAN, R. & DHAMODARAN, T. K. 1993. Ciri-ciri mekanikal kayu getah dari ladang getah berumur 35 tahun di Kerala tengah, India. Ciri-ciri mekanikal kayu getah (*Hevea brasiliensis*) yang telah di kering udara di laporkan. Kayu getah ini berasal dari ladang getah berumur 35 tahun di Kerala tengah, India. Hasil-hasil kajian yang lalu melaporkan, ciri-ciri mekanikal seperti modulus kerekahan (MOR), modulus kekenyalan (MOE) dan ketegangan mampatan maximum (MCS) adalah lebih tinggi bagi kayu getah yang berasal dari ladang getah berumur 35 tahun berbanding dengan kayu getah dari ladang getah yang lebih muda. Ciri-ciri ini menempatkan kayu getah dalam renj yang setanding dengan kayu balak yang tumbuh di Kerala. Kajian ini menunjukkan kayu getah mempunyai kekuatan sederhana.

Introduction

Kerala State accounts for a major share, nearly 90%, of rubber (*Hevea brasiliensis*) plantations in India. Rubber plantations have become a major source of industrial timber in Kerala. Knowledge of the physical and mechanical properties of rubberwood is essential for its proper utilization. Sanyal and Dangwal (1983) reported the results of physical and strength properties of rubberwood from 25- to 30-y-old trees from Kottayam, Kerala. Shukla and Mohan Lal (1985) tested wood from 22-y-old trees from Quilon, Kerala. It was seen from the above studies that rubberwood from 25- to 30-y-old trees had 22% lower MOR values and 26% lower MOE values than those of 22-y-old trees (Table 2). Generally, one would expect the strength values to taper off after attaining the maximum. It is not clear whether these lower values were due to locality differences, even though both Kottayam and Quilon are in the southern region of Kerala. The low strength values may be due to any one of the following reasons. Either the trees were of lower age, around 20 y or less, or they had such fast growth resulting in low strength values. Sanyal

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and Dangwal (1983) tested the material which had been kiln-dried. If the kiln-drying had been carried out properly, there would be no reason for the kiln-drying to have reduced the strength values so drastically. It is probable that the kiln-drying was not done according to the right schedule. One more possibility is that the tested material had tension wood present in them. In this uncertainty, it was decided to confirm whether strength values of rubberwood, after reaching a maximum around the age of 20 years, declined afterwards. Also, in Kerala rubber trees are generally felled at the age of 35 *y* for replanting. So, this study was conducted to evaluate the strength properties of wood from 35-*y*-old trees from central Kerala.

Material and methods

As the general practice in Kerala is to fell rubber trees at the age of around 35 *y* for replanting, the study material was obtained from a 35-*y*-old plantation which was being clearfelled. The plantation was located near Trichur in the central region of Kerala (76° 16' E longitude and 10° 31' latitude). The plantation, in general, was undulating with gentle slopes and good drainage. Stones and boulders were present on the surface but sheet rocks were absent. The soil of the area varied from reddish brown to yellowish red in colour, very gravelly loamy sand to gravelly sandy loam in texture, granular to massive in structure and with low organic matter.

Trees selected had girth varying from 80 to 100 *cm*. These trees were raised from bud material and not seeds. The logs were immediately sawn into sizes of 3 × 3 × 30 *cm* and air-dried. From the air-dried material six clear specimens, one from each tree, were selected randomly and re-sized to 2 × 2 × 30 *cm* for static bending test and 2 × 2 × 8 *cm* for compression test.

Static bending test and compression parallel to grain test were carried out in a 'Amsler' Universal Testing Machine. Tests were limited to these two as modulus of rupture (MOR), modulus of elasticity (MOE) and maximum crushing stress (MCS) will give a fairly good indication of the utilization potential. Density was determined by the water displacement method and moisture content by oven drying. The tests were done as per the Indian Standard IS: 1708 (Bureau of Indian Standards 1986). All the strength data were corrected to 12% moisture content for comparison purposes, using the formula suggested by Sekhar and Rajput (1968).

Results and discussion

Table (1) reports the mean, range and CV values of fibre stress at the limit of proportionality (FSLP), MOR, MOE, MCS and density of the air-dried wood. It can be seen that rubberwood from the 35-*y*-old trees grown in the central region of Kerala had a mean MOR of 98.4 $N\,mm^{-2}$, MOE of 15.7 $kN\,mm^{-2}$, MCS of 52.7 $N\,mm^{-2}$ and density of 580 $kg\,m^{-3}$. Even though wide variation was noticed in the FSLP and MOE values, this was not so in the case of MOR, MCS and density values. Coefficients of variation of MOR, MCS and density were very low compared to the values suggested in the literature (USFPL 1974). In the case of MOR, CV was only 4.2% (against suggested value of 16%), MCS, 9.5% (against 18%) and density, 5.5% (against 10%). Coefficient of variation of FSLP (24.4%) was marginally higher than the suggested value of 22%. This clearly shows that the sample size was adequate.

Table 1. Strength properties of air-dried (12% MC) rubberwood

Property	Mean *	Range	CV (%)
FSLP, $N\ mm^{-2}$	60.45	41.70 - 80.64	24.4
MOR, $N\ m^{-2}$	98.35	91.22 - 102.20	4.2
MOE, $kN\ m^{-2}$	15.67	9.36 - 25.11	37.8
MCS, $N\ mm^{-2}$	52.73	43.23 - 55.95	3.5
Density, $kg\ m^{-3}$	580.0	536 - 624	5.5

* Mean of 6 samples and in the case of density, of 12 samples.

Table (2) shows that the values of the mechanical properties obtained in the present study are higher than those of other studies reported from India and Malaysia (Sanyal & Dangwal 1981, MTIB 1982, Shukla & Mohan Lal 1985). Comparing the present study either with that of Sanyal and Dangwal (1983), or that of Shukla and Mohan Lal (1985), it is seen that strength values increase with age. In rapid-grown *Eucalyptus*, Jain (1969) found that there was no such difference in strength values between wood of 13- to 14-y-old trees and that of 20- to 21-y-old trees, which means that fast growing trees attain maximum strength much earlier than trees growing in natural forests. Rubber trees (*Hevea brasiliensis*) also have fairly fast growth. However, in *Hevea*, strength values continue to increase even up to 35 years. This has to be confirmed by testing wood from different age trees growing in the same locality.

Table 2. Physical and mechancial properties of dried rubberwood from different places

Location	Moisture content, %	Density $kg\ m^{-3}$	MOR $N\ mm^{-2}$	MOE $kN\ mm^{-2}$	MCS $N\ mm^{-2}$	Reference
Malaysia	17.2	550	66.8	9.42	32.9	MTIB (1982)
Kottayam	11.7	562	58.7	6.07	33.1	Sanyal & Dangwal (1983)
Quilon	12.0	557	75.6	8.20	37.4	Shukla & Mohan Lal (1985)
Trichur	12.0	580	98.4	15.67	52.7	Present study

The present study did not give any indication of possible influence of site factors. Whether locality plays a major role in variation in strength values or not can be ascertained only when trees of the usual felling age, that is 35 years, from different localities in Kerala are tested.

There is no strong correlation between density and MOR, and density and MOE. But the correlation coefficient between density and MCS is significant

(Table 3) and nearly 74% variation in MCS can be explained by density alone.

Table 3. Correlation coefficient for the relationship between density and other mechanical properties of air-dried rubberwood

X	Y	R^2
Density	MOR	0.062
Density	MOE	0.538
Density	MCS	0.736

Table (4) compares the physical and mechanical properties of some common timbers of Kerala which are widely utilised for various end-uses. It can be seen that mechanical properties of rubberwood are in the comparable range of most of the conventional timbers.

Table 4. Physical and mechanical properties of some common timber species growing in Kerala (Nazma *et al.* 1981) in comparison with rubberwood

Species	Density *kg m*$^{-3}$	MOR *N mm*$^{-2}$	MOE *kN mm*$^{-2}$	MCS *N mm*$^{-2}$
Tectona grandis (teak)	650	95.9	12.0	53.2
Albizia lebbeck (kokko)	640	88.7	12.3	53.4
Albizia odoratissima (kala siris)	595-1010	143.8	14.5	78.7
Artocarpus heterophyllus (jack)	595	80.6	10.1	49.6
Artocarpus hirsutus (aini)	595	96.9	12.2	61.6
Cocos nucifera (coconut palm)	761	92.7	15.9	57.2
Grevillea robusta (silver oak)	640	63.3	8.3	38.9
Grewia tiliifolia (dhaman)	785	130.2	16.4	70.1
Mangifera indica (mango)	690	90.4	11.2	44.8
Terminalia paniculata (kindal)	785	111.8	14.3	63.9
Xylia xylocarpa (irul)	850	109.8	14.8	71.4
Hevea brasiliensis (rubberwood)*	580	98.4	15.7	52.7

*Data from present study.

It is generally thought that rubberwood is weak. However, this study has shown that rubberwood from 35-*y*-old trees of the central region of Kerala has strength values comparable with those of many structural timbers. This study has indicated that strength values increase with age, and from the utilisation point of view, it is advisable to fell the trees around 35 *y* for replanting.

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