COMPARATIVE STUDIES ON THE SUITABILITY OF SELECTED PALMS FOR FLOORING

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Received July 1990

ABD. LATIF MOHMOD & HILMI MD. TAHIR. 1990. Comparative studies on the suitability of selected palms for flooring. The use of selected palms, namely coconut, oil palm, betelnut, manau cane and nibong for flooring were investigated and tests were conducted in accordance to the ASTM D 1037-72a. The common flooring timber used in Malaysia, kempas (*Koompassia malaccensis*) was used for comparison. The results show that while nibong and betelnut palm are superior to kempas, the rest (tested) are inferior and could only be used under light and medium traffic flooring conditions.

Key words: Palm wood - parquetries - wear resistance

Introduction

The use of palm wood for household products, decorative items and especially as flooring material is by no means a new idea (Durant 1940, Bauza 1983, Salita *et al.* 1983, Abd. Latif *et al.* 1987). A study on the use of selected palm trees, namely coconut (*Cocos nucifera*), oil palm (*Elaeis guineensis*), betelnut (*Areca catechu*), manau cane (*Calamus manan*) and nibong (*Oncosperma* spp.) for parquetry, in terms of physical appearance, dimensional stability and equivalent wear resistance, was carried out.

The suitability of palm parquet boards as flooring material is evaluated based on their wear resistance using an abrasion testing machine. The results obtained were analysed and compared with kempas (*Koompassia malaccensis*), the common flooring timber in Malaysia.

Materials and methods

Preparation of test materials

The test boards of coconut, betelnut, nibong and oil palm were mde from the peripheral portion of the respective stem; rattan specimens were produced from the offcuts derived during the making of rattan furniture. Due to the undifferentiated radial and tangential surfaces of monocotyledon plants like palms, the boards with the longitudinal surfaces were used indiscriminately for the test (Abd. Latif *et al.* 1987, Abd. Latif *et al.* 1990a).

The preparation of longitudinal surface blocks was adapted from Abd. Latif *et al.* (1987). Palm strips of about 12.5 *cm* length were cut and sliced to 2.5 × 12.5 × 0.5 *cm* dimensions and glued on top of a piece of 2500 cm^2 plywood. Planing and sanding were then applied to the boards to give a better appearance. The test parquet specimens were then cut to 76 × 51 × 13 *mm* size. Twenty test specimens from each palm were used. Before any test could be performed, each test specimen was conditioned in a conditioning chamber at 27.5°*C* and 65% relative humidity to a moisture content of about 12%.

Testing procedure

The test procedure adopted in this study is similar to the American Standard D 1037-72a, on the abrasive resistance conducted by the United States Navy Wear Tester (Anonymous 1977) using 80 grit aluminium oxide.

The test specimens were mounted onto the holder using epoxy adhesive. A dead weight of 4.5 *kg* was applied uniformly on top of the holder. The wear on the specimen was obtained by rubbing against a revolving disk covered with the abrasive medium.

The holder revolved clockwise at a constant speed of 32.5 rpm in the same direction. The specimen was lifted at a distance of 1.6 *mm* and dropped back into contact with the revolving disk twice during each revolution of the holder. The abrasive medium was applied through a mechanically agitated hopper at a rate of 46 $g\ min^{-1}$ and changed after every 2000 revolutions.

The weight loss of the specimen was calculated after each 100 revolutions of the revolving disk for a total of 1000 revolutions.

Results and discussion

The results on loss in weight after every 100 revolutions and percentage of weight loss after 1000 revolutions of the disk with respect to the longitudinal surfaces subjected to abrasion for all the palm species are presented in Figure 1. Summary of analyses of variance on the weight loss are shown in Table 1. The average density, shear, compression along the grain, modulus of elasticity (MOE), modulus of rupture (MOR), hardness, fibre length and fibre diameter of the palm species tested are shown in Table 2.

When the weight loss was plotted against the number of revolutions, a linear relationship was obtained for all the species at longitudinal surfaces abraded (Figure 1).

With respect to the initial points on the graphs which were found to be irregular, they were perhaps caused by the uneven surface of the specimens initially.

The percentage of weight loss after 1000 revolutions was found to be as follows: 0.96% - coconut wood, 0.84% - oil palm, 0.49% - nibong, 0.31% - betelnut and 0.96% - manau cane, compared to approximately 0.22, 0.82 and 0.95% respectively for the end grain, tangential and radial surfaces of kempas

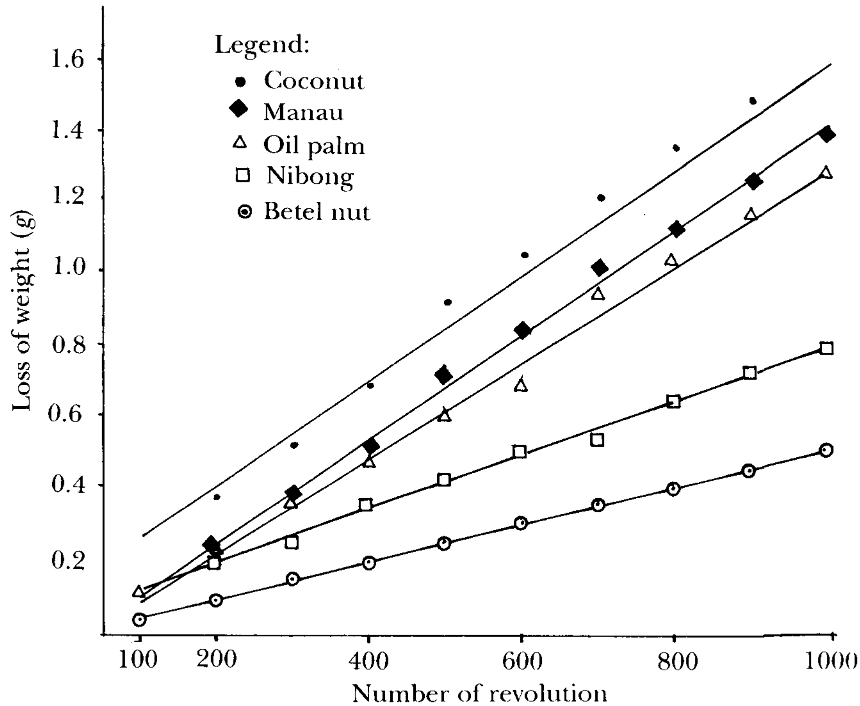

Figure 1. Amount of wear on each surface after each 100 revolutions of disk (*g*)

Table 1. Summary of analyses of variance on the weight loss of palms by abrasion test

Source of variation	Df	Mean square and statistical significance
Species	4	1.27296**
Revolution	9	1.0806**
Species * revolution	36	0.0592 ns

(ns - not significant at 95% probability level; **: significant at 99% probability level)

Table 2. The properties of palm species related to the abrasive test

Species	Density ($kg\ m^3$)	Shear (*MPa*)	Compression parallel (*MPa*)	MOE (*MPa*)	MOR (*MPa*)	Hardness (*N*)	Fibre length (*mm*)	Fibre diameter (μm)
Coconut	870	7.20	46.10	6480	40.53	4230	1.94	18.00 1
Oil palm	584	2.10	17.80	5505	32.90	2450	1.76	32.50 2
Nibong	1103	7.15	62.27	11620	95.63	6058	2.07	37.95
Betelnut	876	7.40	39.85	14369	98.79	6332	2.41	54.66
Manau	750	1.72	27.06	3700	58.61	4397	1.63	21.80 3

Source: 1 Tamolang *et al.* (1958); 2 Killmann & Lim (1985); 3 Abd. Latif *et al.* (1987)

(Mohd. Shukari 1983). When the values are compared, the average wear in kempas at both tangential and radial surfaces are equal to coconut, oil palm and manau, but betelnut and nibong wore only by half. However, the value for kempas at end grain was low, and betelnut and nibong were twice that value.

Further statistical analyses were done to study the effect of disk revolutions on the amount of weight loss of the parquet boards (Table 3). The analyses indicate that the loss of weight of the test specimen boards are highly significant with the number of revolutions. The analyses further revealed that the percentage of weight loss per revolution is significantly low in betelnut and nibong (respective gradient of 0.0502 and 0.0515) compared to the rest of the tested species.

Lim (1983) and Mohd. Shukari (1983) considered kempas as suitable for heavy traffic flooring but preferably for medium traffic conditions. Abd. Latif *et al.* (1989) suggested that manau could be used for light and medium traffic flooring. The criteria used include the abrasive resistance, density, strength group and texture of material.

Table 3. Correlation between loss of weight (*g*) and disk revolution

Species	Linear regression equations	Correlation coefficient	F
Coconut	Weight loss = 0.0323 + 0.1621 (revolution)	0.8333	40.9263**
Oil palm	Weight loss = -0.0387 + 0.1318 (revolution)	0.8699	56.0390**
Nibong	Weight loss = 0.2068 + 0.0515 (revolution)	0.6272	11.6716*
Betelnut	Weight loss = -6.533E-3 + 0.0502 (revolution)	0.9458	152.6784**
Manau	Weight loss = -0.047 + 0.1459 (revolution)	0.9825	502.175**

(* significant at 95% probability level; ** significant at 99% probability level)

In comparing the physical and strength properties of the palm species with kempas, it was found that the density of all the specimens except oil palm is higher than the limit of 650 $kg\ m^{-3}$ (manau) or 800 $kg\ m^{-3}$ (coconut, betelnut and nibong) to be classified under the respective medium and heavy traffic conditions as specified by Lim (1983). In the case of shear, coconut, betelnut and nibong are significantly higher than the limit of 3 *MPa* to be used for heavy traffic flooring while both the manau and oil palm are slightly below or equal for medium traffic flooring. With regard to the criteria of compression parallel to grain, all the species tested well exceeded the limit of 17 *MPa* required for heavy and medium flooring. With these comparable strength properties, supported by its high wear resistance and hardness, betelnut and nibong could be considered suitable for heavy flooring, while coconut, oil palm and manau for light and medium traffic flooring conditions.

The anatomical structure such as size of pores, pore distribution and arrangement, and the fibre structure which influence resistance to wear (Youngquist & Munthe 1948) should be considered in the assessment of palm flooring. Parameswaran and Liese (1985) found that palm fibres, especially rattan, are provided with thick secondary polylamellate walls which are believed to increase the efficacy of the elastomechanical properties of the stem. Since anatomical features play significant role in development of strength properties of bamboo, a monocotyledon (Espiloy 1987, Widjaja & Risyad 1987, Abd. Latif *et al.* 1990b), they could also influence the resistance of palm for flooring. From the anatomical studies, nibong and betelnut were found to have longer and thicker fibre when compared to the other palm species. This may thus explain why both nibong and betelnut palm have higher resistance against wear. It was also observed that the fibre length for all the palm species was longer than the 1.0 to 1.6 *mm* of kempas (Grant 1958).

Conclusion

Betelnut and nibong are found to have higher abrasive resistance than coconut, oil palm and manau cane due to their thicker fibre walls and superior strength properties. The results obtained from this study show that both betelnut and nibong are about twice superior, while coconut, oil palm and manau cane are approximately equal or slightly inferior in abrasive resistance than the radial and tangential surfaces of kempas respectively.

Acknowledgements

We would like to thank Achmad Sulthoni of Gadjah Mada University, Jogjakarta, Indonesia and W.C. Wong of Forest Research Institute Malaysia for their constructive comments on the paper. Thanks are also due to Mohd. Rashid Samad, Hamdan Husain, Mohd. Ehlas Hassan and others who assisted in this study.

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