PROPERTIES AND USES OF COCONUT WOOD

M. A. Sattar

This work includes the determination of moisture content, bulk density, shrinkage, drying properties and strength properties of Coconut wood. It also incorporates some of the findings of other countries. All the properties indicate that Coconut wood offers an excellent possibility of its use in round form as well as in converted form. The strength values of Coconut wood suggest that it can provide necessary materials for low cost housing. The lower part of the bole may be used for making furniture and utility items, while both sawn and round wood may be employed for transmission poles and posts. Thus Coconut wood may serve as an alternative to wood-raw material.

INTRODUCTION

Coconut palm (*Cocos nucifera*) is one of the most important economic trees in the tropical countries. Coconut is planted on a large scale along the coastal belt of Bangladesh, particularly, in the districts of Noakhali, Patuakhali, Barisal and Khulna. According to the national survey of 1980–81, there are about 23.4 million mature and immature Coconut trees in the village groves (Anon. 1982), Many of these trees will be overmature in the next few years and will cross the prime age for the profitable production of nuts. These trees will need replacement by newer and more productive varieties. This necessitates proper utilization of overmature Coconut stems in order to make the felling and replanting operations economically viable. This will prove to be a further step in finding materials alternative to conventional wood.

Extensive investigations on different aspects of Coconut wood have been undertaken in the Philippines. Fiji, New Zealand and other countries (Alston 1973, Alston 1977, Anon. 1976, Anon. 1979, Bergseng 1977, Kininmonth 1977, Kininmonth 1979, Leather 1972, Lauricio and Tamolang 1976, Mosteiro and Siriban 1979, Richolson 1979, Tamolang 1976). In those studies, many important properties of Coconut wood have been determined and possible utilization have been suggested. No information, whatsoever, is available on the Coconut wood grown in Bangladesh. Work has, therefore, been done at the Forest Research Institute

(FRI), Chittagong on the wood of two mature Coconut trees procured from Barisal. The present report incorporates the results of this work along with some of the findings of other countries in order to furnish a basis for effective and economic utilization.

ANATOMICAL CHARACTERS OF COCONUT WOOD

Coconut palm wood has a structure different from that of traditional wood. The stem is comprised of two distinct portions, the central zone and the outer periphery. The vascular bundles are all scattered in the central zone in the midst of softer tissues. Thus the central wood is softer and lighter. The vascular strands become more concentrated towards the peripheral areas, producing an outer band of much harder and denser tissues of about 5.0 cm width. In this outer ring, the vascular strands are generally darker in colour than the ground tissue giving longitudinal surface a quill-like appearance. This contrast is less striking in material from upper portions of the stem (Alston 1973, Tamilson 1961, Richelson 1979).

PROPERTIES OF COCONUT WOOD

Physical properties

Moisture content : The moisture content was found to be highly variable among the different portions of Coconut wood. The core wood contains substantially higher moisture than the wood in the periphery. It was observed that in freshly felled coconut palm 120 to 150% and 270 to 300% moisture were present in the peripheral and the core wood, respectively.

Shrinkage and specific gravity : Shrinkage properties did not show consistent difference between the tangential and radial directions of Coconut wood. This is due to the fact that, unlike the conventional wood, the fibres in coconut wood are not arranged in a way to form annual rings. The specimens were, therefore, prepared without taking the directions into consideration. The shrinkage values were determined by drying the wood from green condition to 12% moisture content level. Specific gravity values based on airdry volume and ovendry weight were found out from separate sets of specimens. These are presented in Table 1.

Mechanical properties

The strength properties of Coconut wood of hard peripheral layer was determined in accordance with ASTM specifications. The wood of the central zone was found to be very soft and so no attempt was made to determine its strength properties. The strength values of Bangladeshi and Philippine Coconut wood (Lauricio and Tamolang 1976) compared with indigenous Teak (*Tectona grandis*) (Yakub *et al* 1976) are shown in Table 2.

Table 1. Shrinkage and specific gravity values of Coconut wood

Position of wood	Specific gravity Airdry volume		Weight (airdry)	Shrinkage from green to 12% m. c. (%)	
	Range	Average	kg/m³	Range	Average
Peripheral layer	0.45–0.68	0.56	627.2	2.4–3.6	3.1
Core	0.20–0.44	0.30	336.0	1.8–3.0	2.4

Table 2. Comparative strength properties of Coconut and Teak wood

	Properties	Bangladeshi Coconut (Airdry) condition)	Philippine Coconut (Green condition)	Teak (Air dry condition)
1.	Specific gravity	0.56	0.53	0.59
2.	Static bending			
	(a) Stress at prop. limit (kg/cm²)	406	310	628
	(b) Modulus of rupture (kg/cm²)	575	527	1008
	(c) Modulus of elasticity (1000 kg/cm²)	79	74	131
3.	Compression parallel to grain			
	(a) Stress at prop. limit (kg/cm²)	233	169	374
	(b) Maximum crushing strength (kg/cm²)	316	294	513
4.	Compression perpendicular to grain			
	Stress at prop. limit (kg/cm²)	89	38	119
5.	Shear parallel to grain			
	Maximum shearing stress (kg/cm)	99	53	106
6.	Hardness			
	(a) Side (kg)	481	524	550
	(b) End (kg)	435	488	532
7.	Nail withdrawal			
	(a) Side (kg)	116	–	80
	(b) End (kg)	95	–	68
8.	Tension perpendicular to grain (kg/cm²)	21	–	37
9.	Cleavage to cause splitting (kg/cm²)	18	–	28
10.	Toughness (kg/specimen)	179	–	184

The strength properties of Philippine Coconut wood compare favourably with many of the Philippine commercial timbers, especially Mahogany (Lauricio and Tamolang 1976). Bangladeshi Coconut wood, though possesses lower strengths than those of indigenous Teak, compares favourably with Philippine Coconut wood.

Sawing

In conversion of logs, sawing proves to be one of the difficult aspects in the utilizarion of Coconut wood. This is probably because of its structure rather than the presence of excessive abrasive components, such as silica (Richolson 1979). Reconversion with bandsaws and circular saws are equally difficult as they get blunted rapidly. The introduction of tungsten carbide tipped blades, which can withstand high temperature developed during cutting, seems to be effective. These saws, however, require expensive precision maintenance and highly skilled saw doctors. The use of inserted teeth saws, which are hardened with some proprietary materials such as stellite, appears to be successful in band saws. Such teeth require equipment for resharpening and can be removed and replaced when worn out (Tamolang 1976, Alston 1973, Meadows 1979). It is claimed that stellite tipped teeth can perform eight times better than ordinary steel teeth in sawing Coconut wood (Richolson 1979).

Machining

Planing : Density variations influence the quality of machined surfaces of Coconut wood. A good planed surface can be obtained in the hard timber from the peripheral zones with occasional chipping only. In planing material from the softer portions, there is a tendency for the vascular bundles to lift producing a fuzzy grain (Alston 1973).

Turning : The hard portions of the Coconut wood cannot be turned for ornamental work due to chipping occuring in the process of turning. With less elaborate profiles, results are better and a surface is obtained which can be sanded to a satisfactory finish. Low density material has poor turning properties resulting in rough, torn and chipped surface which requires an excessive amount of further sanding (Alston 1973).

Seasoning

Coconut timber can be seasoned satisfactorily by both air and kiln drying methods. It is, however, necessary that timber should be segregated into two classes, hardwood and soft wood, before stacking for drying in kilns. These classes of timber should be dried separately in order to avoid drying degrades. For air drying, timber should be stacked outside or under a shed during the winter months, but drying should be done under cover during the monsoon. The comparative drying times of 2.54 cm Coconut planks at different countries are given in Table 3.

The wood of the hard outer layer does not pose any difficulty in seasoning. Distortion and collapse may result in wood of the core region if proper care is not taken. A mild schedule should be employed for kiln drying to avoid drying degrades. Kiln schedule D (Sattar 1980) has been found suitable for drying Bangladeshi Coconut timber.

Table 3. Comparative drying times of Coconut timber

Methods of drying	Drying times (days) from green to moisture content of			
	14–16% at FRI Chittagong	16–17% at Philippine Research Centre Zamboanga (Meadows 1979)	17–19% at FORPRIDECOM, Laguna, Philippines (Casin & Tamolang 1976)	16% at Dept. For, Suva, Fiji (Alston 1973)
Air drying	50–55	60	68	119
Kiln drying	6–7 (12% m. c.)	–	6 (10% m. c.)	–

Preservation

Coconut wood is not naturally resistant to fungi when it remains in contact with ground or is exposed to the weather. In round logs, decay usually occurs first in the central layer. If wood is kept dry during use, it does not get attacked by insects. (Richolson 1979).

Seasoned timber is amenable to pressure treatment and adequate retention is obtained with CCA preservative (Alston 1973). Round woods are also found to be almost completely penetrated with creosote by (a) boiling under vacuum followed by full-cell process, and (b) steaming and vacuum treatment, foll-owed by the full–cell process (Mosteiro and Siriban 1979).

UTILIZABLE COCONUT WOOD

The stem of the Coconut palm may be divided into unusable and usable parts according to the structure and quality of wood. The upper part of the stem cannot be used for any purpose except for fuel due to high moisture content and very low density, and this is designated as unusable part. However, a portion of it may find use in pulping. The upper portion of the usuable part has also low density and possesses properties which are unsuitable for conversion into sawn timber. This portion of the stem can be used for charcoal production. The potential of Coconut wood for sawn timber is thus restricted to the lower portion of the stem which also yields high density wood and low density wood. The recovery of high density and low density timber varies with the log size and age, but on average for 80 years old stands, Jensen and Killmann (1979) estimated the proportional yields as follow for the usable portion :

High density wood = 50 – 60%

Low density wood = 40 – 50%

USE OF COCONUT WOOD

The usable stem is millable timber and can be employed for several purposes– construction, furniture, transmission poles, fence post, charcoal and a host of other uses.

Construction : In Philippines the hard outer layer is used as house walls and flooring. The soft core is used as ceiling and window jalousies. Trusses and internal members can be made from medium density materials (Tamolang 1976). It is used for adzed rafters in Srilanka. In India and Taiwan, short length stocks are used for different constructional purposes (Alston 1973).

It is reported that the absence of knots enhances the possibility of laminating sawn Coconut timber into attractive structural members to meet the modern architectural designs (Richolson 1979).

Furniture : The reddish brown colour and quill-like appearance of the vascular bundles in the high density wood can advantageously be utilized for the production of furniture such as chair, table, wall cabinet, side board, rack, etc. The heavy weight, however, may impose some limitations on the size of the furniture. This problem can be overcome by using Coconut wood in framing and using lighter wood or laminated plywood in other parts. There are reports of using Coconut wood for furniture in various countries (Alston 1973, Richolson 1979, Tamolang 1976).

Utility items : The structure of Coconut wood makes the harder material suitable for a wide range of utility items. The interlocking grain makes the wood ideal for manufacture of tool handles with complex shapes such as axes, paint brushes and hammers. Wooden bowls and boards can be conveniently made by carving. The wood can also be used in a range of rod forms from broom-sticks to surveying staffs (Meadows 1979).

Novelty items : Coconut wood is found suitable for the production of a variety of novelty items. In Philippines, Fiji and other countries novelties like ash tray, glass holder, candle holder, fancy cups, policeman's night stick, assorted walking sticks and many curios have been successfully made from Coconut wood (Alston 1973, Tamolang 1976).

Poles and posts : Round and sawn trunks can be used for transmission poles and fence posts provided these are properly treated with suitable preservatives. Service tests in this regard are underway in the Philippines and other countries (Tamolang 1976).

Charcoal and briquetting : Good quality charcoal can be produced from Coconut trunk for domestic use at an average yield of 25%, based on ovendry weight of the trunk (Tamolang 1976). This charcoal is comparatively soft and light in weight. For fuel purposes, the charcoal must be converted into briquettes to increase the strength and density. Briquettes produced in the Philippines from Coconut charcoal have good crushing strength and burning properties.

Other uses : One of the multiple uses of Coconut stem is pulping. Tamolang (1976) has reported that Coconut stem can be successfully pulped by kraft process which gives a yield of 42.8%. The strength properties of paper are acceptable. But Sudo (1980) in his study, has found that all parts of Coconut stem are not suitable

for pulp. The first 3 m stem from the top may be used for the production of good pulp.

CONCLUSION

The properties of Coconut wood offer a great deal of potential uses both in round form and in converted form. The strength values of Coconut wood suggest that it can provide the necessary materials for lowcost housing. The upper part of the stem, which is unsuitable for any use except as fuel, may be conveniently used for pulping. The lower part of sawn Coconut wood can be used for making furniture, utility and novelty items, while both sawn and round wood can be employed for transmission pole, fence post, etc. In view of the diminishing trend of wood-raw material and increasing demand for timber, Coconut wood, with proper research and development may serve as an alternative renewable source of raw materials.

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M. A. Sattar, Divisional Officer, Forest Research Institute, Chittagong, Bangladesh