Faculty of Engineering

FABRICATION AND TESTING OF BAGASSE PARTICLE REINFORCED BIOCOMPOSITE

Rajiv A/L Selvam

Bachelor of Engineering with Honours
(Mechanical and Manufacturing Engineering)
2010

UNIVERSITI MALAYSIA SARAWAK

R13a

BORANG PENGESAHAN STATUS TESIS

Judul: FABRICATION AND TESTING OF BAGASSE PARTICLE REINFORCED BIOCOMPOSITE

SESI PENGAJIAN : 2009/2010

Saya RAJIV A/L SELVAM

mengaku membenarkan tesis * ini disimpan di Pusat Khidmat Maklumat Akademik, Universiti Malaysia Sarawak dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hakmilik Universiti Malaysia Sarawak.
2. Pusat Khidmat Maklumat Akademik, Universiti Malaysia Sarawak dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Membuat pendigitan untuk membangunkan Pangkalan Data Kandungan Tempatan.
4. Pusat Khidmat Maklumat Akademik, Universiti Malaysia Sarawak dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
5. ** Sila tandakan (√) di mana kotak yang berkenaan

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972).
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan).
☑	TIDAK TERHAD	

Disahkan oleh

(TANDATANGAN PENULIS)

(TANDATANGAN PENYELIA)

Alamat tetap: 376, LARUH SKIM
JALAN MATANG
93050 KUCHING, SARAWAK

EN NOOR HISYAM NOOR MOHAMAD

Nama Penyelia

Tarikh: 20/7/2010

Tarikh: 20/7/2010

Catatan
* Tesis ini dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah, Sarjana, dan Sarjana Muda.
** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyertakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.

APPROVAL SHEET

This Final Year Project attached here:

Title : Fabrication and Testing of Bagasse Particle Reinforced Biocomposite

Student Name : Rajiv A/L Selvam

Matric No : 17133

Has been read and approved by:

b/p:

En. Noor Hisyam Noor Mohamad

(Project Supervisor)

20 - 7 - 2010

Date

FABRICATION AND TESTING OF BAGASSE PARTICLE REINFORCED BIOCOMPOSITE

RAJIV A/L SELVAM

This Thesis Is Submitted To

Faculty of Engineering, Universiti Malaysia Sarawak

As Partial Fulfillment of the Requirements for the

Degree of Bachelor of Engineering with Honours

(Mechanical and Manufacturing Engineering)

2010

Dedicated to my family and friends

ACKNOWLEDGEMENT

I would like to take this opportunity to express my gratitude to everyone who had helped me in the completion of this project which cannot be accomplished by my own efforts alone.

First of all, I would like to thank my project supervisor, En Noor Hisyam Noor Mohamed for all the guidance and support which are very essential for the success of this project.

I would also like to thank the lab technicians and workshop staffs for their guidance and advises on the lab equipments and machineries operation guidelines during the composite fabrication and testing process.

Lastly, I would like to express my deepest gratitude to my family and friends who have continuously given their support and encouragement which leads to the completion of this project.

ABSTRACT

Bagasse is the residue of sugar cane after the juice extraction process. With the increase in sugar cane plantation due to the demands of sugar milling industry, bagasse is also produced in large quantity. Rather than allowing this large amount of bagasse to go to waste, it is more rational to make good use of this material. In this study, the potential of bagasse to be used as biocomposite's reinforcement material is analyzed. This is done by analyzing the mechanical properties of the composite. The effect of particle weight fraction towards the mechanical properties of the composite is also analyzed and discussed. To obtain the mechanical properties data of the composite, three mechanical tests were carried out in accordance with ASTM standards. The tensile strength and Young's modulus value increases with increasing bagasse particle weight fraction. However, the flexural strength and hardness value decreases with increasing bagasse particle weight fraction. The overall outcome is satisfactory as the objective of this study is achieved. There are still a few improvements that can be applied to improve the mechanical properties of the bagasse biocomposite.

ABSTRAK

Bagasse ialah sisa tebu setelah proses pengekstrakan jus. Dengan peningkatan peladangan tebu yang disebabkan oleh permintaan dari industri pengilangan gula, *bagasse* juga dihasilkan dalam kuantiti yang besar. Daripada membenarkan *bagasse* dalam kuantiti yang besar ini terbazir, adalah lebih rasional untuk menggunakan bahan ini sebaik-baiknya. Dalam kajian ini, potensi *bagasse* untuk digunakan sebagai bahan memperteguh biokomposit dianalisis. Ini dilakukan dengan menganalisa sifat-sifat mekanikal komposit tersebut. Kesan nisbah berat partikel *bagasse* terhadap sifat-sifat mekanikal komposit tersebut juga dianalisis dan dibincangkan. Untuk memperoleh data sifat-sifat mekanikal komposit tersebut, tiga eksperimen mekanikal telah dijalankan dengan berdasarkan piawai ASTM. Kekuatan tegangan dan modulus Young meningkat dengan peningkatan nisbah berat partikel *bagasse*. Walau bagaimanapun, kekuatan fleksural dan nilai kekerasan menurun dengan peningkatan nisbah berat partikel *bagasse*. Keputusan keseluruhan adalah memuaskan kerana objektif kajian ini telah dicapai. Masih ada beberapa perbaikan yang boleh dibuat untuk memperbaik sifat-sifat mekanikal biokomposit *bagasse* tersebut.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

NOMENCLATURE

A	-	cross sectional area
ASTM	-	American Society for Testing and Materials
b	-	width of test beam
CMC	-	Ceramic Matrix Composite
d	-	depth of test beam
E	-	Young's Modulus
F	-	force
l	-	original length
L	-	support span
MMC	-	Metal Matrix Composite
P	-	load at a given point on the load deflection curve
PMC	-	Polymer Matrix Composite
Δl	-	elongation
ε	-	strain
σ	-	stress
F_1	-	tensile test force
F_2	-	three point bending test force
W_c	-	weight of composite
w_m	-	matrix weight fraction
W_m	-	weight of matrix

w_p	-	particle weight fraction
W_p	-	weight of particle
σ_f	-	flexural strength

CHAPTER 1

INTRODUCTION

1.1 Background Study

Nowadays, composites have become one of the most important engineering materials in various applications. The demands for composites are steadily increasing as composites are more preferred compared to other materials such as metals and ceramics. The main reason for this is because composites are relatively cheaper and have high availability. On top of that, the properties of composites can be altered according to the desired applications.

However, the trend of the world today leans toward biodegradable or "green" materials which are more environmental friendly. These "green" materials are also sustainable as it comes from renewable resources. Even though composites have many uses in the industry, it is actually a better idea to apply "green" composite or biocomposite.

Biocomposites are a type of composite where either one or both of the constituent materials; matrix and reinforcement are of biological origin (Fowler et al., 2006). As mentioned before, at least one of the constituent materials of the biocomposite must be of biological origin. In this study, bagasse fibers are used as the reinforcement for the biocomposite.

Bagasse is the residue of sugar cane after the process of juice extraction. Sugar canes are largely produced throughout the world as it is very important in the sugar milling industry. This means that, bagasse which is the residue/waste materials are also produced in large quantity along with the sugar canes. Most sugar milling industry uses the bagasse as the fuel resource of the industry itself (Rasul et al., 1999). However, the quantity of bagasse produced by the world is about 54 million dry tons every year (Satyanarayana et al., 2008). Even though bagasse is used as fuel resource of the sugar milling industry, there would still be a large amount of unused bagasse which will become waste material. Thus, it is quite important to make good use of this waste product which is produced in such large quantity.

1.2 Problem Statement

The demands for composites are steadily increasing as composites are becoming a more preferred material compared to metals and ceramics. With the world's trend leaning towards environmental friendly materials (biodegradable materials), the need for biocomposite material are rising. Thus, it has become a necessity to find a new product especially composites which have potential to solve this worldwide problem.

In this study, the potential of bagasse (sugar cane residue) to be used as biocomposite was analyzed and discussed. The mechanical properties of the bagasse particle reinforced biocomposite are the main focus to determine the potential of the sugar cane residue. As bagasse has high availability throughout the world (Satyanarayana et al., 2008), there would be no problem regarding the sustainability of this material. Thus, this study will be mainly focusing on the mechanical properties of the bagasse particle reinforced biocomposite. The effect of bagasse particle weight fraction towards the mechanical properties of the resulting biocomposite is also one of the main concerns.

1.3 Objective

The objective of this study is to analyze and discuss the mechanical properties of biocomposites. In this study, bagasse particles were used for the fabrication of the biocomposite. Thus, the mechanical properties of the bagasse particle reinforced biocomposite will be studied and discussed.

Besides that, the effect of bagasse particle weight fraction towards the mechanical properties of the biocomposite is also studied. This is achieved by fabricating the composite with different particle composition. Then, the mechanical properties of the composites with different particle weight fraction are compared and discussed.

Overall, the focus of this study is to analyze the potential of bagasse (sugar cane) to be used as biodegradable composite material. By the end of this study, it will be known whether the bagasse composite exerts good mechanical properties or not. The effects of bagasse particle weight fraction with the mechanical properties of the resulting biocomposite will also be related. With all these data, the future course of bagasse fibers/particles as biocomposite materials can be predicted.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Composites are materials which consist of two or more distinct constituents or phases which can be combined to produce a material with entirely different properties from the individual constituents (Fowler et al., 2006). Another definition of composite is material composed of two or more distinct phases and has bulk properties which are significantly different from the constituent materials (Kopeliovich, 2009). Both of the definitions suggest the same meaning where two or more materials with different properties are combined into one material with different properties compared to the constituent materials. Two major groups of materials (constituent materials) in a composite are the matrix and reinforcement.

The reinforcement of a composite is a discontinuous material usually in the form of fibrous or particulate. As the name 'reinforcement' implies, this fibrous/particulate material is used to reinforce and enhance the properties of the composite. It can be said these reinforcement materials are the backbones of composites as they are the principle load carrying agent. This material has better properties or stronger than the matrix material. However, the reinforcement fibers or particles require the matrix substance to hold it and to spread out the load uniformly.

The matrix of a composite is usually polymer, ceramic or metallic materials which are called as resin. Types of matrices/resins will affect the properties of the composite. Thus, the selection of matrices/resins depends on the application of the composite to be produced. Matrices are responsible to distribute the load throughout the composite. As mentioned before, another function of matrix is to hold and support the reinforcement part in the composite.

Both matrix and reinforcement are essential to form the desired composite. These two constituent materials; matrix and reinforcement is mixed together in a proportion and shaped to produce the desired composite. This combination of the chemical and mechanical properties of these two groups of constituent materials will produce a composite with different properties than the constituent materials.

2.2 Classification of Composite

Types of composites depend on its constituent materials which are the matrix and reinforcement material. Therefore, composite can be classified into two groups according to the matrix material and reinforcing material structure (Kopeliovich, 2009). The classifications are as follows.

2.2.1 Classification based on matrix material

I. Metal Matrix Composite (MMC)

Composed of metallic matrix such as magnesium, aluminum, iron and other metallic materials

II. Ceramic Matrix Composite (CMC)

Composed of ceramic matrix with embedded fibers which are also from ceramic materials

III. Polymer Matrix Composite (PMC)

Composed of thermoset or thermoplastic matrix with embedded glass or carbon fibers

2.2.2 Classification based on reinforcing material structure

I. Particulate Composites

a) Random orientation of particles

b) Preferred orientation of particles

II. Fibrous Composites

a) Short fiber reinforcement

i. Random orientation of fibers

ii. Preferred orientation of fibers

b) Long fiber reinforcement

i. Unidirectional orientation of fibers

ii. Bidirectional orientation of fibers (woven)

III. Laminate composite