UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FABRICATION OF WOOD PLASTIC COMPOSITES FROM *LALANG* GRASS AND POLYPROPYLENE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia (UTeM) for the Bachelor Degree of Manufacturing Engineering (Engineering Materials) with Honours.

by

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I hereby, declared this thesis entitled "Fabrication of Wood Plastic Composite From *Lalang* Grass and Polypropylene" is the results of my own research except as cited in references.

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APPROVAL

This PSM submitted to the senate of UTeM and has been as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Material Engineering). The members of the supervisory committee are as follow:

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ABSTRACT

This study is discussed about the fabrication of wood plastic composite from *lalang* grass and polypropylene. From this study, effect on composite panel by using two different processes such as mixing process and extrusion process are carried on. In this study it is begins with the preparation of *lalang* fiber into a short form. When the preparation of *lalang* grass fiber is done, *lalang* grass fiber reinforced polypropylene composites in different volume fraction of ratio will be prepared. From this study, the weight ratio of the *lalang* grass fiber is 0 wt. %, 5 wt. %, 15 wt. % and 25 wt. %. Firstly, the *lalang* grass and polypropylene are mixed either using internal mixer machine at temperature of 190°C about 10 minutes or put the mixture into extruder to form extrudate. Then, it is gone into crusher machine to form granule. The granule is then pressed to form composite panels by hot pressing process. After that, the composite panels are cut to desired dimension of specimen according to ASTM standard. The specimens are tested to measure their mechanical properties through tensile, flexural, impact and also hardness test. From this study, the composite which is produced by mixing process is better than composite which is produced by extrusion process. Composite which is produced by extrusion process is more brittle than composite which is produced by mixing process. From the research, the composition with 5 wt. % of fiber shows the best composition for mechanical properties for both processes.

ABSTRAK

Kajian ini adalah berkaitan dengan penghasilan bahan komposit berbentuk kayu. Dalam kajian ini akan melihat kesan penggunaan dua proses yang berbeza, iaitu proses percampuran dan proses *extrusion* untuk menghasilkan komposit asli. Kajian ini dimulakan dengan penyediaan gentian pendek rumput lalang. Apabila penyediaan gentian pendek rumput lalang sudah selesai, komposit polipropilena tetulang rumput lalang digunakan dengan nisbah berat yang berbeza. Dalam kajian ini, nisbah yang disediakan untuk rumput *lalang* adalah 0 wt. %, 5 wt %, 15 wt. % dan 25 wt. %. Pada mulanya, rumput lalang dan polipropilena dicampurkan pada suhu 190 darjah *Celsius* selama 10 minit dengan mengunakan mesin *internal mixer* atau campuran tersebut dimasukkan ke dalam mesin *extruder* untuk menghasilkan *extrudate*. Selepas itu, ia akan dimasukkan ke dalam mesin penghancur untuk menghasilkan butiran-butiran kecil. Butiran-butiran kecil ini kemudian ditekan untuk menghasilkan panel-panel komposit dengan proses penekanan panas. Setelah itu, panel-panel komposit ini dipotong mengikut ukuran-ukuran yang disarankan dalam piawaian ASTM. Specimen-specimen ini seterusnya dikaji bagi ciri-ciri mekanikal seperti ketegangan, pembengkokan, ujian impak dan juga ujian kekerasan. Dalam kajian ini, komposit yang dihasilkan oleh proses pencampuran adalah lebih baik daripada komposit yang dihasilkan oleh proses *extrusion*. Komposit yang dihasilkan daripada proses *extrusion* adalah lebih rapuh daripada komposit yang dihasilkan oleh proses pencampura. Hasil kajian dengan komposisi percampuran 5 wt. % adalah nisbah terbaik bagi sifat-sifat mekanikal untuk kedua-dua proses.

DEDICATION

For my beloved family

My father, Lau Hieng Yew,

My mother, Tang Chuoi Tieh,

My elder brother, Michael Lau,

My younger brother, David Lau,

Thank you for everything.

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LIST OF ABBREVIATIONS

AERT	-	Advanced Environmental Recycling Technologies
ASTM	-	American standard test method
CMC	-	Ceramic matrix composite
FRP	-	Fiber reinforced polymers
HDPE	-	High density polyethylene
MAPP	-	Maleic anhydride grafted polypropylene
MMC	-	Metal matrix composite
MPP	-	Maleated polypropylene
PE	-	Polyethylene
PMC	-	Polymer matrix composite
PP	-	Polypropylene
PS	-	Polystyrene
PVC	-	Polyvinyl chloride
U.S.A	-	United State of America
UTS	-	Ultimate Tensile Strength
UV	-	Ultra violet
WPCs	-	Wood Plastic Composites
Wt. %	-	Percentage of weight
S.I.	-	International System
ISO	-	International Organization of standardization
PSM	-	Projek Sarjana Muda

LIST OF SYMBOLS

g	-	gram
cm^3	-	cubic centimeter
mm	-	millimeter
ft	-	feet
$	-	US dollar
A_0	-	original area
Li	-	instantaneous length
L_0	-	initial length
Pa	-	pascal
F	-	Load at the fracture point
L	-	Length of support span
B	-	Specimen width
d	-	Specimen thickness
Wf	-	Work of fracture of fibers
Wm	-	Work of fracture of matrix
Wmf	-	Work due to fiber and matrix interactions such as sliding, debonding, fiber pullout
Wi	-	crack initiation energy
m/s	-	meter per second
μ	-	micro
rpm	-	revolution per minute
d	-	distance

CHAPTER 1

INTRODUCTION

Wood plastic composites (WPCs) are defined as filled thermoplastics which are consisted primarily of wood fiber and thermoplastic polymer. Thermoplastics such as polyethylene (PE), polyvinyl chloride (PVC), and polypropylene (PP) are currently being utilized for a variety of commercial products including automotive trim, window frames and roof singles.

If compared with log timbers, WPCs exhibited an increase in durability with minimal maintenance. Wolcott (2001) found that the addition of 40 to 50 percent wood improved thermal stability while the thermoplastic component improved moisture and thermal formability. When it exposed to moisture, WPCs absorb less moisture at a slower rate, leading to superior fungal resistance and dimensional stability when compared to log timbers (Clemons, 2002). Waterfront applications were also demonstrated that WPC materials exhibit an improvement in the durability with respect to check, decay, termites and marine organisms in contrast to log timbers (Balma and Bender, 2001).

There has recently been a dramatic increase of interest in using biomass materials such as wood or agricultural fibers as replacements for glass to reinforce thermoplastic composites because the wood material offers several advantages over inorganic fillers such as its low price, biodegradability, renewability, recycle-ability, low density and others. Because of those advantages, the use of natural fibers as fillers for plastic has been rapidly expanding.

1.1 Statement of the Purpose

The purpose of this study is to analyze the mechanical properties such as tensile, flexural and impact test of *lalang* grass fiber reinforced polypropylene composites with different volume fraction of ratio which tested in this study are

(a) 100wt. % of polypropylene.
(b) 5wt. % of *lalang* grass fiber, 95wt. % of polypropylene.
(c) 15wt. % of *lalang* grass fiber, 85wt. % of polypropylene.
(d) 25wt. % of *lalang* grass fiber, 75wt. % of polypropylene.

1.2 Hypotheses

The use of different volume fraction ratio of *lalang* grass fiber as reinforcement will affect the mechanical properties of *lalang* grass fiber reinforced polypropylene composites.

1.3 Problem Statements

WPC which is fabricated by *lalang* grass and polypropylene is a new research and it is potentially leads to production of economically viable products which could have positive consequences for the WPC industry. It is because it can be easily obtained from natural resources and they can be made relatively easily. Besides that, they offer the possibility of resolving various environmental problems such as green house gases emission.

1.4 Objectives

The purposes of this project are

(a) To study mixing processes that is using extrusion process and mixer process for *lalang* grass/polypropylene composite fabrication.

(b) To study the mechanical properties of the *lalang* grass fiber reinforced polypropylene composites in different volume fraction.

1.5 Scope of Study

The composites are fabricated by using internal mixer machine or extruder machine. After that, it will be sent to hot press machine to form composite panel after granule is formed. Mechanical testing such as tensile test, flexural test and impact test are carried out on both mixer product and extrusion product. Then, their mechanical properties are identified and analyzed.

1.6 Research Frame

This study is done with 5 main chapters which are introduction, literature review, methodology, result and discussion. Conclusion and recommendation is the final part of this study. Chapter one briefly explained the statement of the purpose, hypothesis, problem statements objective and scope. Chapter two is discussed about the theory of composite, definition of WPC, types of fillers used in WPC and WPC manufacturing process. Mechanical testing on the WPC and some previous research for WPC also discussed in Chapter two. Chapter three is discussed about the manufacturing process on WPC from *lalang* grass and PP. This chapter also included the test and analysis for the product. In Chapter four, all the result based on the test of the specimens is attached. There are some discussion done regarding to the result that obtained. For the Chapter five, conclusion is made by referring to the result that obtained and objective. Recommendation to the future work on this study is also discussed in this chapter.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction of Composite

Composite material is a material composed of two or more distinct phases. They are matrix phase and dispersed phase. Composite having bulk properties significantly different form those of any of the constituents.

(a) Matrix phase

The primary phase, having a continuous character, is called matrix. Matrix is usually more ductile and less hard phase. It holds the dispersed phase and shares a load with it.

(b) Dispersed (reinforcing) phase

The second phase (or phases) is imbedded in the matrix in a discontinuous form. This secondary phase is called dispersed phase. Dispersed phase is usually stronger than the matrix, therefore it is sometimes called reinforcing phase.

The advantages of composite materials is they exhibit a higher strength to weight ratio than steel or aluminum and can be engineered to provide a wide range of tensile, flexural and impact strength properties. Besides that, composite materials are corrosion resistant to most chemicals, do not suffer from electrolysis and incorporate long-term benefits such as weather ability and UV stability.

2.1.1 Types of Composite

There are two classification systems of composite materials. One of them is based on the matrix material such as metal, ceramic and polymer. However, another one is based on material structure.

Matrix materials are

(a) Polymer Matrix Composite (PMC)

These are the most common and will be discussed here. It is also known as fiber reinforced polymers. These materials use a polymer-based resin as the matrix, and a variety of fibres such as glass, carbon and aramid as the reinforcement. WPC is one of the examples of PMC.

(b) Metal Matrix Composite (MMC)

Increasingly found in the automotive industry, these materials use a metal such as aluminium as the matrix, and reinforce it with fibres such as silicon carbide.

(c) Ceramic Matrix Composite (CMC)

Used in very high temperature environments, these materials use a ceramic as the matrix and reinforce it with short fibres, or whiskers such as those made from silicon carbide and boron nitride.

Reinforcing material structures base are

(a) Particulate Composites

Particulate Composites consist of a matrix reinforced by a dispersed phase in form of particles.

(i) Composites with random orientation of particles.
(ii) Composites with preferred orientation of particles. Dispersed phase of these materials consists of two-dimensional flat platelets, laid parallel to each other.

(b) Fibrous Composites

(i) Short-fiber reinforced composites. Short-fiber reinforced composites consist of a matrix reinforced by a dispersed phase in form of discontinuous fibers with the length less than 100 times diameter.

(1) Composites with random orientation of fibers.
(2) Composites with preferred orientation of fibers.

(ii) Long-fiber reinforced composites. Long-fiber reinforced composites consist of a matrix reinforced by a dispersed phase in form of continuous fibers.

(1) Unidirectional orientation of fibers.
(2) Bidirectional orientation of fibers.

(c) Laminate Composites

When a fiber reinforced composite consists of several layers with different fiber orientations, it is called multilayer composite.