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EFFECTS OF SAMPLE LOCATION AND SAWING METHOD ON QUALITY OF OIL PALM WOOD

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By

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Chair: Associate Professor Edi Suhaimi Bakar, PhD

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Decreasing of the rubberwood supply and increasing of world demand towards palm oil, significantly cause the abundant oil palm truck which is consider as an agriculture waste were investigate as a possible alternative as a future source of timber. In establishing oil palm wood as a potential wood substitute its own imperfection need to be enhance. To solve the problems, it is treated using chemical modification method known as Com-press. Continuation of the method done before, improvement was made and new method was invented known as Integrated Treatment Process. It consists of a six-step processing method (sawing, steaming and compression, drying, resin soaking, heating, and hot-pressing). In this study, effect of sample location and sawing method using Integrated Treatment Process was highlighted. The thickness of both slab shape was cut to 40 to 80 mm with 150 mm width and 300 mm in length. All slabs were treated with Low molecular weight phenol formaldehyde. This process used a reversed cant sawing method that not only produce normal square slab but also wane slab. Steaming was applied as pre-treatment before the sample compressed to avoid excessive cracking. The formation of the micro-cracks facilitates resin inclusion. The sample then soaked instead of impregnation. The sample heated by semi-cured in an oven and finally compressed by using hot-press. The slab then tested to see it mechanical and physical properties. For mechanical properties static bending, compression parallel to grain, and shear tests were done and for physical properties water absorption and thickness swelling tests were applied. Result was analysis using computer statistical program, Statistical Package for the Social Sciences (SPSS) and complete randomized design analysis of variance (ANOVA). The results show that waney slab treated oil palm wood have better properties than square slab treated oil palm wood by almost 7 % for weight percentage gain, 113 kg/m^3 higher for wood density, 0.9 % lower for water absorption percentage, and 0.3 % slightly lower for thickness swelling. Same goes for mechanical properties, waney slab treated oil palm wood have better mechanical

properties compared to square slab treated oil palm wood. For bending strength, value of modulus of elasticity is 2325 N/mm² better than square slab treated oil palm wood, and value of modulus of rupture is 18 N/mm² higher. 1.9 N/mm² better value of shear strength of waney slab of treated oil palm wood calculated compared to square slab treated oil palm wood. Only compression strength parallel to grain for square slab found to be better than wane slab treated oil palm wood by 16 N/mm². As a whole, wane slab of treated oil palm wood have higher values of all tests but no specific slab thickness were obtained and gave the best result. Contradictory, value of compression parallel to grain gave result that is not complied as what was expected. In conclusion, the Integrated Treatment and Process do give effect on the quality of oil palm wood. It is proven fast, practical and economically viable for the industry.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Sarjana Sains

KESAN LOKASI SAMPLE DAN KAEDAH PENGGERGAJIAN PADA KUALITI KAYU KELAPA SAWIT

Oleh

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Penurunan bekalan kayu getah dan peningkatan permintaan dunia terhadap minyak kelapa sawit, secara tidak langsung menyebabkan kebanjiran kayu kelapa sawit yang dilihat sebagai bahan buangan agrikultur dijadikan bahan penyelidikan sebagai satu cara alternatif untuk digunakan sebagai sumber kayu masa hadapan. Dalam memperkukuhkan kayu kelapa sawit sebagai kayu gantian berpotensi kekurangannya harus diperbaiki. Bagi menyelesaikan masalah kekurangan sifat kayu kelapa sawit, kayu tersebut diubahsuai secara kimia melalui kaedah Com-press. Namun peningkatan dibuat dan kaedah baru dicipta dan dikenali sebagai Proses Rawatan Bersepadu. Ia mempunyai 6 langkah iaitu melalui proses kukusan, pemampatan, pengeringan, rendaman fenol formaldehide molekul berketumpatan rendah, pemanasan dan pemampatan panas. Ketebalan kedua-dua bentuk papan kayu tersebut dipotong bermula dari 40 ke 80 mm dengan 150 mm lebar dan 300 mm panjang. Semua papan kayu dirawat dengan fenol formaldehide molekul berketumpatan rendah. Kaedah ini menggunakan cara penggergajian kayu yang baru yang bukan hanya menghasilkan papan kayu bersegi empat tetapi juga kayu beralun. Kaedah pengukusan telah digunakan sebagai pra-rawatan sebelum sampel dimampatkan untuk mengelakkan keretakan yang berlebihan. Pembentukan retakan-mikro memudahkan kemasukan resin. Sampel kemudian telah direndam. Sampel dipanaskan di dalam ketuhar dan akhirnya dimampatkan dengan menggunakan tekanan panas. Papan kayu itu kemudiannya diuji untuk melihat sifat mekanikal dan fisikalnya. Bagi sifat mekanikal, ujian statik lentur, mampatan selari dengan ira, dan ricih dilakukan. Bagi sifat fisikal, ujian penyerapan air dan tahap kebengkakkan kayu dijalankan. Hasil ujian dianalisis menggunakan program statistik komputer, SPSS dan analisis rekabentuk rawak lengkap bervariasi, ANOVA. Keputusan mendapati, papan kayu beralun yang telah dirawat mempunyai sifat lebih baik berbanding papan kayu biasa iantu 7 % baik untuk peratus pertambahan kayu, 113 kg/m^3 lebih tinggi pada ketumpatan kayu, 0.9 % pengurangan dari segi penyerapan air, dan 0.8 % lebih rendah untuk pembengkakan ketebalan. Begitu juga dengan sifat mekanikal kayu, papan kayu beralun mempunyai sifat lebih baik berbanding papan kayu biasa. Untuk

sifat kekuatan kelunturan kayu, nilai modulus keanjalan ialah 2325 N/mm² lebih tinggi dan nilai modulus keampuhan 18 N/mm² lebih baik. 1.9 N/mm² nilai lebih tinggi untuk kekuatan ricihan papan kayu beralun berbanding dengan papan kayu biasa. Hanya nilai kekuatan mampatan untuk papan kayu biasa didapati lebih tinggi berbanding papan kayu beralun dengan nilai 16 N/mm² lebih baik. Secara keseluruhan, papan kayu beralun yang telah dirawat memberi keputusan lebih baik di dalam semua ujian kecuali nilai kekuatan Kesimpulannya, Kaedah Rawatan Bersepadu ini memberi kesan kepada kualiti kayu kelapa sawit. Kaedah baru ini dibuktikan lebih cepat, praktikal dan berdaya maju dari segi ekonomi untuk industri perkayuan.

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Nurul Nabilah binti Hamzah

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
ASE	Anti Swelling Efficiency
ASTM	American Society for Testing and Materials
BS	British Standards
FSP	Fibre Saturation Point
h	Hours
kN	Kilo Newton
LmwPF	Low Molecular Weight Phenol Formaldehyde
MC	Moisture Content
Min	Minutes
MOE	Modulus of Elasticity
MOR	Modulus of Rupture
MPa	Mega Pascal
M_w	Molecular Weight
OPW	Oil Palm Wood
PF	Phenol Formaldehyde
ST	Soaking Time
TS	Thickness Swelling
UPM	Universiti Putra Malaysia
WPG	Weight Percent Gain

CHAPTER 1

INTRODUCTION

1.1 Background of study

Oil palm, *Elaeis guineenisis* Jacq., was first grown in Africa (Corley *et al*., 1976). It is endemic to a wide coastal belt stretching from Senegal to Angola, extending further along the Congo River (Moll, 1987). Evidence show in Egyptian tombs, people buried in casks of palm oil, reflecting the high societal value attributed to the product. Needless to say with the origins in West Africa and evident consumption in Egypt, palm oil can be considered one of the earliest traded commodities (Reade, 1872)

European settlers and entrepreneurs, see the opportunity for commercial palm oil production to produce soaps, lubricants and edible oils had lead to a dramatic expansion of oil palm productions throughout Sub-Saharan and Southeast Asia (Arif, 2015).

The palm oil industry in Malaysia has evolved dramatically since the first commercial planting took place in Tennamaran Estate in Selangor in 1917, laying the brass tacks for the industry in Malaysia. The astonishing development of the oil palm that started off as ornate into a multibillion ringgit industry makes Malaysia among as the largest oil palm producing country. Currently, there are about 5.74 million hectares of oil palm had been planted (MPOC, 2017).

The phenomenal growth of this crops in Malaysia, led to the new challenge where the rapid increase of the oil palm plantation resulted to environmental pollution. Being sensitive to environmental concerns is becoming important to sustain the environment well-being by changing a so called waste to wealth.

1.2 Problem Statements

The oil palm trunk is one of the forms of residues and waste generated from the oil palm industry. Malaysia currently holds a backlog of 365,414 hectares of oil palm trees older than 25 years old (Dompok, 2014). Decreasing of rubberwood supply cause by the plant is replacing by the oil palm plantation furthermore will result decreasing of solid wood supply for furniture industry and increase massive residue and waste in the future if the oil palm waste does not use efficiently.

To cater the lost of source by the decreasing of rubberwood supply, the oil palm trunk seems to be the preferred choice. Palm waste is abundant and readily available

(Salmiyati *et al.,* 2016). It is accessible in large amount throughout the year but this material has not been fully utilized yet. This is due to not only variation but also quality inferior. It is why the quality improvement needed. The great variations in physical and mechanical properties caused many difficulties of working and using the wood for application.

Therefore, quality improvement is vital. It is true that many specialty treatments can be applied to wood by either improve its performance or change its properties, and then compressed to improve dimensional stability and increase hardness. A number of studies have been carried out through resin impregnation and compression (Zaidon, 2009; Aik Fei, 2010; Nur Izreen *et al.,* 2011; Rabia'tol Adawiah *et al.,* 2012).

Indeed this area had been widely explore, and capable to enhance the properties of oil palm wood, but there are few things that seems needed to be alter and one can be simplifying in the process and significantly may improve the weakness of the usual method that had been done before. From that, new method had been introduced (Bakar *et al*., 2014).

The new technique known as Integrated Treatment Process consists of six-step process has been introduced by Bakar, 2014. This method involve six processing step. Debarking-sawing, steaming and compression, drying, resin inclusion, resin semi-curing heating and hot pressing. The key point and the essential parts of this process is that the sawing process of the oil palm trunk is unique without need to be squared and then followed by the compression under cold pressing.

Instead of using the polygon sawing that is not only time consuming but also difficult and required high-skilled operator to conduct, this process uses a newly introduced sawing pattern called "reverse cant sawing". On the other hand, the compression is made to reduce the moisture content and create micro cracks necessary for fastening the drying process (Bakar *et al*., 2014).

1.3 Justifications of study

This research was carried out to study the performance of oil palm when treated with low molecular weight phenol-formaldehyde (Lmw-PF) using new method, integrated treatment process which is a continuous improvement of previous impregnation and densification method. As this is a new technique, more research needed to be done in many ways which targeted to enhance the physical and mechanical properties of the treated oil palm wood. There are several variables in the each steps of the new process need to be optimized especially the variables in the compression step and resin inclusion step. There are no study have been done in this aspect of where the effect of compression affects towards oil palm wood that varies in shape and thickness.

The treatments are designed to improve the properties of oil palm wood, and in return promote the usage of this wood species. These treatments may minimal the costs because resin inclusion is done by soaking instead impregnating. Furthermore, it is expected that the increasing quality of the material may also offset the cost of processing.

1.4 Objectives of study

The objectives are to

1. Determine the effect of sample location on quality of treated oil palm wood;
2. Determine the effect of initial timber shape (square and waned) on the properties of treated oil palm wood;
3. Determine the effect of sawn timber thickness on the properties of treated oil palm wood;

1.5 Significance of study

This study emphasizes the new method of the oil palm wood quality enhancement. It does simplify the procedure and fasten the processing time of the method introduced before. It may save time, energy and cost, yielding good quality treated oil palm wood. Combined with other environmental aspect, this high quality treated oil palm wood can be a viable alternative for solid wood. The use of oil palm biomass also supports the conservation of forests in Malaysia and the rest of the world. Hopefully, the outcome of this research can be used as future reference by other researcher.

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