BONDING PROPERTIES OF ACACIA MANGIUM FOR CROSS-LAMINATED TIMBER (CLT) MANUFACTURE

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BONDING PROPERTIES OF *ACACIA MANGIUM* FOR CROSS-LAMINATED TIMBER (CLT) MANUFACTURE

BY

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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

For my beloved family:

Mohd Zaili Bin Ghazali

Sharinah Binti Said

Also my siblings,

To all my friends,

People that involves in my project

Thank you for your encouragements and supports

And the sacrifices that you have given.

Thank you for everything. May Allah Bless All of us

ABSTRACT

This study aim is to evaluate bonding properties of *Acacia mangium* wood for lamination process. Shear performance of the laminated panel were evaluate for suitability of two different adhesives, phenol-resorcinol formaldehyde (PRF) and one-component polyurethane (PUR). Delamination tests were performing on samples that were subjected to accelerated aging to assess the durability of bonds in severe environmental conditions. Both tested adhesives produced boards with shear strength values within the edge bonding requirements of prEN 16351 for all manufacturing pressures. The PRF bonded specimens demonstrated superior durability characteristics in the delamination tests, while the PUR bonded specimens had the highest shear strength.

ABSTRAK

Kajian ini bertujuan untuk menilai sifat ikatan kayu *Acacia mangium* untuk proses laminasi. Prestasi ricih panel berlapis telah dinilai untuk kesesuaian dua pelekat yang berbeza, fenol-resorcinol formaldehyde (PRF) dan satu komponen poliuretana (PUR). Ujian pemeriksaan dilakukan terhadap sampel yang tertakluk kepada penuaan dipercepatkan untuk menilai ketahanan bon dalam keadaan alam sekitar yang teruk. Kedua-dua pelekat yang diuji menghasilkan papan dengan nilai kekuatan ricih dalam keperluan ikatan ikatan prEN 16351 untuk semua tekanan pembuatan. Spesimen terikat PRF menunjukkan ciri-ciri ketahanan yang lebih baik dalam ujian pengecualian, manakala spesimen terikat PUR mempunyai kekuatan ricih tertinggi.

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APPROVAL SHEET

This project report entitled "**Bonding Properties Of *Acacia mangium* for cross-laminated timber (CLT) manufacture**" is prepared by **Asnawi Nazran Bin Mohd Zaili (178755)** and submitted to the Faculty of Forestry in fulfillment of the requirement of FHH 4999 (Final Year Project) for the award of the degree of Bachelor of Wood Science Technology in Faculty of Forestry, Universiti Putra Malaysia

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LIST OF ABBREVIATIONS

CLT	Cross laminated timber
GLULAM	Glued-laminated timber
Kg/m^2	kilogram/meter^2
Kg/m^3	kilogram/meter^3
MC	Moisture content
MF	Melamine-formaldehyde
mm	Millimeter
MUF	Melamine-urea-formaldehyde
pMDI	Polymeric methylene-diphenyl-diisocyanate
PRF	Phenol resorcinol formaldehyde
PUR	One component polyurethane
PVAc	Polyvinyl acetate
SG	Specific gravity
UF	Urea-formaldehyde

CHAPTER 1

INTRODUCTION

1.1 Background of study

Acacia mangium are leguminous tree species of the sub-family Mimosoideae. Native to north Queensland, Australia, the trees are also found in Asian country such as Malaysia, Indonesia and Thailand (Harwood & Nambiar CSIRO, 2014). On account of their fast growth, good form and utilization potential of the timber, these species have been chosen as plantation species in Malaysia (Lawrence & Dey, 2013). *A.mangium* is a tropical tree species capable of colonizing difficult sites. It is important attributes include rapid early growth, good wood quality (for pulp, sawn timber, and fuel wood), and tolerance of a range of soil types and pH (Ratnasingam, Thiruselvam, & Ioras, 2016). It produces pulp logs and small saw logs on rotations as short as 7 years. *A.mangium* is known to have exceptionally low allelic diversity compared to other forest trees, as assessed by isozyme analysis (Hai, Duong, Toan, & Ha, 2015). This uniqueness made *A.mangium* as one of the main component in national forestation programs (Palma, 2014). The assessment of timber quality may involve anatomical, physical, mechanical and bonding properties of wood which are crucial when deciding the end uses of the timber. Certain features are good general indicators of timber properties and uses for instance fibre morphology for pulp and paper, bonding properties for laminated board and panel products, and mechanical properties for structural use.

Nonetheless, little information is available about the bonding properties of *A.mangium*. The density or specific gravity (SG) of *A.mangium* varies depending on the origin of the wood which ranges from 500 to 600 kg/ m^3 (Sarmin, Rosman, Kasim, Abdul, & Yamani, 2014). *A.mangium* wood from the natural stands is normally about 0.6. According to the apparent density of *A.mangium* is 520kg/m^3 at 12% moisture content, the volumetric contraction is 0.37%, total tangential contraction is 7.0%, total radial contraction is 3.1% which is considered as moderately stable (Gutemberg, Segundinho, Caiado, & França, 2015). However, (Wahab, Ghani, Samsi, & Rasat, 2017) stated that this fast-growing species has some disadvantages such as it has high proportion of juvenile wood, poorly developed heartwood and fast rate of growth that resulted in wide growth rings which eventually lowers its density of wood and dimensional stability as well as increases biodegradation rate. (Hegde, Palanisamy, & Yi, 2013) reported that the timber seasons fairly rapidly without developing serious defects, and responds satisfactorily to preservative treatment. The timber planes well and sands easily, producing smooth surface without torn fibres. It also drills satisfactorily and turns well, requiring only low to moderate pressure.

1.2 Problem statement

Bonding properties is the important factor in making laminated product. Poor bonding properties may produce low quality of product. *A.mangium* had been reported to have low wettability (Tenorio & Moya, 2011) thus it's not easy to be bonded. *A.mangium* contain heart rot (Ratnasingam & Scholz, 2008) which typical white rot caused by hymenomycetes, that attacks cellulose and lignin. Its development is associated with changes in colour, texture and appearance of rotted wood. These features were used as

the basis for the rapid assessment of the incidence and severity of heart rot on harvested log- ends in the field (Mohammed, Barry, & Irianto, 2006). Therefore, it must be cut in smaller dimension, hence requires a lot of bonding to make acacia wood as product. Since *A.mangium* has low surface wettability, it is difficult to be penetrated by adhesive (Miyazaki & Hirabayashi, 2011). Several studies reported that this wood has poor bonding properties compared to rubber wood (Alamsyah, Nan, Yamada, Taki, & Yoshida, 2007). In the CLT construction, a good bonding integrity is very crucial as it determines how much load can be carried by the panel. Thus, this study would provide an information on the performance of laminated *A.mangium in* terms shear strength and adhesive compability.

1.3 Objectives

This study aims to evaluate the effects of adhesive types and spread rate on the bonding properties of cross laminated *A. mangium*.

1) To evaluate the adhesion properties of *A.mangium.*
2) To evaluate the effect of adhesive types and spread rate on the bonding properties of laminated *Acacia mangium*.

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