

**EVALUATION OF ORIENTED STRAND BOARD MADE FROM  
RUBBERWOOD USING PHENOL FORMALDEHYDE AS A BINDER**

**By**

**SUFFIAN MISRAN**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,  
in Fulfilment of the Requirements for the Degree of Master of Science**

**February 2005**

**To my parents, wife and daughters**

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**Chairman: Associate Professor Paridah Md. Tahir, PhD**

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This study evaluates the potential of rubberwood to be used as raw material for the manufacture of oriented strand board (OSB). The logs were flaked using a disc flaker at a fixed length (152 mm). The resulting strands were examined for quality and physical appearance such as curliness, slenderness, dimensions and screening analysis. The strands were used for OSB manufacture and bonded using four types of phenol formaldehyde (PF) resins labelled as L1, L2, C1 and C2. The study shows that about 79% of the strands have size of bigger than 22 x 22 mm wire mesh. The strands have an average length of 69 mm, width 35 mm and thickness 0.6 mm. The edges of the strands were mostly not perpendicular with the adjacent surface which attributed by the deviation in cutting angle of the disc flaker. Most of the strands curled immediately after they came out from the disc flaker. The study also established five categories of curling: (1) flat, (2) curl and quarter round, (3) curl and half round, (4) curl and round, (5) curl and rolled. Almost half of the total strands produced can be grouped under curl classes 3, 4 and 5. It was observed that thicker strands are wider. However, strands with thickness of more than 0.5 mm has tendency to break into halves producing a lot of narrow strands. The strands have

high slenderness and aspect ratios, averaged at 123 and 2.4 respectively. The degree of curling of rubberwood strands was small in thicker strands, while in wider strands, the degree of curling is higher. Pre-soaking of rubberwood billets in water for 24 hours prior to flaking did not give significant different in length, width and curliness with strands from unsoaked rubberwood billets. The modulus of rupture (MOR), modulus of elasticity (MOE) and internal bond (IB) improved with the increasing of board density. The thickness swelling (TS) was low on boards with low board density. On the other hand, these boards absorbed more water than do higher density boards. Increasing the resin level during board manufacture did not give much significant contribution to the MOE and MOR of the boards. Good IB value was achieved when 5% resin level was used. The swelling of boards can be reduced significantly by increasing the resin level to 5%. The type of PF resins used for bonding rubberwood strands has significant influence on the strength properties of rubberwood OSB. Significantly high MOE, MOR and IB values were obtained with C2 resin used at 7%. Whilst, boards bonded with L2 resin had very high TS.

**PENILAIAN PAPAN STRAND BERORIENTASI DIPERBUAT DARIPADA  
KAYU GETAH MENGGUNAKAN FENOL FORMALDEHID SEBAGAI  
PEREKAT**

**Oleh**

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Kajian ini menilai potensi kayu getah untuk digunakan sebagai bahan mentah dalam pembuatan papan strand berorientasi (OSB). Balak kayu getah telah diproses menggunakan pengeping disk pada panjang yang tetap (152 mm). Kualiti dan sifat fizikal strand terhasil kemudiannya dikaji. Strand kayu getah digunakan bagi pembuatan OSB dan dilekatkan dengan empat jenis resin fenol formaldehid (PF) iaitu L1, L2, C1 dan C2. Kajian menunjukkan hampir 79% strand mempunyai saiz lebih besar daripada dawai penapis 22 x 22 mm. Proses pengepingan menghasilkan strand dengan purata panjang 69 mm, lebar 35 mm dan tebal 0.6 mm. Bahagian tepi strand kebanyakannya tidak berserenjang dengan sisinya disebabkan terdapat lencongan pada sudut pemotongan di pengeping disk. Kebanyakan strand melengkung sebaik sahaja keluar daripada mesin. Lima kategori kelengkungan telah dikelaskan dalam kajian iaitu: (1) rata, (2) melengkung dan suku bulat, (3) melengkung dan separuh bulat, (4) melengkung dan bulat, (5) melengkung dan bergulung. Hampir separuh daripada jumlah strand mempunyai kelas kelengkungan 3, 4 dan 5. Strand yang lebih tebal mempunyai lebar yang lebih besar. Walau bagaimanapun, strand berketebalan lebih 0.5 mm cenderung untuk pecah

menghasilkan nilai lebar yang lebih kecil. Strand kayu getah mempunyai nisbah kerampingan dan aspek yang tinggi, purata masing-masing 123 dan 2.4. Darjah kelengkungan adalah rendah pada strand yang tebal, manakala pada strand yang lebar, potensi untuk melengkung adalah tinggi. Perendaman balak kayu getah dalam air selama 24 jam sebelum proses pengepungan tidak menghasilkan strand yang berbeza daripada segi panjang, lebar dan darjah kelengkungan dengan strand daripada balak yang tidak direndam. Modulus kepecahan (MOR), modulus kekenyalan (MOE) dan ikatan dalaman (IB) meningkat dengan bertambahnya ketumpatan panel. Pembengkakan ketebalan (TS) adalah rendah pada panel berketumpatan rendah. Namun, panel berketumpatan rendah menyerap lebih banyak air berbanding yang berketumpatan tinggi. Peningkatan kandungan resin dalam panel tidak memberi peningkatan yang banyak terhadap MOE dan MOR. Nilai IB yang baik dicapai apabila 5% resin digunakan dalam panel. Pembengkakan panel dapat dikurangkan secara signifikan dengan menambah kandungan resin kepada 5%. Jenis PF resin memberikan kesan signifikan terhadap sifat OSB kayu getah. Panel mempunyai MOE, MOR dan IB paling tinggi apabila dilekatkan menggunakan resin C2 sebanyak 7%. Sementara TS adalah paling tinggi dalam panel yang menggunakan resin L2.

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I certify that an Examination Committee met on 28 February 2005 to conduct the final examination of Suffian Misran on his Master of Science thesis entitled 'Evaluation of Oriented Strand Board (OSB) Made from Rubberwood using Phenol Formaldehyde Resin' in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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## **DECLARATION**

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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## LIST OF ABBREVIATIONS/NOTATIONS/GLOSSARY OF TERMS

APA	The Engineered Wood Association (formerly known as American Plywood Association)
ASTM	American Society for Testing and Materials
ANOVA	Analysis of variance
BS EN	European Standard with the status of British Standard
BSI	British Standard Institution
FRIM	Forest Research Institute Malaysia
IB	Internal bond
LGM	Lembaga Getah Malaysia
MC	Moisture content
MDI	Isocyanate based resin
MTIB	Malaysian Timber Industry Board
MUF	Melamine urea formaldehyde resin
MOE	Modulus of elasticity
MOR	Modulus of rupture
NaOH	Sodium hydroxide
NMR	Nuclear magnetic resonance
OSB	Oriented strand board
PF	Phenol formaldehyde resin
PROSEA	Plant Resources of South East Asia
SBA	Structural Board Association
TAPPI	Technical Association of the Pulp and Paper Industry

TS	Thickness swelling
WA	Water absorption
WBPI	Wood Based Panel International