ORIENTED STRAND BOARD FROM RUBBERWOOD AND JUVENILE SENTANG

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Abstract: The effects of wood species namely rubberwood and sentang (*Azadirachta excelsa)* to oriented strand board (OSB) has been investigated. The species were different in term of wood density. Series of OSBs were produced using the selected species at board density of 650 kg/m^3. During the manufacture, a phenol formaldehyde resin with solids content of 54% was used as binder at resin loading of 3, 5 and 7% of the board weight. The boards' properties namely modulus of rupture (MOR), modulus of elasticity (MOE), internal bond (IB) and thickness swelling (TS) were determined according to European Standards. The effects of wood species to the boards' properties were significant. The appropriate parameters of OSB using rubberwood and sentang have been suggested in this study.

Keywords: Oriented strand board, rubberwood, *Azadirachta excelsa*, phenol formaldehyde

INTRODUCTION

Oriented strand board (OSB) is a wood composite panel product made from long, thin and narrow wood strands that are aligned parallel with each other, bonded together under heat and pressure with a water proof resin [21]. The layers on the panel surfaces are generally aligned in the panel-length direction while the core layers are usually cross aligned to the surface layer [7]. There are at least three layers present in an OSB; top surface, core and bottom surface. The core could also be arranged in random position or consists of two or three layers.

Generally, any kind of raw materials could be used for OSB manufacture as long as it able to produce sufficient strand dimension. The raw materials must satisfy the following requirements: availability in adequate quantities, inexpensive, suitable form for board manufacture, and incurring relatively low cost in handling and storage [16]. Wood density has significant influence on product properties and on processing. OSB can be produced using low density of wood material ranging from 350 to 700 kg/m^3 [10].

Rubber tree (*Hevea brasiliensis*) is a native tree of Brazil [9]. The tree was introduced to Malaysia in 1877 when nine seedlings of para rubber planted at the Residency in Kuala Kangsar, Perak [19]. According to Malaysian Rubber Board (LGM), about 1.4 million hectares of land are available as rubber estates (13%) and smallholdings (87%) in year 2000 (8). The wood is pale cream in colour and the air-dried density of the wood range from 560 to 640 kg/m^3 [2].

Sentang (*Azadirachta excelsa*) considered as a plantation tree of great potential as it has been reported to have favourable growth [13]. Planted sentang has the potential to meet the log demand in the future due to its fast growth, favourable growth properties (shade tolerance, hardy, good natural bole form, prolific seed production and ability to regenerate and propagate easily) and timber acceptance quality as well as good economic value [15].

The aim of this study was to evaluate the possibility of producing OSB from rubberwood and juvenile sentang with phenol formaldehyde resin as binder.

MATERIALS AND METHODS

Rubberwood, 25-year-old, was obtained from Malaysian Rubber Board plantation located in Sungai Buluh, Selangor, whereas sentang , 7-year-old, was obtained from the thinning residues at a plantation plot in Merlimau, Melaka. The trees with the diameter about 127 to 152 mm (5 to 6 inch) were selected for this study. The trees were felled and cut to about 1.22 m (4 feet) logs prior to manual debarking. The logs were then cut into billets of about 203 mm (8 inch) long.

During the tree felling, wood disks of about 25.4 mm (1 inch) thick were obtained from top, middle and bottom part of the trees. The samples were labelled and kept in plastic bags to maintain its freshness. The density and moisture content of rubberwood and sentang were determined from the disks according to a standard method published by the Technical Association of the Pulp and Paper Industry (TAPPI) [1].

The flaking process of rubberwood and sentang billets was conducted by using a disc-flaker (model LS 100/27). The machine consists of a steel-disc about 1 meter in diameter rotated using a 7.5 KW electric motor. The disc was equipped with 4 sets of cutting and scoring knives. The machine was set to produce strand at 75 mm long and 0.5 mm thick. The strand normally has width of about 35 mm. The wood strands were dried to moisture content below 5% prior to mixing with resin.

Phenol formaldehyde resin with solids content of 54%, supplied by Dynea Sdn. Bhd., Seremban, was used as binder in the OSB production. The resin content used was at 3, 5, and 7% of the board weight.

The resinated wood strands were consolidated manually in a mould with dimension of 350 by 350 mm. Three layer boards with core to surface ratio of 50:50 and target density of 650 kg/m^3 were produced in this study. The furnished mat was initially pressed using a cold press to bring down the thickness and then pressed in a hot pressing system at a temperature of 180°C for 6 to 7 minutes until the resin cured. Three pieces of board were produced for each variation of board combination. All samples were cut and tested to determine its modulus of rupture (MOR), modulus of elasticity (MOE), internal bond (IB) and thickness swelling (TS) according to the European Standards [3,4,5].

RESULTS AND DISCUSSIONS

The mean moisture content (MC) and density values are shown in Table 1. The MC of rubberwood logs was about 70% which was much higher than the MC of sentang (49%). The values were varied between the specimens. According to Skaar [18], factors such as environment moisture, tree height and growth ring (hardwood and sapwood) could influence the MC of a tree.

The rubberwood and sentang logs have the average density of 573 and 520 kg/m^3 respectively. The lowest density value was recorded at the top portion of the stem, while the highest value was observed at the bottom portion. The wood density of rubberwood and sentang increased from top to the bottom portion of the trees. The wood density was varied even within the same tree and this is supported by Tredelenburg [20,11]. The dissimilarities might be influenced by the factors especially cell sizes, wall thickness and microfibril orientations, varying proportions of particular cell types, growth rate and ring width, knot volume, in situ moisture content and wood chemistry of the tree [11,12,17].

Table 1: Density and moisture content of rubberwood and sentang used in the study

Tree	Height	Moisture Content (%)		Density (kg/m^3)	
		Rubberwood	Sentang	Rubberwood	Sentang
1	Top	70.2	48.9	561	496
	Middle	71.9	39.7	574	523
	Bottom	70.8	51.5	580	548
2	Top	70.0	50.7	554	502
	Middle	69.9	47.4	562	515
	Bottom	64.7	55.0	608	535
Average		69.6	48.9	573	520

The mean values of MOE, MOR, IB and TS of OSB from rubberwood and sentang are shown in Table 2. The values were compared with the European standard requirements for oriented strand board (BS EN 300: 1994) for general purpose boards [6].

The result shows that generally the bending strength of OSB produced from rubberwood and sentang satisfied the standard value of 2500 N/mm^2 for MOE and 18 N/mm^2 for MOR as specified in the standard. The effect of wood species to the MOE and MOR of OSB is not significant (Table 3). Boards produced from rubberwood and sentang recorded significant improvement of MOE and MOR when the resin content was increased from 3 to 5%. However, further addition of the resin content in boards has not improved the properties.

Overall, the boards met the IB requirement for general purpose boards stated in the standard, except for OSB produced from rubberwood at resin content of 5%. The effects of wood species and resin content to the IB were very significant (Table 3). Generally, OSB produced from sentang has better IB strength than rubberwood at target density of 650 kg/m^3. OSB from sentang has higher inter particle bonding pressure since high volume of sentang strands was used in the manufacture due to its low wood density. The IB improved as the resin content of the boards increased. The addition of resin content affects the IB strength by creating extra linkages between the wood strands, thus provide better inter-particle bonding.

Effects of wood species and resin content were significant on the TS of OSB in this study. The TS was less than 25% as required by the standard on OSB produced from rubberwood strands. On the other hand, the swelling exceeded the standard limit on boards from sentang even though the resin content was increased up to 7% of the board weight. High volume of sentang strands in the boards probably caused high degree of hygroscopic response. The utilisation of juvenile wood has significant effect to the swelling of boards when soaked in cold water for 24 hours. The increasing in resin content improved the water resistance of the boards and thereby reducing the swelling as supported by Maloney [14].

Table 2: Properties of oriented strand board (OSB) from rubberwood and sentang at target density of 650 kg/m^3

Species	Resin (%)	MOE (N/mm^2)	MOR (N/mm^2)	IB (N/mm^2)	TS (%)
	3	5849 ^{b}	24.2 ^{b}	0.30 ^{bc}	20.4 ^{d}
Rubberwood	5	6954 ^{a}	41.4 ^{a}	0.22 ^{c}	13.2 ^{e}
	7	6693 ^{a}	42.7 ^{a}	0.40 ^{ab}	11.4 ^{e}
	3	5902 ^{b}	26.1 ^{b}	0.29 ^{bc}	52.8 ^{a}
Sentang	5	6956 ^{a}	38.1 ^{a}	0.38 ^{ab}	45.1 ^{b}
	7	6391 ^{ab}	35.3 ^{a}	0.51 ^{a}	33.6 ^{c}
BSEN 300: 1994[1]		Min. 2500	Min. 18	Min. 0.28	Max. 25

Note: [1] according to Anonymous (1994)

- Means with the same letter within the same column are not significantly different at 5% level of significance
- MOE is modulus of elasticity, MOR is modulus of rupture, IB is internal bond, TS is thickness swelling

Table 3: Analysis of variance (ANOVA) of wood species and resin levels on the properties of rubberwood oriented strand board

Source of variation	Significance level			
	MOE	MOR	IB	TS
Wood species (W)	0.578 ns	0.079 ns	0.005 **	0.000 **
Resin content (R)	0.000 **	0.000 **	0.000 **	0.000 **
W x R	0.565 ns	0.071 ns	0.062 ns	0.000 **

Note: ns indicates no significant difference at $p>0.05$, ** indicates significant difference at $p\leq0.01$
MOE is modulus of elasticity, MOR is modulus of rupture, IB is internal bond, TS is thickness swelling

It is feasible to produce OSB from rubberwoood and sentang using phenol formaldehyde resin as binder. The wood material did not give significant effect to the bending strength but responsible to the IB and TS values of the boards. The increasing in resin content improved the properties of the boards. It is suggested to use more than 7% of phenol formaldehyde resin in boards from juvenile sentang in order to reduce the swelling.

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