Effect of Strand Sizes and Resin on Oriented Strand Board using Kelempayan *(Neolamarckia cadamba)*

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Abstract

Wood based panel has been used in North America since 1985 and has proven themselves in virtually millions of boats, both large and small. In this study, three different sizes of kelempayan wood strand (0.5 cm, 1.0 cm, and 2.0 cm) and different types of resin (UF and PF) were used. The mechanical and physical properties of oriented strand board (OSB) were carried out according to British standard (BS). The mechanical properties test included water absorption (WA) and thickness swelling (TS) and physical properties include internal bonding (IB), Modulus of rupture (MOR) and Modulus of elasticity (MOE).From the result, it showed that 1.0 cm strand size and phenol formaldehyde (PF) showed the higher strength followed by 2.0 cm of strand size and phenol formaldehyde (PF) resin and 0.5 cm of strand size and PF resin. Phenol formaldehyde (PF)exhibits more strength compared to urea formaldehyde (UF) due to its water resistance and better mechanical strength.

***Keywords**: OSB, strand size, resin, kelempayan, mechanical testing and physical testing.*

INTRODUCTION

In Malaysia, Rubber wood is almost exclusively as a raw material for the production of particleboard and medium density fiberboard (MDF) in Malaysia. This wood species is also responsible for the establishment and growth of the Malaysian wood-based in particular MDF, particleboard, wood lamination and furniture. However, due to the demand of rubber wood that keeps increasing, the price is also increasing since the last decade (Paridah*et al.*, 2009).

The increase of the price surely has caused a burden to the furniture product manufacturers. This situation has urged them to find alternative materials that can help them continuously producing furniture products with reasonable cost. Fast growing species such as Kelempayan has been discovered to be a suitable tree species for such purpose. Kelempayan is one of the fast-growing species and possesses good mechanical and physical properties.

Oriented strand board (OSB) is a structural panel made of wood strands that are arranged in cross-oriented layers, similar to plywood. OSB is equivalent to other structural panels such as plywood and fiberboard in its strength and rigidity, panel size and thickness, fastener performance and printability. Since its debut in 1978, OSB has been gaining rapid acceptance as a structural panel. OSB is widely used in residential and commercial construction (Song &Hwang, 1997)

Kelempayan is *Neolamarckiacadamba,* one species occurs in Peninsular Malaysia. Medium sized to large trees to 40 m tall, sometimes 45 m tall, bole straight and

cylindrical, often branchless of up to 25 m and a diameter of up to 100 cm, rarely up to 160 cm, sometimes with buttresses to 2 m tall. Distributed in lowland to mountain forests to 1000 m altitude often by streams and river sand in open sites in the forest. Characteristics and physical properties the sapwood is not well defined from the heartwood, which is white turning to yellow on exposure. Texture is moderately coarse and even. Vessels lines present. Grain is generally straight. The timber is light and soft with an air-dry density of 290 to 465 kg m (Lim*et al*, 2007).

The purpose of this study was to investigate the density, bending properties, internal bonding strength, and thickness swelling (TS) of oriented strand board, which were impregnated with phenol formaldehyde (PF) and urea formaldehyde (UF) resin. Furthermore, properties of the manufactured oriented strand board were also evaluated (Te-Hsin*et al.*, 2005).

MATERIALS AND METHODS

Field Procedure

Kelempayan (*Neolamarckiacadamba)* at HutanSimpan UItm Cawang Pahang in Jengka was harvested. Before cut down the log, the diameter breast height (DBH) of tree were measured. The branches were then removed and cut into eight feet billets and transported to the workshop.

Debarking, cut to length and flaking

Barks were removed manually using a machete. Bark is unwanted in the final product since it will consume a lot of resin and reduces the strength properties of the board. The log then cut into smaller block measuring 8 inches in length and then spilt into four halves. The block is the flaked using a disc flaker into wood strands measuring 114 to 152mm.

Pre-Drying, screening and oven drying

Then, the strands are having a pre-dry session where we left them at the open and dry place at our workshop for a few days before screening process. Then the airdried strands were screened to separate fine and core strands. The screened strands were then dried in an oven at 60-70 C for 24 hours. The moisture content is 6% (less moisture).

Glue mixing and mat forming

The dried strands were proceeding to the blender where was mixed with resins. The amounts of resin based on the board requirement were continuously calculated before mixed in the OSB mixer machine. After that was begin mixing process that was combining the Phenol Formaldehyde and urea formaldehyde resin, strand and particle to be mixed sufficiently.

After blending with resin, the strands was mat formed in a mould where cross-directional layers are formed. The mould OSB is 380 mm x 380 mm. The mat was cold-pressed at 1000 psi for about 1 min to consolidate it before hot pressing. The cold presses were to reduce the danger of disturbance of the graded structure while transferred to the hot press. In hot pressing machine, the mats were placed in the press accommodating one sheet at each time. Layers of cross-directional strands are pressed under intense heat and pressure to form a rigid, dense structural panel of OSB. The Oriented Strands Board mat was first press at 1200 psi for 180 sec, followed by a pressure of 1000 psi for 120 sec and lastly 800 psi for 60 sec. The OSB produced was cooled at room temperature for about 4 to 6 minutes to cool down.. The board was trimmed to obtain the desired length and width and to square the edges. The board also cut to required size based on the testing method.

Method of Testing

To evaluate and determine the properties of the particleboard, several types of testing that were conducted. Europe Standard (EN 310:1993) to test the oriented strand board. The tests are bending strength or modulus of rupture (MOR), modulus of elasticity (MOE), internal bonding (IB), and thickness swelling (TS).

RESULTS AND DISCUSSIONS

Mechanical and Physical Properties

Bending Strength (BS)

Figure 1 shows the MOR values of the OSB produced. Based on result, 1.0 cm PF resin exhibit high strength compare to UF resin which is probably means at that stage show good combination strand and resin and probably the strand also stable because stiffness of board are high compare 0.5 cm and 2.0 cm strand sizes. The 0.5 cm and 2.0 cm PF resin have no significant different but 1.0 cm are show significant different. Based on result, conclude strength of MOR based on their different of strand sizes and resin.

Figure 2 shows that 1.0 cm PF resin have high strength which is probably means at that stage show good combination strand and resin and probably the strand also stable because stiffness of board are high compare 0.5 cm and 2.0 cm strand sizes. It is probably 0.5 cm was too small and 2.0 cm was too big of strand sizes. The 0.5 cm and 2.0 cm have no significant different but 1.0 cm are show significant different .Based on value MOE, conclude of strength of MOE based on their different of strand sizes and resin. Therefore, value of OSB still above the standard requirement.

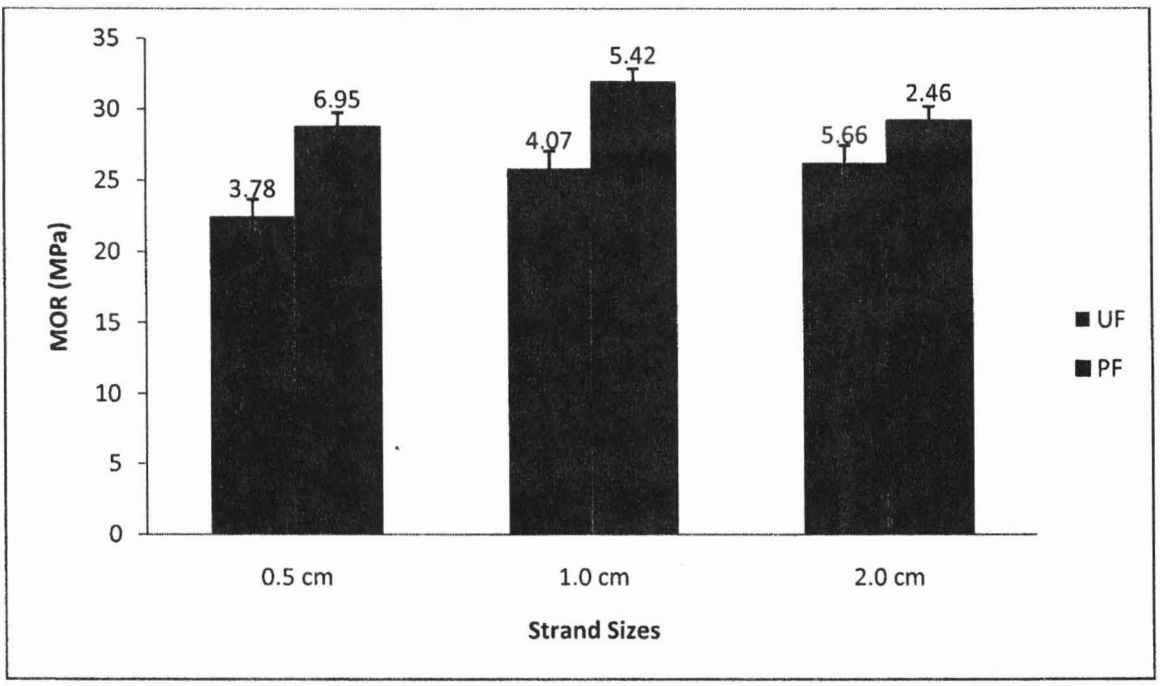

Figure 1: Effect of strand sizes and resin on MOR properties (600 kg/m³) of OSB

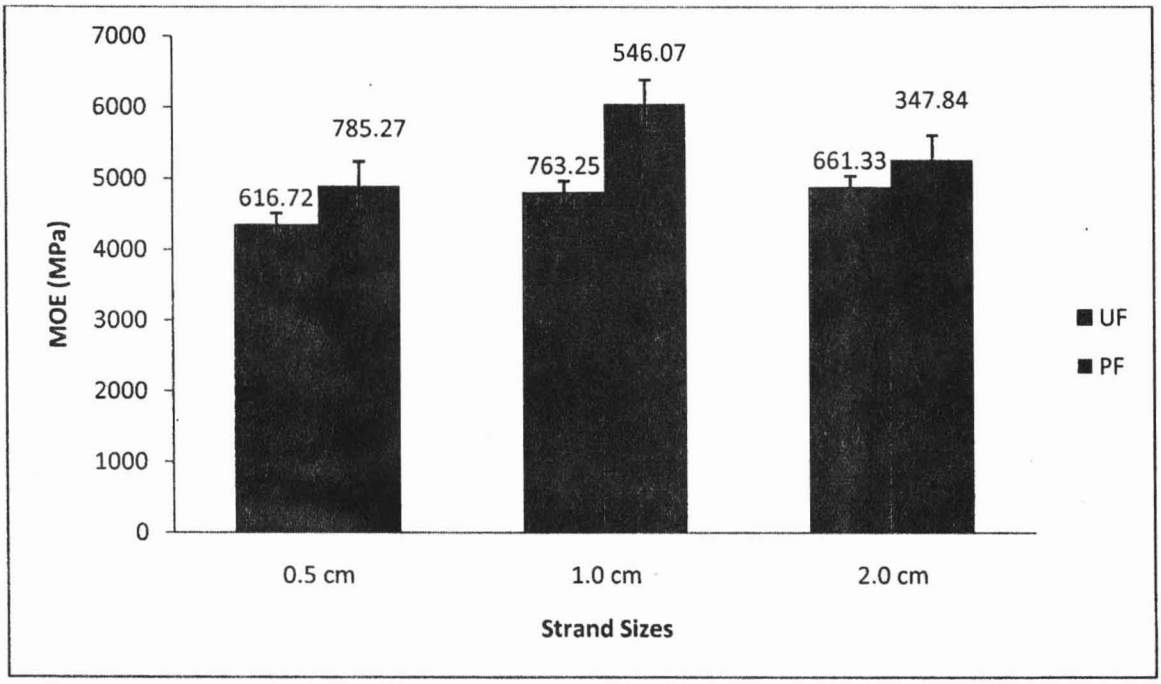

Figure 2: Effect of strand sizes and resin on MOE (600 kg/m³) properties of OSB

Internal Bonding (IB)

Based on results (Figure 3), internal bonding UF resin was not significant between 0.5 cm, 1.0 cm and 2.0 cm. Strand size 1.0 cm of UF resin was are stable or increase strength of board compare 2.0 cm and 0.5 cm because stability and absorb increase resin to gluing in mixing stage . Based on results, internal bonding PF resin was not significant between 0.5 cm and 1.0 cm but 2.0 were significant. Based on value of internal bonding were conclude the strength of internal bonding based on their effect of resin and strand sizes of OSB and PF resin more strength compare to UF resin.

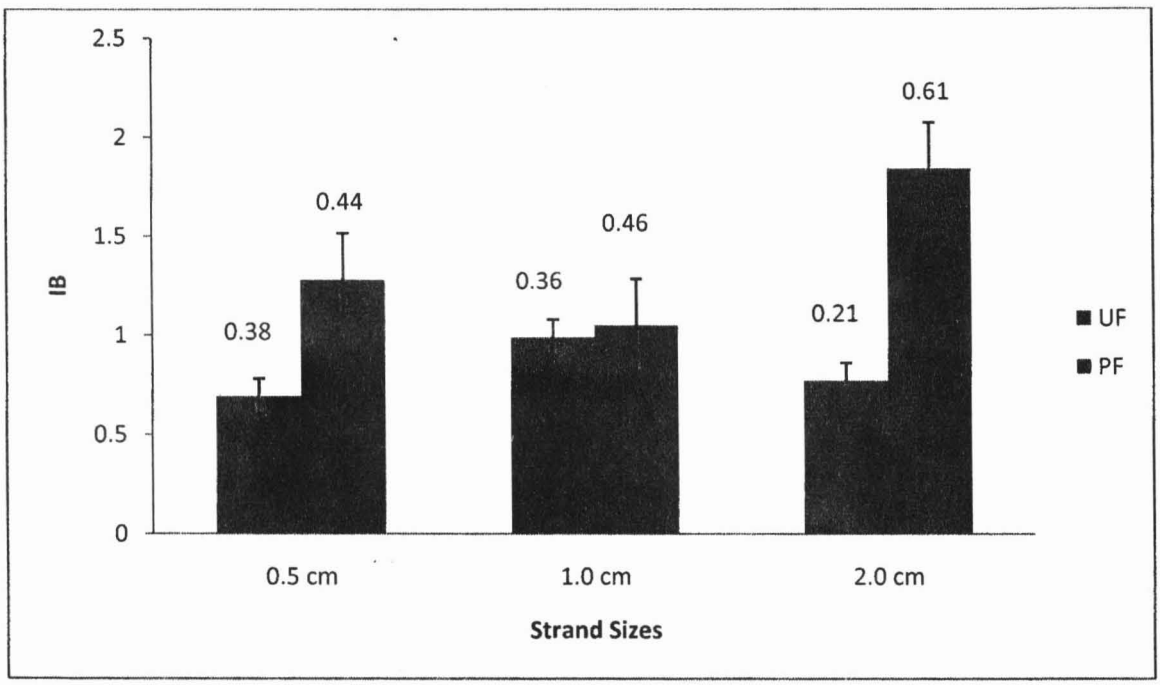

Figure 3: Effect of strand sizes and resin on internal bonding properties (600 kg/m³) of OSB

Thickness Swelling (TS)

Based on result, Thickness swelling PF resin was no significant between 0.5 cm, 1.0 cm and 2.0 cm were significant. Strand size 0.5 cm of PF was increase absorbs water compare 1.0 cm and 0.5 cm because the sizes of strand are small and character of strand was more bulk density of board. This cause the sample has more void area, so the sample becomes easier to absorb more water and will change the dimension of board. Based on Thickness swelling UF resin was no significant between 1.0 cm and 2.0 cm but 2.0 have significant. Strand size 0.5cm and 1.0 cm was absorbing more water because small of strand and character of strand was more bulk density of board.Based on value UF resin was absorbing more water compare PF resin and means OSB from PF resin are more strength compare to UF resin.

Table 1: Effect of strand sizes and resin of PF on thickness swelling properties (600 kg/m³) of oriented strand board (OSB)

Strand sizes (cm)	Thickness Swelling (%)	
	UF	PF
0.5	43.92(8.62)	36.38 (6.99)
1.0	45.21 (6.38)	33.98 (5.88)
2.0	30.68 (5.88)	32.72 (6.43)

Water Absorption (WA)

Based on Table 2, UF resin absorbs more water compare to PF resin and between 0.5 cm and 1.0 cm shows no significant compare to 2.0 cm. Based on water absorption PF resin was no significant between 0.5 cm,1.0 cm but 2.0 cm were significant. Strand size 0.5 cm PF resin was increase absorbs water compare 1.0 cm and 0.5 cm because the sizes of strand are small and character of strand was more bulk density of board. This cause the sample has more void area, so the sample becomes easier to absorb more water. Based on water absorption UF resin was no significant between 1.0 cm and 2.0 cm but 2.0 have significant. Strand size 0.5 cm and 1.0 cm was absorbing more water because small of strand and character of strand was more bulk density of board.

Table 2: Effect of strand sizes and resin on water absorption properties (600 kg/m³) of oriented strand board (OSB)

STRAND SIZE (cm)	Water Absorption (%)	
	UF	PF
0.5	95.47(3.58)	92.45(4.23)
1.0	97.62(3.99)	91.26(6.79)
2.0	82.98(10.66)	82.68(6.77)

Statistical significance

According to the Table 4.3, PF shows that p-value of MOR was 0.206, MOE was 0.340, Internal bonding was 0.016 and Thickness swelling was 0.378 which all variables was not significantly different between the means value and water absorption was 0.001 which was significant. UF shows that p-value of MOR was 0.223, MOE was 0.269 and internal bonding was 0.173which all variables was not significantly different between the means value andThickness swelling and water absorption was 0.000 which are significant.

Table 3: The summary of ANOVA results

Resin	Dependent Variable	f-value	p-value	Significance (Yes/No)
PF	**MOR**	1.707	0.206	No
	MOE	1.138	0.340	No
	Internal bonding (IB)	5.060	0.016	No
	Thickness swelling (TS)	1.002	0.378	No
	Water absorption (WA)	9.309	0.001	Yes
UF	**MOR**	1.613	0.223	No
	MOE	1.399	0.269	No
	Internal bonding (IB)	1.909	0.173	No
	Thickness swelling (TS)	11.507	0.000	Yes
	Water absorption (WA)	15.799	0.000	Yes

Notes; MOR – Modulus of Rupture, MOE – Modulus of Elasticity, IB - Internal Bonding, TS – Thickness Swelling, WA – Water Absorption, PF – Phenol formaldehyde, UF – Urea Formaldehyde

CONCLUSIONS

From the result, the fast growing species especially forkelempayanas a substitute to establish species from virgin forest is not environmentally friendly but also economical to produce wood composite product. Kelempayan tree is widely regarded as a lead tree because of its fast growth compare to the other commercial tropical tree. The intention of this research is to investigate on whether kelempayan can be used as raw material for oriented strand board, and to determine whether different resin and strand sizes of oriented strand board give significant effect on OSB.

The quality of board were evaluated by determine of bending properties including modulus of elasticity (MOE), modulus of rapture (MOR), internal bonding (IB) strength and thickness swelling (TS) and water absorption (WA).

Generally, the mechanical strength increases with different of strand sizes and resin of OSB. All mechanical properties of the board meet the minimum requirement of standard EN 300 OSB/1.Thickness swelling increase with increasing board density and percentage of oil palm particle, but still below the maximum requirement of 25 percent for all board. It appears that strand sizes of 0.5 cm and 1.0 cm and PF resin of kelempayan wood with board density of 600kg/m³ has a potential for OSB manufacturer.

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