THE EFFECT OF HOLES PARAMETER ON THE PROPERTIES OF SUPER-FAST DRIED OIL PALM LUMBER (OPL)

FARID BIN RAMLI

THE EFFECT OF HOLES PARAMETER ON THE PROPERTIES OF SUPER-FAST DRIED OIL PALM LUMBER (OPL)

By

FARID BIN RAMLI

A Project Report Submitted in Partial Fulfilment of the Requirements for the Degree of Bachelor of Wood Science and Technology in the Faculty of Forestry
Universiti Putra Malaysia

2019

DEDICATION

Special dedication to my family:

Ramli B. Abd Hamid

Hauza Bt. Abdul Malik

And my siblings.

To all my friends,

Thank you for your encouragements

And supports that you have given.

Last but not least,

I dedicated this dissertation to Assoc. Prof. Dr. Edi Suhaimi Bakar

Who has encourage me, helped and give support during conducting this research.

Thank you for everything. May Allah bless all of us.

ABSTRACT

"Super-Fast Drying" is a new oil palm lumber (OPL) drying method which involve drilling holes and 2-step drying which is hot pressing and oven drying. From previous study, this technique could increase the drying rate of OPL with least defects. However, the method is still in preliminary phase. In this study, the best holes parameters for the OPL were verified. OPL were cut to the size of 300 x 50 x 20 mm, followed by holes drilling with the holes distance of 1.5 and 2.0 inch and holes depth of 1/3, 1/2, 2/3 and full depth. The specimens were hot pressed and oven dried. Mechanical and physical testing was carried out to determine the optimum parameters that show the best properties of super-fast dried OPL. From the findings, holes depth showed significant effect on the properties, while holes distance does not. The optimum holes distance and holes depth are 2.0 inch and 1\3 depth, respectively.

ABSTRAK

"Super-Fast Drying" Pengeringan cepat adalah kaedah baru untuk pengeringan kayu kelapa sawit (OPL) yang melibatkan penebukkan lubang dan pengeringan 2 langkah iaitu tekanan panas dan pengeringan ketuhar. Daripada kajian sebelumnya, teknik ini boleh meningkatkan kadar pengeringan OPL dengan kecacatan yang kurang. Walau bagaimanapun, kaedah ini masih dalam fasa awal. Dalam kajian ini, parameter lubang yang terbaik bagi OPL telah dipilih. OPL dipotong kepada saiz 300 x 50 x 20 mm, diikuti oleh penebukkan lubang dengan jarak 1.5 dan 2.0 inci dan kedalaman lubang 1/3, 1/2, 2/3 dan kedalaman penuh. Spesimen telah ditekan panas dan dikeringkan dengan ketuhar. Ujian mekanikal dan fizikal telah dijalankan untuk menentukan parameter optimum yang menunjukkan ciri-ciri terbaik untuk OPL yang telah melalui pengeringan cepat. Dari hasil kajian, kedalaman lubang memberi kesan yang besar kepada ciri-ciri, manakala jarak lubang tidak. Jarak lubang optimum dan kedalaman lubang adalah 2.0 inci dan 1/3 kedalaman.

ACKNOWLEDGEMENTS

Alhamdulillah and thank to Allah S.W.T with all His Gracious and His Merciful for giving me strength and the ability to accomplish this project successfully. I would like to take the utmost opportunity to express my sincere and gratitude to my supervisor, Assoc. Prof. Dr. Edi Suhaimi Bakar, who is always giving me supports and guidance.

My greatest appreciation also goes to the people that have been involved directly or indirectly in making this research project paper success. They are my parents, siblings and Siti Wahdaniyah Mohd Ismail. Thank you for always support me mentally and physically during conducting this research.

Finally, special thanks are also expressed to UPM staff (En. Zamani, En. Mohd Fakharuddin and En. Mohd Hafizie) and my research team and colleagues for their help and constructive suggestion through this study, especially to Mohd Rafsan, Muhammad Nadzim, Ruslan, Nur Shakirin and Farizatul Shahira. Last but not least to those whose names are not mentioned, I wish to express my special thanks for their helps in one way or another during this project.

APPROVAL SHEET

I certify that this research project report entitled "The Effect of Holes Parameter on the Properties of Super-Fast Dried OPL" by Farid Bin Ramli has been examined and approved as a partial fulfilment of the requirements for the Degree of Bachelor of Wood Science and Technology in the Faculty of Forestry, Univeristi Putra Malaysia.

Assoc. Prof. Dr. Edi Suhaimi Bakar
Faculty of Forestry
Universiti Putra Malaysia
(Supervisor)

Prof. Dr. Mohamed Zakaria Bin Hussin
Dean
Faculty of Forestry
University Putra Malaysia

Date: January 2019

TABLE OF CONTENTS

			Page
DEDICATION			ii
ABSTRACT			iii
ABSTRAK			iv
ACKNOWLEDGEMENT			v
APPROVAL SHEET			vi
TABLE OF CONTENTS			vii
LIST OF TABLES			ix
LIST OF FIGURES			x
LIST OF ABBREVIATION			xii
CHAPTER			
1	INTRODUCTION		
	1.1	Background	1
	1.2	Problem Statement	3
	1.3	Justification	4
	1.4	Objective	5
		1.4.1 General Objective	5
		1.4.2 Specific Objective	5
2	LITERATURE REVIEW		
	2.1	Oil Palm Tree Botanical	6
	2.2	Oil Palm Plantation in Malaysia	7
	2.3	Utilization of Oil Palm Trunk (OPT)	8
	2.4	Oil Palm Trunk Characteristic	9
	2.5	Physical Properties of Oil Palm	10
		2.5.1 Density	10
		2.5.2 Moisture Content	11
		2.5.3 Shrinkage	12
	2.6	Mechanical Properties of Oil Palm	12
	2.7	Sawing Pattern of Oil Palm Wood (OPW)	13
	2.8	Super-Fast Drying Method	14
	2.9	Holing of Wood	15
3	METHODOLOGY		
	3.1	Raw Materials	16
	3.2	Experimental Design	17
	3.3	Preparation of Samples	18
	3.4	Hot Pressing	19
	3.5	Determination of Mechanical Properties	20
	3.6	Determination of Physical Properties	22
		3.6.1 Thickness Swelling	22
		3.6.2 Water Absorption	22
	3.7	Statistical Analysis	23

4	RESULT AND DISCUSSION	
	4.1 Introduction	24
	4.2 Drying Rate of Super-Fast Dried OPL	24
	4.2.1 Drying Condition	24
	4.2.2 Drying Defects	26
	4.3 Density	26
	4.4 Physical Properties of Super-Fast Dried OPL	28
	4.4.1 Thickness Swelling (TS)	28
	4.4.2 Water Absorption (WA)	30
	4.5 Mechanical Properties of Super-Fast Dried OPL	31
	4.5.1 Modulus of Elasticity (MOE)	32
	4.5.2 Modulus of Rupture (MOR)	34
5	CONCLUSION AND RECOMMENDATION	
	5.1 Conclusion	36
	5.2 Recommendations	37
	REFERENCES	38

LIST OF TABLES

		Page
Table 4.1	Summarization of ANCOVA for the physical properties of super-fast dried OPL	28
Table 4.2	Summarization of ANCOVA for the thickness swelling at 2^{nd} and 24^{th}	29
Table 4.3	Summarization of ANCOVA for the water absorption at 2^{nd} and 24^{th}	30
Table 4.4	Summarization of ANCOVA for mechanical properties of super-fast dried OPL	32
Table 4.5	Summarization of ANCOVA for the Mean of MOE	32
Table 4.6	Summarization of ANCOVA for the Mean of MOR	34

LIST OF FIGURES

		Page
Figure 2.1	Density Variation in OPT	10
Figure 2.2	Polygon Sawing And Reverse Cant Sawing	13
Figure 3.1	Cutting Process of OPT and OPL soaked with borax	16
Figure 3.2	Experimental design for Super-fast dried OPL	18
Figure 3.3	Holes Template for 1.5 Inch And 2.0 Inch	19
Figure 3.4	Hot press process and the OPL board after hot press	20
Figure 3.5	Bending test	21
Figure 3.6	Test pieces of sample before immersion	22
Figure 4.1	Drying period of super-fast dried OPL with different holes distance (1.5" & 2.0") compare with conventional drying	25
Figure 4.2	Drying period of super-fast dried OPL with different holes depth (1/3, 1/2, 2/3 & Full) compare with conventional kiln drying.	25
Figure 4.3	End checks and crack on the super-fast dried OPL	26
Figure 4.4	The density of super-fast dried OPL	27
Figure 4.5	Thickness swelling after 2nd and 24th hours against holes distance and holes depth	29
Figure 4.6	Water absorption after 2nd and 24th hours against holes distance and holes depth	31

Figure 4.7 Mean differences of specific MOE on 1.5” and 2.0” holes distances at different holes depth 33

Figure 4.8 Mean differences of specific MOR on 1.5” and 2.0” holes distances at different holes depth 35

LIST OF ABBREVIATION

ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
MC	Moisture Content
MPOB	Malaysian Palm Oil Board
MPOC	Malaysian Palm Oil Council
OPL	Oil Palm Lumber
OPT	Oil Palm Trunk
OPW	Oil Palm Wood
sMOE	Specific Modulus of Elasticity
sMOR	Specific Modulus of Rupture
TS	Thickness Swelling
WA	Water Absorption

CHAPTER 1

INTRODUCTION

1.1 Background

Oil palm (*Elaeis guineensis*) was first introduced to Malaysia as a plant ornament in 1870 according to the Malaysian Palm Oil Board (MPOB). It was planted rapidly in 1960 and reached 1.5 million hectares of oil palm plantation in 1985 (Official Palm Oil Information Source, 2011). In the mid-20th century, Malaysia has become the world's largest producer of palm oil. However, this record has been addressed by Indonesia in 2006. In 2016, based on the description of MPOB, Malaysia reached 5.74 million hectares of oil palm plantations while based on data Association of Palm Oil Indonesia (Gapki), there are about 11.8 million hectares of planted oil palm in Indonesia. These data show the development of the palm oil industry in both countries that have created one of the most successful stories in the history of the country's agricultural sector.

Palm trees have an economic life of about 25 years. Subsequently, replanting will be carried out as oil palm fruit production declines after 25 years. Oil palm tree stems are usually left aside after replanting, not only can lead to soil pollution but also affect the growth of young palm trees. The utilisation of oil palm trunk is not limited in biomass purpose only; it also can be used as raw material for wood composite products.

The deficiency of solid wood as a crude material of plywood and the plenty of oil palm trunk (OPT) waste in Malaysia have turned OPT to be one of the potential replacements for timber. OPT is a lignocellulosic material exists an immense amount; however, they low in quality. The poor dimensional stability, bad machining properties, low strength and resistance to bio gradable agents are the reasons why many wood industries decline to utilize OPT as their raw materials (Bakar et al., 2013).

To address the oil palm solid waste problem, many investigations has been conducted from around the world. Among all the research, intensive research was the use of OPT. Because of the lack of solid wood raw materials has forced the wood-based industry to find alternatives for wood raw materials. Furthermore, the OPT was low cost, low density, safe handling, renewable, economically feasible and can be simplified compared to ordinary timber in the market (Dungani et al., 2013). However, most timber manufacturers still refuse to use OPTs as raw material as it has some inherent problems compared to ordinary timber. OPT has high moisture content (MC), high-density variation, and a high percentage of tissue parenchyma (Mokhtar et al., 2011). These properties may cause some wood drying defects such as twisting, warping and at the same time increasing the cost of processing and manufacturing time.

The defects can be reduced by utilizing the right drying technique and drying conditions. As of late, there are a few new drying advancements that have been offered to create high processing recovery and enhance the quality of oil palm lumber (OPL) and additionally to make reasonable drying Tables for OPL. The "Super-fast drying" method is one of the newest innovations developed by Bakar et al. (2016). This method just takes 3 hours of drying to dry the 30 mm thick OPL with a minimal drying defects. It includes 2 stages of drying, which incorporates hot plate contact drying to certain MC and high-temperature kiln drying to a targeted MC. The drying involves holing in the OPL samples to accelerate the drying process. The existence of holes in the OPL limits its utilization. Thus, an investigation has been done where the holing variables were modified including the introduction of blind holing. The holes are drilled to a certain depth to form blind-hole OPL.

1.2 Problem statement

The super-fast drying method of OPL involves holing process to speed up the evaporation of moisture. From the previous study, it was found that holing process is essential and cannot be eliminated from the super-fast drying method. Having holes on the surface, the dried OPL has exceptionally constrained applications because of holing appearance. Besides that, it additionally caused the working time long, decrease the quality and appearance of the board and utilized an excessive amount of adhesive in the production of laminated OPL.

1.3 Justification

Oil palm trunk are left on the field and only 20% of OPT have been utilized in wood based industries. The oil palm factories create up to 18 million OPT biomass consistently every year (Harun & Loh, 2017). This will results an increasing concern of environmental issues such as insect pests and steam rotting fungi (Lim & Gan, 2005) also pollution and sustainable utilization of natural resources (Othman et al., 2013). Hence OPT is utilized as a substitute material for the wood composite product.

Super-fast drying method needs some improvement so that it can be commercialized. The blind-holed super-fast drying method is used in this study with only one sided is holed and the others is clear surface OPL. This is to build the capability of OPL to be utilized as a part of different applications without influencing its properties and appearance as compared to full holing dried OPL. Besides that, the depth and distance of holes are optimized to reduce the adhesive used during the production of laminated OPL.

1.4 Objective

1.4.1 General Objective

To study the effect of holing variable of super-fast dried OPL for laminated lumber application.

1.4.2 Specific Objective

1. To determine the effects of holing distance on the drying rate and the physical and mechanical properties of super-fast dried OPL

2. To determine the effects of holing depth on the drying rate and the physical and mechanical properties of super-fast dried OPL

REFERENCES

Abdullah, C., Jawaid, M., Shawkataly, A., & Fazita, M. (2013). Termite and borer resistance of oil palm wood treated with phenol formaldehyde resin. *Journal of Industrial Research & Technology*, *3*, 41-46.

Bakar, B., Tahir, P., Karimi, A., Bakar, E., Uyup, M., & Yong Choo, A. (2013). Evaluations of some physical properties for oil palm as alternative biomass resources. *Wood Material Science and Engineering*, *8*(2), 119-128.

Bakar, E. S., Febrianto, F., Wahyudi, I., & Ashaari, Z. (2006). Polygon sawing: An optimum sawing pattern for oil palm stems. *Journal of Biological Science*, *6*(4), 744–749.

Bakar, E. S., Hermawan, D., Karlina, S., Rachman, O., & Rosdiana, N. (1998). Pemanfaatan batang kelapa sawit sebagai bahan bangunan dan furniture. *Jurnal Teknologi Hasil Hutan (Indonesia), 11*(1), 1-12.

Bakar, E. S., Soltani, M., Paridah, M. T. & Choo, S. C. Y. (2016, November). *Super-fast drying method for oil palm lumber*. Paper presented at the Pameran Rekacipta, Penyelidikan dan Inovasi, Universiti Putra Malaysia, Malaysia.

Chudnoff, M. (1972). Void volume wood: An any tree-whole tree use concept. *Journal of Forest Production*, *22*(6), 49-53.

Corley, R. H. V. & Tinker, P. B. (2003). The oil palm. *Experimental Agriculture*, *4*, 1 -18.

Dungani, R., Jawaid, M., Khalil, H., Jasni, J., Aprilia, S., & Hakeem, K. (2013). A review on quality enhancement of oil palm trunk waste by resin impregnation: Future materials. *Journal of Bioresources*, 8(2), 4-6.

Ebadi, S., Karimi, A., Choo, A., Ashari, Z., Naji, H., Soltani, M., & Ridzuan, S. (2015). Physical behaviour of hydro-thermally treated oil palm wood in different buffered pH media. *Journal of Bioresources*, 10(3), 7-10.

Feng, L. Y., Tahir, P. M., & Hoong, Y. B. (2011). Density distribution of oil palm stem veneer and its influence on plywood mechanical properties. *Journal of Applied Sciences*, *11*, 824-831.

Githiomi, J., & Kariuki, J. (2010). Wood basic density of Eucalyptus grandis from plantations in Central Rift Valley, Kenya: Variation with age, height level and between sapwood and heartwood. *Journal of Tropical Forest Science*, *22*(3), 281 –286.

Harun, J., & Loh, Y. (2017). *Oil palm trunk: 18 million logs and lets use it*. Retrieved from www.mtib.gov.my/repository/MTIB.pdf

Haslett, A. N. (1990). Sustainability of oil palm trunk for timber uses. *Journal of Tropical Forest Science*, *2*(3), 243-251.

Ho, Y. W., Varghese, G., & Aylor, G. S. T. (1985). Pathogenicity of *Fusarium oxysporum* isolates from Malaysia and *F. oxysporuin f. sp. elaeidis* from Africa to seedlings of oil palms (*Elaeis guineensis*). *Journal of Phytopathology, 114*(3), 193-202.

Keey, R. B., Langrish, T. A. G., & Walker, J. C. F. (2000). Wood-drying kinetics. *Kiln Drying of Lumber*, *2*(1), 65-115.

Lamaming, J., Hashim, R., Leh, C. P., Sulaiman, O., & Sugimoto, T. (2014). Chemical, crystallinity and morphological properties of oil palm trunk parenchyma and vascular bundle. *Journal of Bio-Technology and Environmental Engineering*, *2*(1), 68–72.

Lim, S. C., & Gan, K. S. (2005). Characteristic and utilisation of oil palm stem. *Journal of Forest Research Institute Malaysia, 35*, 139– 258.

Lim, S. C., & Khoo, K. C. (1986). Characteristics of oil palm trunk and its utilization. *Malaysian Forester, 49*(1–2), 3–22.

Massijaya, M., Darwis, A., Nurrochmat, D., Nugroho, N., Alamsyah, E., Bahtiar, E., & Safe`i, R. (2013). Vascular bundle distribution effect on density and mechanical properties of oil palm trunk. *Asian Journal of Plant Sciences*, *12*(5), 208-213.

Mokhtar, A., Hassan, K., Aziz, A. A., & Wahid, M. B. (2011). Plywood from oil palm trunks. *Journal of Oil Palm Research*, 23(12), 1159–1165.

Obahiagbon, F. I. (2012). A review: Aspects of the African oil palm (*Elaeis guineesis* jacq.) and the implications of its bioactive in human health. *American Journal of Biochemistry and Molecular Biology, 2*, 106-119.

Official Palm Oil Information Source. (2011). Retrieved from www.palmoilworld.org/about_malaysian-industry.html.

Othman, K., Yamani, S. A. K., Sahat, S., Shafie, A., Junaiza, A. Z., Latif, N. H., Aminudin, M., Hazlan, N. H. & Norashikin, K. (2013). Study on Drying of Oil Palm Trunk with Ethanol. Paper presented at Konferensi Akademik (KONAKA) 2013, 127-133. UiTM Cawangan Pahang, Malaysia.

Sulaiman, O., Hashim, R., Raza, K. W., Hashim, W. S., & Azmy, M. (2008). Evaluation on some finishing properties of oil palms plywood. *Holz Roh Werkst*, *66*, 5-10.

Sulaiman, O., Salim, N., Nordin, N. A., Hashim, R., Ibrahim, M., & Sato, M. (2012). The potential of oil palm trunk biomass as an alternative source for compressed wood. *Journal of Bioresources, 7*(2), 2688–2706.

Tan, K. T., Lee, K. T., Mohamed, A. R., & Bhatia, S. (2009). Palm oil: Addressing issues and towards sustainable development. *Renewable and Sustainable Energy Reviews, 13*(2), 420–427.

The Oil Palm Tree. (2013). Retrieved from www.mpoc.org.my/The_Oil_Palm_Tree.aspx.

William, T. S. (1985). Laser incising to increase drying rate of wood. *Wood Fiber Science*, *19*(1), 9–25.