



Faculty of Engineering

IMPROVEMENT OF COMPOSITE WOOD PROPERTIES MADE FROM WOOD WASTE CHIPS

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Bachelor of Engineering with Honours
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WOOD WASTE CHIPS**

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This project is submitted in partial fulfilment of the requirements for the degree of
Bachelor of Engineering with Honours
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2009

Dedicated to my beloved family and friends

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ABSTRAK

Penghasilan kayu komposit seperti “particleboard” adalah satu cara yang baik untuk mengitar semula sisa kayu yang dihasilkan daripada aktiviti perindustrian. “Particleboard” digunakan secara meluas kerana kos yang rendah dan spesifikasi yang boleh dikawal. Maka, memperbaiki sifat “particleboard” merupakan satu tugas yang penting untuk meningkatkan potensi “particleboard” untuk prestasi yang lebih baik dan aplikasi yang lebih meluas. Tujuan ujikaji ini adalah memperbaiki sifat mekanikal dan fizikal “particleboard” dengan menggunakan salutan permukaan. Salutan permukaan yang dipilih untuk projek ini adalah varnis kayu poliuretane, cat kilau, cat laker dan kulit kayu. Salutan permukaan digunakan pada “particleboard” untuk mencapai pembaikan dalam modulus elastik, modulus pecah, penyerapan kelembapan, dan pertambahan ketebalan. Hasil ujian yang diperolehi telah dianalisis untuk menentukan keberkesanan setiap salutan permukaan untuk memperbaiki “particleboard”. Hasil daripada ujian telah menunjukkan bahawa kulit kayu berkesan dalam memperbaiki sifat-sifat mekanikal “particleboard” manakala varnis kayu poliuretane amat berkesan untuk memperbaiki sifat-sifat fizikal “particleboard”. Namun begitu, setiap salutan permukaan mempunyai ciri-ciri dan sifat-sifat yang berlainan yang dapat memperbaiki “particleboard” dengan cara tersendiri. Data mengenai pembaikan yang dicapai oleh setiap salutan permukaan boleh dijadikan rujukan yang berguna untuk pengeluar dan pengguna dalam pemilihan salutan permukaan yang sesuai untuk aplikasi “particleboard” tertentu.

ABSTRACT

Producing composite wood such as particleboard is a great way to recycle wood waste produced from the industrial activities. Particleboard is widely used due to its low cost and controllable specification. Therefore, improving the properties of the particleboard is an important task in order to extend the potential of particleboard for greater performance and more diversity of applications. The aim of this study is to improve the mechanical and physical properties of particleboard by using surface coating. The surface coatings chosen for the project are polyurethane wood varnish, gloss paint, lacquer paint, and wood veneer. Surface coatings were used on the particleboard to achieve improvements on modulus of elasticity, modulus of rupture, moisture absorption and thickness swelling. Test results obtained were analyzed to determine the effectiveness of each surface coating to improve the particleboards. Result obtained from the tests showed that wood veneer could effectively improve the mechanical properties of the particleboard while polyurethane wood varnish was excellent in enhancing the physical properties of particleboard. Nevertheless, each surface coating has different characteristics and properties which can improve the particleboard in its unique way. The data on the improvements achieved by each surface coating could become useful reference for manufacturers and users to select suitable coatings for particleboards with specific application.

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LIST OF ABBREVIATIONS

OSB	-	Oriented strand board
UF	-	Urea Formaldehyde
PF	-	Phenol Formaldehyde
MF	-	Melamine Formaldehyde
UMF	-	Urea-Melamine Formaldehyde
CPL	-	Continuous Press Laminates
MDF	-	Medium Density Fiberboard
MR	-	Moisture Resistant
MDI	-	Methylene Diphenyl di-Isocyanate
PVA	-	Poly Vinyl Acetate
EVA	-	Ethyl Vinyl Acetate
PVC	-	Poly Vinyl Chloride
MOE	-	Modulus of Elasticity
MOR	-	Modulus of Rupture
IB	-	Internal Bond
TS	-	Thickness Swelling
ASTM	-	American Society for Testing and Material
BS EN	-	British European Standard
DIN	-	German Institute for Standardization
E_B	-	Modulus of Elasticity in Bending
σ_f	-	Flexural Stress
ε_f	-	Flexural Strain

RC	-	Resin Content
M _t	-	Moisture Content
JIS	-	Japanese Industrial Standard
MPa	-	Mega (10 ⁶) Pascal

CHAPTER 1

INTRODUCTION

1.1 Introduction

In this chapter, topic such as background study, objectives, problem statement, scope of study and importance of study will be discussed. All the related topics for this thesis will be briefly introduced in this chapter.

1.2 Background Study

Wood waste is one of the highly produced wastes in this country, and illegal disposal of this waste either into the rivers or by combusting is a very serious environmental issue. It is estimated that 175,000 tonnes of wood waste are produced annually in the state of Sarawak alone [1]. Wood wastes are generated in massive amount from processing mills, saw mills, logging activities, furniture manufacturing plants, constructions and demolition sites. Recycling of the wood waste can be done in many ways and one of them is by using the wood waste to manufacture composite wood.

Composite woods, or also known as the engineered woods are wood products that are engineered by using wood as the main material. The wood used for the manufacturing of composite wood can varied in various form, from chips, strands, fibres, veneer or particles form together with addition of adhesives to produce a new product [2]. Besides using wood as main materials, other lignin containing natural fibres such as wheat straw, rice husk, sugar cane, hemp stalks, and rye stalks can also be used to produce similar products with composite wood. Types of engineered woods includes glued laminated timber, I-joist, multi-laminar veneer, plywood, laminated veneer lumber, parallam, parallel strand lumber, fiberboard, particleboard, strawboard and wood plastic composites [2].

Particleboard is a type of composite wood made from wood particles typically by using wood chips that is bonded with resins and then pressed under high pressure and temperature. The wood chips used for the production of particleboard can be produced by chipping wood logs but more commonly the wood chips used are from wood waste generated from construction and demolition sites, as well as saw mills and other wood processing factories. The particleboards fabricated by using wood waste chips can be generally applied as flooring, wall and ceiling panels, office dividers, bulletin boards, furniture, cabinets, counter tops, and desk tops [3].

There are basically few main types of particleboard. These includes standard particleboard, single layer particleboard, waferboard, oriented strand board (OSB), moisture resistant particleboard, high performance particleboard, particleboard flooring, melamine faced particleboard, underlayment particleboard, and urea-bonded fine-furnish particleboard. Each of the particleboard has its own

characteristics and unique properties from each other to suit a particular environment and application.

Resin is one of the integral parts of composite wood as a binder to glue the particles of the wood together. Common types of industrial used resin are Urea formaldehyde (UF), phenol formaldehyde (PF), melamine formaldehyde (MF), and methylene diphenyl diisocyanate or polyurethane resins. There is an issue that is raised on the use of formaldehyde based resin which is formaldehyde release. Formaldehyde is a ubiquitous chemical compound that is dangerous to human health if there is an over exposure in a long period of time.

Surface coating is a kind of finishing that was used mainly to decorate the surface of wood based products. Besides as a mean of decoration, some surface coating is also effective in preventing termites and improving moisture resistance. There are basically a few surface coatings that are used in the wood based products, such as wood veneer, paint, melamine papers, CPL (continuous press laminates), high and low pressure laminates and powder coatings. Each coating varied from appearance, pricing, usage and duration, depends on the condition where the products are going to be used.

1.3 Objective

The objective of this research is to improve the particleboard made from wood waste chips by using surface coatings. The study will test the improvements

achieved by particleboard coated with polyurethane, gloss paint, lacquer paint, and wood veneer. Test conducted include 3 point bending test, thickness swelling test and moisture absorption test. The properties compared are modulus of elasticity, modulus of rupture, moisture absorption and thickness swelling.

1.4 Problem Statement

The aim of this study is to improve the particleboard properties made from wood waste chips. The improvement on the particleboard will provide local industries with particleboards of better quality for various type of application. The study will also analyze the effectiveness of different surface coating on the mechanical and physical properties of particleboards.

The study for the improvement for properties of particleboard made from wood waste chips is to promote an alternative way to recycle wood waste chips produced from local logging and milling industries. Through the recycling, the cost for waste disposal can be cut down and the environmental effects due to the disposal can be reduced.

The reason for the use of surface coatings as a mean to improve the physical and mechanical properties is because the method is easy to apply and can still be used on existing particleboards that are already in use. Surface coating can also help to improve the aesthetics of the particleboard.

1.5 Scope of Study

This project will study on the effect of various surface coating to improve the physical and mechanical properties of particleboards. The surface coatings that are going to be studied are polyurethane, gloss paint, lacquer paint, and wood veneer. The physical and mechanical properties that will be involved for analysis are modulus of elasticity, modulus of rupture, moisture absorption and thickness swelling. The thesis will also analyze the surface coating in terms of cost, aesthetics and ease of application.

1.6 Importance of Study

The project will research on the use of wood waste chips as raw material for fabricating particleboards. The study will also compare the improvements of each surface coating will have on the physical and mechanical properties of the particleboard. The test result will provide the user and manufacturer the data on the improvements of the particleboard properties with different types of coating. This data will help in terms of surface coating selection and different types of application.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

For this chapter, topic that will be discussed includes wood waste recycling, composite wood, particleboard, resin, formaldehyde release, surface coating, standard testing and particleboard properties. These topics were elaborated in details with the support of literatures such as books, journals, and articles.

2.2 Wood Waste Recycling

Wood waste is one of the highly produced wastes in this country, and illegal disposal of this waste to rivers and landfills or through combustion has been a serious issue. According to the Ministry of Sarawak environment and public health, it is estimated that 175,000 tonnes of wood waste are produced from industries yearly in the state of Sarawak in 2006 [1]. Wood wastes are generally produced from processing mills, logging activities, saw mills, furniture manufacturing plant, construction and demolition

sites. Disposal of wood waste through landfills but landfills need to be rapidly built to accommodate large amount of waste [4]. Beside that, wood waste in the environment might cause some environmental side effects [5]. The biodegradation of wood can generate methane and carbon dioxide which are the gases that contributes to the global warming. Beside that, disposal of wood in landfills also encourage the formation of leachate, which was a kind of noxious liquid that consumed oxygen in the water and caused problem to the aquatic environment. To avoid the option of disposing through landfills, wood waste are now being reused or recycled for many purposes. Wood waste in mass quantity is used for electric generation and also as raw materials for furniture manufacturing of composite wood. The composite wood produced are usually urea formaldehyde bonded particleboard or fiberboard. Besides composite wood, wood waste is also reused as animal bedding, cat litter, mulches, and composting [6].

2.3 Composite Wood

Composite woods, or also known as the engineered woods are wood products that are engineered by humans by using wood as the main material. The wood used for the manufacturing of composite wood can varied in various form, from chips, strands, fibres, veneer or particles form together with addition of adhesives to produce a new product [2]. Besides using wood as main materials, other lignin containing natural fibres such as wheat straw, rice husk, sugar cane, hemp stalks, and rye stalks can also be used to produce similar products with composite wood. Types of engineered woods includes glued laminated timber, I-joist, multi-laminar veneer, plywood, laminated veneer lumber,