Research Note: Cocowood Properties

This research note provides an overview of the physical, mechanical and chemical properties of wood and veneer recovered from the harvested stem of the coconut palm (*Coco nucifera*). It is a development of the Cocowood project note: 'Properties and processing facts for coconut wood' available at cocowood.net. The stem fibre of the coconut palm is not a true wood. As a monocot (grass), the stem's vascular structure is largely different to that found in traditional timber. The stem has a high density zone towards the periphery while the inner zone is much lower in density. Material from the outer, higher density section has properties similar to many hardwood timbers and boards sawn from it can be suitable for various traditional products including high-value flooring. The stem can also be peeled with the density of the recovered veneer reducing towards the centre of the log. The innermost core and the outlying bark of the coconut stem have low density and may be used for by-products such as composting, wood chips and insulation.

Introduction

This research note gives an overview of the properties of wood and veneer produced from the coconut palm (*Cocos nucifera*). The properties of coconut wood are shown in Table 1. Important aspects include:

Hardness - Coconut palm fibre or 'wood' density decreases towards the centre of the stem and with height. The highest density fibre occurs around the outer periphery of the stem and is suitable for many end-uses requiring a hard 'wood'. The inner core can be very low density.

Appearance - The colour of seasoned coconut wood ranges from medium to dark brown with prominent, darker, quill-like streaks for high-density outer material to light and pale brown for lower density inner material.

Durability - Tested, untreated cocowood has limited natural durability, suggesting it cannot be used in weather-exposed conditions.[f] However, above-ground durability greater than 10 years has been observed for higher density cocowood sawn boards.

High density, dry cocowood is not susceptible to the *Lyctus* beetle and is suitable for use in fully protected applications. Untreated cocowood is not resistant to termite attack.

Figure 1: Production line for CocoVeneer

Figure 2: Coconut log disk and veneer illustrating the concentration of vascular bundles on the log's perimeter

Using Coconut Stems

Coconut stems can be used in the round-form, sawn into board, or peeled into veneer. The outer high-density coconut wood can be used for flooring, furniture, joinery, panelling, pallets, plywood and decorative veneers, utility poles (preservative treated) and feature posts. The lower density material can be used in handicrafts, turnery, insulation, charcoal and firewood, or chipped as a base for compost or a potting substrate for plants.

Processing Coconut Wood and Veneer

Sawing - Cocowood has a high mineral content and large variation in grain angle (caused by the vascular bundle structure) so sharp, specialised tools are needed. High speed steel blades or Stellite-tipped blades and regular sharpening are recommended for breaking down the logs.

Peeling – Heated coconut logs can be rotary peeled into veneer using a spindleless lathe. Rotary peeling produces a continuous thin ribbon of CocoVeneer that ranges between 2.5-6.0 mm in thickness.

Stain-prevention - Freshly sawn boards or veneer are prone to mould and staining and should be processed rapidly after harvest. An appropriate anti-stain dip may be used if required.

Drying - Green boards and veneer have high moisture content and must be processed quickly to avoid deterioration caused by pests and staining.

Cocowood boards can be kiln-dried at 60-65° (dry bulb) over 10-14 days, depending on the equipment. The required moisture content for Australian and European markets is 9-14% and 7-11% respectively.

Grading - Key grading parameters of sawn boards for flooring are density (hardness) and straightness (limited spring, twist or bow). The recommended minimum density for flooring is 700kg/m^3 (Janka hardness threshold >7kN) for boards. Density can

be graded visually (with limitations), using piece weight, vascular bundle patterns and colour as a broad indicator.

Machining - Tungsten-carbide tool edges give the best results at feed-speeds of 12m/min. At higher speeds Stellite knives give a better result. Lower feed speeds are recommended for moulding boards because the risk of torn grain and soft tissue roughness is greater at high feed-speeds.

Sanding - Cocowood can be sanded to a smooth finish at a range of speeds with the best results achieved at 12m/min compared with 18m/min.

Table 1. Physical, mechanical and chemical properties of the coconut palm (*Cocos nucifera*)

Physical Properties (units)	**Range = low-high density fibre**
Density – basic (kg/m^3)	100-1020 [a]
Density – air dry (kg/m^3)	200-1170 [a]
Density for flooring products (Janka hardness >7) (kg/m^3)	>700 [a]
Specific gravity	0.26-0.59 [d]
Shrinkage: tangential, green to dry (%)	3.0-6.0 [b,c,d]
Shrinkage: radial, green to dry (%)	2.7-7.4 [b,c,d]
Unit shrinkage: tangential	0.05-0.42 I high density: 0.32-0.38 [a]
Unit shrinkage: radial	0.05-0.34 I high density: 0.24-0.3 [a]
Workability	Firm to hard; use sharp tools
Mechanical Properties (units)	
Modulus of elasticity: dry (GPa)	2-25 [a] I high density: 11.4 [c]
Modulus of rupture: dry (GPa)	28-205 [a] I high density: 104 [c]
Maximum crushing strength: dry (MPa)	19-57 [c] I high density: 40 [a]
Janka hardness: dry (kN)	0.7-23.9 [a]
Chemical Properties (units)	
Inorganic pure ash (%)	0.75 (0.25-2.4) [a]
Silica (%)	0.07 (0.01-0.2) [a]
Lignin (%)	25.1 [d]
Holocellulose (%)	66.7 [d]
Pentosans (%)	22.9 [d]
Starch (%)	4.3-4.6 [e] (> 6 m/old; starch reduces with age)
pH	6.2 [e]
Durability, susceptibility to pests and staining	
Natural durability above-ground (averaged over all densities)	Class 4; life expectancy 0-7 years [f]
Natural durability below-ground (averaged over all densities)	Class 4; life expectancy 0-5 years [f]
Susceptibility to *Lyctus*	Not susceptible [b,f]
Termite resistance (averaged over all densities)	Not resistant [a]
Staining	Susceptible to staining [b]

For more detailed information on the properties of cocowood, refer to:

Hopewell & Bailleres (2010) Improving value and marketability of coconut wood. Final report, project ACIAR FST/2004/054. http://aciar.gov.au/publication/fr2012-08

Bailleres *et al*. (2010) Cocowood processing manual. From coconut wood to quality flooring, Department of Employment, Economic Development and Innovation, Brisbane. http://aciar.gov.au/publication/cop015

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