

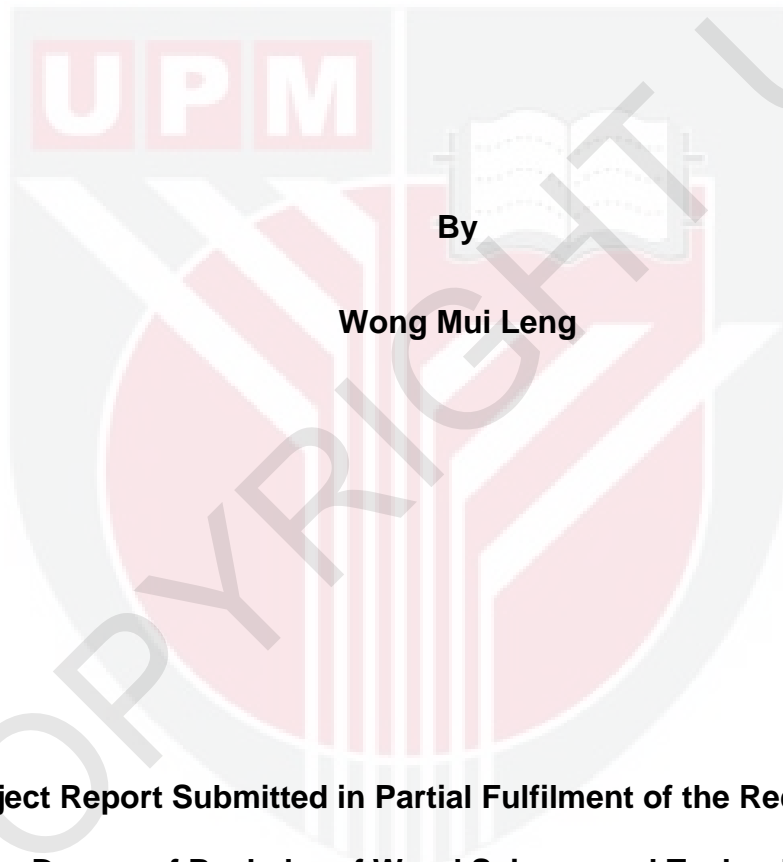


***PERFORMANCE OF LAMINATED SUPER-FAST DRIED OIL PALM
LUMBER BY USING THERMOPLASTIC POLYMERS
AS BINDING AGENT***

WONG MUI LENG

FH 2018 83

**PERFORMANCE OF LAMINATED SUPER-FAST DRIED OIL PALM
LUMBER BY USING THERMOPLASTIC POLYMERS
AS BINDING AGENT**



By

Wong Mui Leng

**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

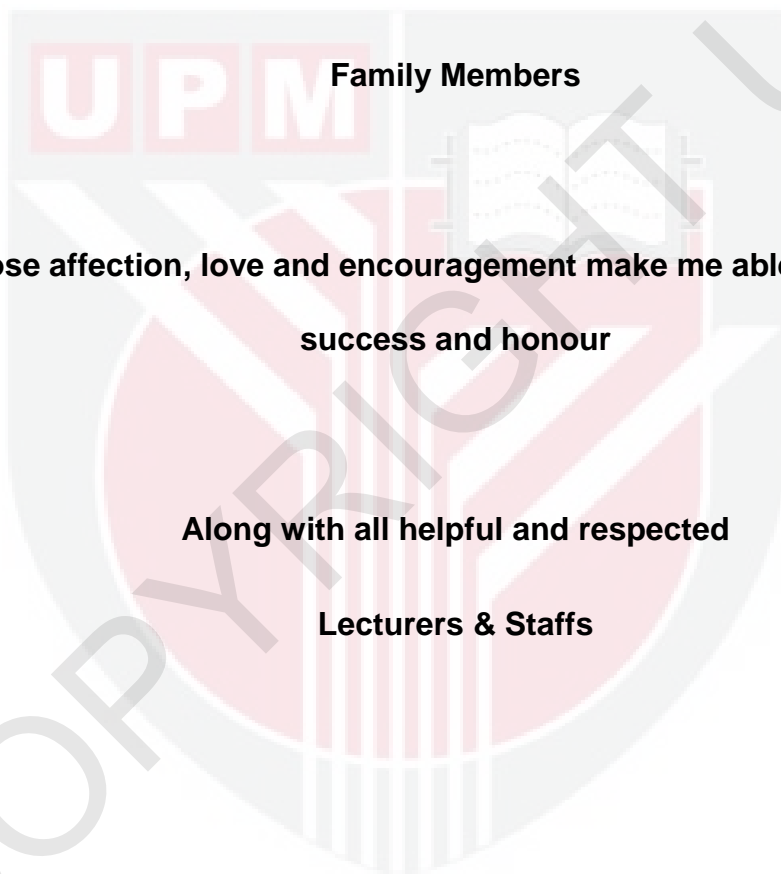
Universiti Putra Malaysia

2018

DEDICATION

Every challenging work needs self-efforts as well as guidance of elders especially those who were very close to our heart.

My humble effort I dedicate to my sweet and loving



Family Members

Whose affection, love and encouragement make me able to get such success and honour

Along with all helpful and respected

Lecturers & Staffs



ABSTRACT

Laminated lumber has uniform properties and higher strength which make it a superior structural wood composite product than other solid timber or glue-laminated timber. However, due to formaldehyde emission of commercial adhesive and reduction of log production from forest, efforts have been made to use alternative materials such as oil palm trunk to produce laminated board with thermoplastic polymer as binding agent. This study was undertaken to determine the gluing condition and physio-mechanical properties of laminated super-fast dried oil palm lumber by using thermoplastics as binding agent. In this study, two different types and forms of thermoplastics were used as binding agent for laminated super-fast dried oil palm lumber. The results revealed that laminated super-fast dried oil palm lumber with optimum physical (thickness swelling and water absorption) and mechanical properties (bending properties and shear strength) was produced using high density polyethylene in powder forms as binding agent.

ABSTRAK

Papan berlamina mempunyai sifat yang serata and kekuatan yang tinggi menjadikan ia satu produk kayu komposit yang dititikberatkan selain kayu keras atau papan berlapis. Tetapi, oleh sebab plepasan formaldehid daripada perekat komersial dan pengurangan keluaran kayu balak dari hutan, usaha untuk mencari bahan alternative telah dijalankan seperti balak kelapa sawit diguna untuk menghasilkan papan berlamina dengan termoplastik polimer sebagai ajen penjilidan. Kajian ini dijalankan untuk menentukan keadaan perekat dan sifat fizikal, juga sifat mekanikal 'super-fast dried' papan kelapa sawit berlamina yang menggunakan termoplastik sebagai bahan perekat. Dalam kajian ini, dua berlainan jenis dan bentuk termoplastik telah digunakan sebagai bahan perekat kepada 'super-fast dried' papan kelapa sawit berlamina. Hasil kajian ini membuktikan bahawa 'high density polyethylene' dalam bentuk serbuk memberi sifat fizikal dan mekanikal yang optimum kepada 'super-fast dried' papan kelapa sawit.

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APPROVAL SHEET

I certify that this research project entitled "Performance of Laminated Super-fast Oil Palm Lumber by using Thermoplastic Polymer as Binding Agent" by Wong Mui Leng has been examined and approved as a partial fulfilment of the requirement for the degree of Bachelor of Wood Science Technology in the Faculty of Forestry, Universiti Putra Malaysia.

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LIST OF ABBREVIATION

ANOVA	Analysis of variance
B	Flexural Bending
EN	European Standard
EPA	Environmental Protection Agency
FRIM	Forest Research Institute Malaysia
HDPE	High density polyethylene
LDPE	Low density polyethylene
LVL	Laminated Veneer Lumber
MC	Moisture Content
MDF	medium density fibreboard
MOE	Modulus of Elasticity
MOR	Modulus of Rupture
NFPC	Natural fibre polymer composite
NFRPC	Natural fibre reinforced polymer composite
OPL	Oil Palm Lumber
OPT	Oil Palm Trunk
OPW	Oil Palm Wood
PF	Phenol formaldehyde
SPSS	Statistical Package for Social Science
SWP	Solid wood panel
TS	Thickness Swelling
UF	Urea formaldehyde
WA	Water Absorption
WPC	Wood plastic composite

CHAPTER 1

INTRODUCTION

1.1 Background

In recent years, the words such as “environmental friendly”, “going green” and “eco-friendly” have become buzz phrases on commercials, talk shows and product packaging. The terms “eco-friendly” literally means not harmful to the environment (Eco-friendly, n.d.). While, eco-friendly product refers to the product that do not contribute to the water, air and land pollution. A truly eco-friendly product will keep both environmental and human safety. At a minimum, the product has no toxicity. Therefore, all the agencies and industries including wood industry, try to figure out ways to produce an eco-friendly product or implement environmentally friendly practices into their products.

Formaldehyde emission is one of the safety and health issue that concerned by agencies such as United State Environmental Protection Agency (EPA), California Air Resources Board, Occupational Safety & Health Administration (OSHA). Formaldehyde is a colourless gases with pungent smell. It can be flammable at room temperature. Usually, formaldehyde can be found in resins and binding agent such as urea formaldehyde (UF) and phenol formaldehyde (PF) that used in the manufacture of composite wood products like particle board, medium-density fibreboard (MDF) and plywood. Exposure to formaldehyde emission lead to negative health effect to human such as irritation of skin, eyes and noses. In addition, high level of exposure to formaldehyde emission can lead to cancer diseases. Therefore, United State

Environmental Protection Agency (EPA) published a final rule in the Federal Register in order to reduce the exposure to formaldehyde emissions from certain wood products produced domestically or imported into United State on December 12, 2016 (Formaldehyde Emission Standards for Composite Wood Products, 2017).

Thermoplastic, also known as thermo-softening plastic, is a plastic polymer which becomes shape able and mouldable after heating above a specific temperature and returns to a solid form after cooling (Thermoplastics, 2017). As UF and PF release the formaldehyde emission, alternative or new binding agent is needed in order to solve this problem. The advantage of thermoplastics is thermoplastic does not have formaldehyde emission. Therefore, thermoplastics have the potential to replace commercial binding agents in wood composite product industry.

Besides, Malaysia is the second largest of producers and exporters of oil palm in the world (Workman, 2016). Oil palm tree has an economic life about 25 years. After that, replanting will be carried out because the production of oil palm fruits start to decrease after 25 years. The extensive development in palm oil sector has created critical environmental problem during the production chain. Oil palm trunk (OPT) usually left aside after replanting process, it not only can lead to land pollution, but also affect the growth of young oil 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.

OPT is a lignocellulosic material exists in huge amount, but low in quality. It has poor dimensional stability, bad machining properties, low strength and susceptibility to bio gradable agents (Bakar et al., 2013). As a result, OPT is still underutilised by industry in Malaysia due to the poor properties and difficulties in drying process. High cost and long-time are needed, and yet the dried lumber show severe defects (Dungani et al., 2013). High density variation and high moisture content (MC) variation from outer layer to core layer of OPT lead to difficulties in drying process.

Super drying method is the method which helps to solve the drying problems and improve the efficiency of drying process (Bakar et al., 2013). This drying method requires two process which are thermal modification and densification process. Before that, holes are formed on one surface oil palm lumber to fasten the drying process. The advantages of this drying methods are fully utilised all parts of oil palm trunk which consists of outer and inner part, drying process only required 3 hours and the quality of dried oil palm lumber can be guaranteed. However, the holing surface deducts the commercial value. Thus, laminated board is suggested as the end product which the holing surface of super-fast dried lumber is binding together using thermoplastic.

Laminated lumber can be defined as one type of engineered wood product, where two or more layers of lumber is used and bind together using adhesive or binding agent. This concept is quite similar with Laminated veneer lumber (LVL) or glulam, the differences are the thickness of laminates and the number

of laminates layer. In this research, two pieces of super-fast oil palm lumber bind together using thermoplastic and form two layers of laminates.

A few physio-mechanical properties of laminated board will be evaluated. Physical properties such as water absorption and thickness swelling will be tested. For mechanical properties, flexural test will be conducted to determine the Modulus of Elasticity (MOE) and Modulus of Rupture (MOR), while shear strength test will be conducted to evaluate the shear strength and gluing condition of laminated super-fast dried OPL. It is expected that laminated lumber which using HDPE is better than laminated board which using LDPE as binding agent. Besides, it is expected that laminated lumber which using powder form thermoplastics as binding agent is better than granule form thermoplastics.

1.2 Problem Statement and Justification

Formaldehyde emission from wood composite panel which using the commercial adhesive (UF and PF) is the most important problem statement in this research. Formaldehyde is a colourless gas with a pungent smell. These composite panel will emit formaldehyde due to the adhesive used during manufacturing. Formaldehyde brings toxicity to human and environment. Some individuals may having adverse effects such as coughing and skin irritation when the formaldehyde in the air at levels exceeding 0.1 ppm ("Formaldehyde", 2017). High level of exposure to formaldehyde emission can lead to cancer diseases. Therefore, thermoplastic which has no formaldehyde emission is chosen as binding agent to replace the commercial adhesive.

Besides, the production of logs from natural forest reduced and the supply is limited due to National Forest Policy (NFP) and Sustainable Forest Management (SFM) that are implemented in Malaysia's forest (National Timber Industry Policy 2009 – 2020, 2009). But, there is availability of Oil Palm Trunk as the oil palm will be replanted when there is reduction of oil palm fruit production. Most of the oil palm trunk is felled and left it in the plantation, because oil palm trunk has poor machining properties, physical and mechanical properties. The oil palm mills produce up to 18 million OPT biomass every year (Harun & Loh, 2017). The OPT resources are huge in amount, and it is also considered as natural lignocellulosic polymer such as wood. Therefore OPT is used as an alternative material for wood composite product. Other than that, wastage of natural resources also can be prevented.

After that, super-fast drying method is introduced by Bakar et al. in 2016. This method not only can improve the efficiency of drying, but also minimize the defects happened during drying process. However, these super-fast dried lumber has its limitation - the poor appearance of the holing surface which is not pleasant to be a final product. Therefore, the surface of the super-fast dried lumber should be embellished for commercialization. Laminated board is one of the solution to solve the poor appearance of holing surface, where two pieces of super-fast oil palm lumber (OPL) is binded together with thermoplastic to form two layer of laminates.

1.3 Objectives

The general objective of this study is to produce high performance laminated super-fast dried oil palm lumber (OPL) with thermoplastic polymer as binding agents. This study also was aimed to evaluate the gluing condition of laminated super-fast dried OPL with different types and forms of thermoplastics as binding agent. Besides, the physio-mechanical properties of laminated super-fast dried OPL were determined.

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