

SUPERVISOR DECLARATION

“I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Structure-Materials)”

Signature:

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MD.FADZULLAH

Date:

**THE EFFECT OF FIBRE SIZE, FIBRE/MATRIX INTERPHASE ADHESION
AND FIBRE LOADING ON MECHANICAL PROPERTIES OF BIO
COMPOSITE**

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**This thesis is submitted in partial fulfillment of the requirements for the award
of Bachelor of Mechanical Engineering (Structure & Materials)(HONS.)**

**Fakulti Kejuruteraan Mekanikal
Universiti Teknikal Malaysia Melaka**

JUNE 2015

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DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotation which have been duly acknowledged."

Signature:

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Date:

I would like to dedicate this research to my beloved parents, who always support and keep praying for my success.

ACKNOWLEDGEMENT

Greatest thank to Allah Almighty God for giving me a strength, ability and idea to finish this project, which hopefully will and can contribute for further research.

I would like to express my special thanks and appreciation to my lecture supervisor, Mrs. Siti Hajar Binti Sheikh MD. Fadzullah for her invaluable advice and inspiring encouragement in guiding me in completing this research.

Further acknowledgement also to my beloved parents for their pray and my entire friend who always giving a moral support to keep me full of high spirit in completing this research.

ABSTRACT

The main focus of the research is to assess the effect of the fibre size, fibre/matrix adhesion and fibre loading on mechanical properties of the biocomposites. First of all, the development of biocomposites consisting of a degradable polymer matrix, namely polylactic acid (PLA) and pineapple leaf fibre (PALF) as a reinforcement materials from natural resources. The natural fibres were pre-treated by alkaline treatment using sodium hydroxide (NaOH). This is followed by compression moulding via a Hot Isostatic Press to produce a composite plate. The effect of fibre size in terms of fibre length and orientation (long) as well as fibre loading, which are 0% (plain PLA) and 30% fibre loading, were assessed via mechanical testing. In addition, the effect of pre-treatment were observed. To analysed the effect of fibre size, fibre/matrix adhesion and fibre loading on mechanical properties of the biocomposites, mechanical testing, which are impact test via Charpy Impact Test, Flexural Test as per ASTM D790 and Tensile Test as per ASTM D3039 were carried out. Following this, a Scanning Electron Microscope (SEM) was used to study surface morphology of the biocomposites with different fibre loading and size, as well as to assess the dispersion between the fibre in the composites for both treated and untreated conditions. From the experimental work, it has been proven that treated continuous long fibre exhibit superior mechanical properties in comparison to that of the unreinforced polymer.

ABSTRAK

Fokus utama bagi kajian ini adalah untuk menilai kesan saiz serat, pelekatan antara serat dengan matriks dan juga pecahan berat pada sifat mekanik komposit bio. Pertama sekali, penghasilan biokomposit yang terdiri daripada matriks polimer terdegradasi iaitu asid polylactic (PLA) dan juga serat daun nenas (PALF). Serat daun nenas telah menjalani pra-rawatan alkali menggunakan sodium hidroksida (NaOH). Ini diikuti oleh pengacuan mampatan melalui panas isostatik tekan untuk menghasilkan sample komposit. Kesan saiz serat dari segi panjang gentian dan orientasi (panjang) dan juga pecahan berat, yang 0% (PLA biasa) dan 30% telah dinilai melalui ujian mekanikal. Di samping itu, kesan pra-rawatan turut diperhatikan. Untuk analisa, ujian hentaman melalui Charpy Kesan Ujian dan ujian tegangan seperti ASTM D3039 telah dijalankan. Berikutan ini, sebuah Mikroskop Imbasan Elektron (SEM) digunakan untuk mengkaji morfologi permukaan biokomposit dengan muatan gentian yang berbeza, dan juga saiz dan juga untuk menilai serakan antara gentian. Berdasarkan Hukum Campuran biokomposit dengan muatan serat mempamerkan sifat mekanik unggul.

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CHAPTER I

INTRODUCTION

1.1 Introduction

The development of biopolymers, based on constituents obtained from natural fibres are gaining increasing attentions in the recent years. This is due to the need to develop a technology of using natural fibres as reinforcement agent in biopolymer matrices in order to create environmental preservations. The recent development of reinforcement between polymer and natural fibres had resulted in a lot of modifications and better biocomposites. The reinforcement of natural fibre bio polymer will produce "green composites" that might be able to deal with many sustainability issues such as carbon dioxide emission, less reliance on foreign oil resources and recyclability.

Poly (lactic) acid (PLA) is the only natural based polymer that is produce in large scale in year. Thus, it is widely used as polymer that reinforced with natural fibres such as kenaf, hemp, flax, jute, bamboo, elephant grass, and more to compete with non renewable petroleum based product.

Natural fibres are substances that are produced by animals and plants. In industrial product, plant natural fibre type are widely used. They can be used as a component of composites material where plant natural fibre are widely used. Natural fibre bio composites have good mechanical properties and it helps in reducing dependence on non renewable source. This could benefit both the economic and environmental. As well as having good mechanical properties, natural fibres also have many other advantages such as abundantly available, low weight, biodegradable, cheaper, renewable, low abrasive nature, and natural fibre are waste biomass. Besides, natural fibre bio composites are also low cost, low density, acceptable specific strength properties, ease of separation and biodegradability. However, it also comes with some disadvantages which are moisture absorption, quality variations, low thermal stability and poor compatibility with the hydrophobic polymer matrix. Despite all the disadvantages, natural fibre bio composites still a good development to achieve "green composites".

1.2 Objectives

The objectives of this research are listed as below :

- i. to study the effect of fibre size on the properties of polymer composites.
- ii. to study the effect of fibre/matrix interface adhesion on the mechanical properties of recycled polymer composites.
- iii. to study the effect of fibre loading on the mechanical properties of polymer bio composites.

1.3 Problem statement

In the previous research, poor adhesion was obtained due to debonding during mechanical testing or poor approximation during composite production. Thus, in this research, fibre matrix adhesion will be enhanced so that the mechanical properties will also be improved by altering the matrix of the polymer bio composites or by using fibre surface treatment.

1.4 Scope of research

The research scope are as listed below :

- i. selection of matrix materials and chemical treatment process in producing polymer bio composites.
- ii. fabrication of bio composites test panels.
- iii. mechanical testing.
- iv. surface morphology.

1.5 Planning and execution

1.5.1 Gantt chart Final Year Project I

Table 1.1 : Gantt chart of Final Year Project I

NO	TITLE	WEEK														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Selection of PSM title and confirmation	■	■													
2	Literature Review	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
3	Design of experiment				■	■	■									
4	Draft of PSM I Poster						■	■	■							
5	Submission of Poster								■							
6	Characterisation of raw material								■	■	■	■				
7	Fabrication of polymer bio composites									■	■	■				
8	Characterization of test										■	■				
9	Preliminary data analysis											■	■			
10	PSM I report writing											■	■	■	■	
11	Submission of PSM I report														■	
12	PSM I seminar															■

1.5.1 Gantt chart Final Year Project II

Table 1.2 : Gantt chart of Final Year Project II

Week \ Items	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Material Review	■	■	■											
Design Test Model			■	■										
Experimental Work				■	■	■								
Fabrication						■	■							
Mechanical Test								■	■	■				
Analysis										■	■			
Result & Discussion											■	■	■	
Report Submission													■	■

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

Physical combination of two polymer or a polymer with a non-polymeric component can be done to modification of its properties. Forming composite material is one of the method. Composite are formed by combining polymer of some type non-polymeric solid or by combination of some type of engineering materials. High modulus, low density and excellent resistance to fatigue, creep, creep rupture, corrosion and wear are unremarkably characteristic of composite [1]. Table 2.1 below list some advantages and disadvantages of composites [2].

Table 2.1 : Advantages and Disadvantages of Commercial Composite [2].

Advantages	Disadvantages
<ul style="list-style-type: none"> • Weight reduction • High strength or stiffness to weight ratio • Tailorable properties : can tailor strength or stiffness to be in the load direction • Redundant load paths (fibre to fibre) • Longer life (no corrosion), better fatigue life • Lower manufacturing cost • Inherent damping • Increased or decreased thermal or electrical conductivity 	<ul style="list-style-type: none"> • Cost of raw materials and fabrication • Transverse properties may be weak • Matrix toughness, low toughness • Matrix subject to environmental degradation • Difficult to attach • Analysis for physical properties and mechanical properties difficult, analysis for damping efficiency has not reached a consensus • Non-destructive testing tedious

From Table 2.1, it shows that commercial composite application are still restrained because of economic factor. The composite are using fibre glass or other engineering material as the reinforcement. Thus, the cost of raw material and fabrication might be high. For example, this can be seen in the aeronautic and marine engineering that demand for advanced composite material [1].

Polylactic acid (PLA) is at present one of the most promising biodegradable polymers (biopolymers) and have been the subject of abundant literature over the last decade. It can be process with a large number of techniques and commercially available (large scale production) in a wide range of grades. It is relatively cheap have some remarkable properties which make it suitable for different applications. Compared to the other biodegradable polymer, Polylactic acid (PLA) has better mechanical properties than many petroleum based polymer such as polyethelene (PE), polystherene (PS), polypropylene (PP) and polythylene terephthalate (PET) [3]. PLA advantages are biodegradability, ability to be seal at low temperature, low gas

emission, and the renewability of its raw material. Nevertheless, as well as advantages, PLA also has disadvantages. It is brittle, low thermal stability, medium gas barrier properties and low water resistance.

Natural fibres are fibres that obtained from animals, plants or minerals. Usually, natural fibre will be mixed with plastic to produce composite products [4]. Natural fibres constantly used as fillers in improving the properties of composite [5]. Plant fibre type are common natural fibre used. Detail classification of natural fibres are as in figure below;

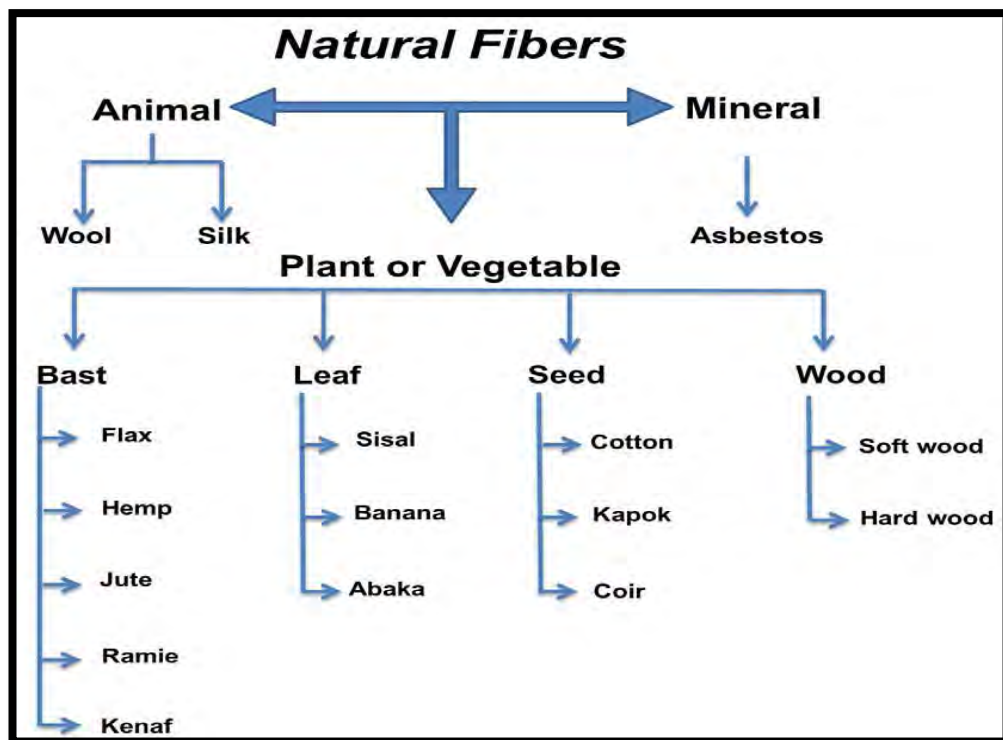


Figure 2.1 : Classification of natural fibres according to their origin with examples [5].