Proceedings of the International Conference for Agricultural Machinery & Process Engineering
October 19-22, 1993, Seoul, Korea

INVESTIGATION OF MECHANICAL PROPERTIES OF RATTAN

by

Dr. ShahNor Basri, PhD, MNES, MIEM
Department of Mechanical and Systems Engineering
Universiti Pertanian Malaysia
43400 Serdang, Selangor
Malaysia

and

Wan Tarmeze Wan Ariffin, BSc
Forest Research Institute, Malaysia

ABSTRACT

Rattan has found various engineering application, especially in furniture industry, however its potential engineering application has not been fully realised because of lack of information of its mechanical properties. It is therefore the objective of this paper is to report some of the recent research work conducted to investigate some of mechanical properties of rattan. The principal tests performed were compression strength parallel to grain in green and dry conditions.

Key Word: Rattan, Properties.

INTRODUCTION

Rattan, a spiny climbing plant belonging to the subfamily *Calamoidease* (Dransfield & Uhl, 1986) is an important forest product in Malaysia. In Peninsular Malaysia alone, there are about 104 species found of which only 20 species are widely exploited (Dransfield, 1979).

Rattan are pliable and have been used mainly for furniture and basketry products. In Malaysia, rattan furniture industry is becoming increasingly important as its export value has increased about 27-fold (from RM 2.8 million to RM 75.5 million) during the past decade 1980-1991 (Anon, 1992).

However, regardless of the growing importance of rattan products, the material's basic properties such as physical and mechanical strength characteristics are not fully known yet. Further knowledge regarding these is important as it would allow a better utilization of the material and the manufacture of higher quality products.

The objective of the study was to investigate the basic physical and mechancial properties of *Calamus manan Miq.* (local name "Rotan manau") in its most common application condition, i.e. boiled, air-dried and peeled. In addition, effects of peeling and moisture content on the compressive strength of the rattan were also studied.

MATERIAL AND METHOD

Calamus manan, the most commercially available rattan species was used in the study. The tests were divided into following three phases:

i) Investigation of basic physical and mechanical properties,
ii) Study on effect of pelling on compressive strength, and
iii) Study on effect of moisture content (MC) on the strength.

For test (i), air-dried (13 - 15% MC) and peeled rattan samples of size 32 mm in diameter were randomly obtained from a local supplier. The samples were tested for compressive strength, hardness, static bending and shear strength using a Shimadzu Universal Testing Machine. Specific gravity and moisture content of the samples were measured immediately after test. The test procedures adopted for prepared specimens were based on similiar test for timber described in the ASTM D143-83 and BS373 with modification in the sample size (Table 1).

Table 1. The size of the samples for physical and mechanical test

Test	Size (diameter x length) (mm)	Loading rate (mm/min)
Static bending	32 x 450 (Span = 390)	6.60
Compression	32 x 110	0.60
Hardness	32 x 100	6.00
Shear	32 x 40	0.60

For the test (ii), boiled and air-dried (13 - 15% MC) rattan samples of size 34-40 mm in diameter with and without skin (10% peeled) were tested in compression. Peeling (removing the dense outer layer) process was done on a lathe machine.

For test (iii), raw rattan samples of size 31-35 mm in diameter in green and air-dried conditons were tested in compression.

RESULTS AND DISCUSSION

Physical and mechanical properties of the boiled, peeled and air-dried rattan are summarized in Table 2. The regression analyses between the specific gravity and mechanical properties of the rattan are given in Table 3. The effects of outer-layer removing and moisture content of rattan on its compressive strength are shown in Table 4 and Table 5, respectively. Some mechanical properties of selected Malaysian timber tested at a similar specific gravity (0.50-0.52) as the rattan are shown in Table 6 for comparison purposes.

The results (Table 2) show that most of the rattan strength values were lower than that of Malaysian timbers (Table 6). The percentage of inferiority varies from 30% in shear to 89% in the modulus of elasticity. The results also show that rattan has a much lower modulus of elasticity than that of wood. This would be one of the reasons that cause rattan furniture structures to be much less rigid as compared to the wood furniture of similar amount of materials. This low modulus of elasticity would be considered as the major disadvantage and challenge especially when to mass produce simple rattan chair that use least amount of materials.

Table 2. Summary of physical and mechanical properties of *Calamus manan* (boiled, air-dried and peeled to 32 mm in diameter)

					Static bending			
No. of samples	SG	Compress ∥ (Mpa)	Hardness ⊥ (kN)	Hardness ∥ (kN)	Stresspl (MPa)	MOE (10^3 MPa)	MOR (MPa)	Shear (MPa)
14	0.512	18.47	3.14	4.16	14.6	2.19	49.8	8.07

Note: SG = Specific Gravity; Compress = compression; ∥ = parallel to grain; ⊥ = perpendicular to grain; Stresspl = stress at proportional limit; MOE = modulus of elasticity; MOR = modulus of rupture. Notations follow for for Tables 3, 4, 5, & 6.

Table 3. **Regression analysis between specific gravity and mechanical properties of *Calamus manan* (boiled, air-dried and peeled to 32 mm in diameter)**

Properties	Linear Regression	Coeff. of Determination, R^2
Compression ‖	= -3.05 + 46.90 (SG)	0.91
Hardness ⊥	= -2.71 + 12.11 (SG)	0.97
Hardness ‖	= -4.44 + 17.78 (SG)	0.98
Stresspl	= -11.90 + 49.31 (SG)	0.70
MOE	= -0.26 + 4.56 (SG)	0.73
MOR	= -48.9 + 178.7 (SG)	0.46
Shear	= 1.37 + 12.48 (SG)	0.57

Table 4. **Effect of outerlayer removal on compressive strength of *Calamus manan* (boiled, air-dried, 10% peeled to 31-36 mm in diameter)**

Specimen	No. of samples	Compression ‖ (MPa)	SG
Unpeeled	12	21.8	0.525
10% peeled	12	18.8	0.468

Table 5. **Effect of moisture content on compressive strength of *Calamus manan* (raw, 10% peeled to 28-32 mm in diameter)**

Specimen	No. of Sample	Compression ‖ (MPa)	Density (g/cm^3)	MC %
Green	12	16.90	0.811	64
Air dry	12	19.07	0.551	13.5

Linear regression analyses (Table 3) show that most of the mechanical properties were influenced by the specific gravity where the rattan with higher specific gravity showed stronger mechanical properties. This effect could also be seen in Table 4 where peeling of rattan has reduced its specific gravity and consequently the compressive strength. This seems to suggest that peeling of rattan (common practise in rattan furniture industry) should be done carefully to avoid too much reduction in its strength properties.

Table 6. Some average strength value of hardwood at 12 percent moisture content for comparison purposes (Source: Lee *et al*, 1979 and Engku, 1988)

				Static Bending		
Species	SG	Compression ‖ (MPa)	Side hardness (KN)	MOE (1000MPa)	MOR (MPa)	Shear (MPa)
Keledang *(Arrogarpus rigidus)*	0.51	47.5	4.94	12.2	93	12.5
Mempisang *(Monocarpia marginalis)*	0.51	46.0	4.23	13.8	85	8.4
Meranti Tembaga *(Shorea leprosula)*	0.50	41.4	2.94	13.6	75	6.8
Terap *(Parartocarpus trianda)*	0.51	34.8	3.29	12.0	68	9.2
Kedondong *(Santiria laevigata)*	0.52	43.1	4.45	12.1	81	10.9
Average	0.51	42.6	3.97	12.7	80	9.6

Another parameter governing the strength properties of rattan was its moisture content. As shown in Table 5, the rattan of lower moisture content (air-dry) have higher compressive strength than that of the green ones.

CONCLUSION

The study has shown that strength properties of rattan are in general much lower than that of Malaysian timber. The strength properties of rattan are significantly influenced by its specific gravity and moistures content. Peeling of rattan reduces its specific gravity and thus reducing its strength properties. Dry rattan are stronger than the green ones.

AKNOWLEDGEMENTS

The authors wishes to aknowledge the financial supports of the Ministry of Sciences, Technology and Environment under research grant MPKSN No. 50382. The author also aknowledge the help by the staff of FRIM Timber Testing Unit.

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SB/nhar:WP:a:Rattan
1993