



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**STUDY THE MECHANICAL PROPERTIES ON  
BIOCOMPOSITES OF KENAF FIBERS**

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

by

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## **DECLARATION**

I hereby, declared this report entitled “ Study The Mechanical Properties on Biocomposite of Kenaf Fibers” is the results of my own research except as cited in references.

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Date : 21 May 2010

## **ABSTRACT**

The polymeric bio-composite material is a constituent a polymeric matrix (resin) and a reinforcement of natural fibers which usually derived from plants or cellulose. The objective of this study is to study the mechanical properties on bio-composite of kenaf fiber and application to commercial products. The bio-material that are been used in this research is mainly from the thermoset polymer which is polyester and kenaf fiber from kenaf plant. Furthermore, treatment for kenaf reinforcement fiber for its concentrations is 2% NaOH and with soaking time of 3 hours. For the manufacturing process, the kenaf and Polyester is prepared using Hand Lay-up process. There are 4 difference elongations on matrix and fiber reinforcement which is particulate fiber, randomly oriented fiber, unidirectional fiber and crossply continues fiber. The reinforcement fiber is being put on into difference type of fiber alignment such as discontinuous and continuous fiber reinforcement composition. Next, the sample will be going through to check their mechanical properties, such as tensile test, flexural test, impact test and hardness test. The entire test had been analyse to make a final conclusion based on the result finding. Based on the final finding the conclusion will be derived to the next implementation for the best application using the higher mechanical properties.

## **ABSTRAK**

Bahan bio-komposit polimerik ialah satu konstituen acuan polimerik (resin) dan satu peneguhan serat semula jadi yang biasanya berasal daripada tumbuh-tumbuhan atau selulosa. Objektif kajian ini ialah untuk mengkaji sifat-sifat mekanikal pada bio komposit serat kenaf dan diaplikasi untuk tujuan produk komersial. Bahan yang digunakan dalam penyelidikan ini adalah terdiri daripada polimer termoset iaitu polimer poliester dan serat kenaf daripada tumbuhan kenaf. Tambahan pula, rawatan untuk serat peneguhan kenaf untuk penumpuannya ialah 2% NaOH dan dengan tempoh rendam selama 3 jam. Untuk proses pembuatan, kenaf dan Poliester disediakan menggunakan proses 'Hand Lay-up'. Terdapat 4 perbezaan penumpuan pada susunan matriks dan serat yang disediakan iaitu, secara rawak diorientasikan serat, serat searah dan ayaman serat. Gentian fiber akan diletakkan dalam keadaan yang berbeza susunan fiber iaitu gentian fiber berulang dan gentian fiber tidak berulang. Berikutnya, sampel akan melalui fasa untuk memeriksa sifat-sifat mekanikal mereka, seperti ujian tegangan, ujian lenturan, ujian hentaman dan ujian kekerasan. Seluruh ujian akan dianalisis bagi menjadikan satu keputusan muktamad berdasarkan penemuan yang dihasilkan. Berdasarkan keputusan akhir, kesimpulan yang dapat , akan dilaksanakan proses berikutnya untuk diujikaji cara yang terbaik menggunakan sifat-sifat mekanikal lebih tinggi untuk menghasilkan produk.

## **DEDICATION**

*For my beloved family. Especially to my parents, Hj. Mohd Fauzi bin Hj Mohd Salleh and Hjh. Normah Binti Hj. Abdul Latif. Thank You Very much for all the supports and strength you given to your daughters.*

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# TABLE OF CONTENTS

Abstract	i
Abstrak	ii
Dedication	iii
Acknowledgement	iv
Table of Contents	v
List of Figures	viii
List of Tables	xi
List of Abbreviations, symbols, specialized nomenclature	xii
<b>1.0 INTRODUCTION</b>	
1.1 Introduction	1
1.2 Problem Statement	2
1.3 Objectives	3
1.4 The Methodology	3
1.5 Scope	4
1.6 Structure of Thesis	4
<b>2.0 LITERATURE REVIEW</b>	
2.1 Composite	6
2.1.1 Polymeric Matrix Composite (PMC)	8
2.2 Matrix	10
2.2.1 Thermoplastic	11
2.2.1.1 Polypropylene	13
2.2.1.2 Polyethylene	13
2.2.2 Thermoset	15
2.2.2.1 Polyester	16
2.2.3 Fiber	18
2.2.4 Reinforcement use	20
2.3 Natural Fiber Reinforcement in Composite	22
2.3.1 Kenaf	23

2.3.1.1	Introduction	23
2.3.1.2	Processing of Kenaf Fiber	24
2.4	Processing	25
2.4.1	Closed Mould	26
2.4.2	Open Mould	27
2.4.2.1	Hand Lay-up	27
2.5	Composite Properties	29
2.5.1	Tensile Test	29
2.5.2	Flexural Test	31
2.5.3	Impact Test	32
2.5.4	Hardness Test	35
2.6	Rule-of- Mixture (ROM) Equation	35
2.6.1	Tensile Strength	36
2.6.2	Ultimate Tensile Strength	36
2.6.3	Modulus of Elasticity	36
2.6.4	Flexural Strength	37
2.6.5	Tangent Modulus of Elasticity	38

### **3.0 METHODOLOGIES**

3.1	Introduction	39
3.2	Research Flow Chart	39
3.3	Raw Material Preparation	41
3.3.1	Fiber	41
3.3.3	Fiber Treatment	41
3.3.3	Polyester	42
3.3.4	Hardener	42
3.4	Process Sequence of Polyamide-Kenaf Composite	42
3.5	Testing Method	46
3.5.1	Tensile Test	46
3.5.2	Flexural Test	48
3.5.3	Impact Test	49
3.5.4	Hardness Test	51
3.5.5	Testing Analysis	51

<b>4.0</b>	<b>RESULTS AND DISCUSSION</b>	
4.1	Introduction	53
4.2	Tensile Properties	53
4.2.1	Stress- Strain Curve Analysis	56
4.2.2	Comparison of Tensile Properties in Difference Type Of Reinforcement	58
4.2.3	Sampling Analysis for Tensile Test	61
4.3	Flexural Properties	63
4.3.1	Comparison between Flexural Modulus and Flexural Strength	66
4.3.2	Analysis Graph of the Strongest and Weakness for Flexural Test	67
4.3.3	Sampling Analysis for Flexural Test	68
4.4	Impact Properties	69
4.4.1	Sampling Analysis for Impact	71
4.5	Hardness Properties	71
<b>5.0</b>	<b>CONCLUSION AND FUTURE WORK RECOMMENDATIONS</b>	
5.1	Conclusion	73
5.2	Future Work Recommendation	74
	<b>REFERENCES</b>	<b>76</b>
	<b>APPENDICES</b>	
	<b>A Result for Tensile Test</b>	
	<b>B Result for Flexural Test</b>	
	<b>C ASTM</b>	
	<b>D Gantt chart PSM I</b>	
	<b>E Gantt chart PSM II</b>	

## LIST OF FIGURES

2.1	Polyester Resins	16
2.2	Idealized Chemical Structure of A Typical Isophthalic Polyester	17
2.3	Composite Material Classification	21
2.4	Classification of Natural fiber according to Origin Together with Several Example	22
2.5	Kenaf in Field	23
2.6	The Basic Process of Hand Lay-up	28
2.7	Dimension for Specimen of Tensile Test	30
2.8	Tensile Test Machine	30
2.9	Allowable Range of Loading Nose and Support Radius	31
2.10	Pendulum Impact Test	33
2.11	Cantilever Beam (Izod-Type) Impact Machine	33
2.12	Relation of Vise, Specimen and Striking Edge to Each Other for Izod Test	34
2.13	The Dimension of The Izod Test Specimen	34
2.14	Durometer	35
3.1	Research Flow Chart	40
3.2	Kenaf Fiber	41
3.3	Unsaturated Polyester	42
3.4	Type of Hardener	42
3.5	Process sequence for Polyamide Kenaf Fiber	43
3.6	a) Layer of Kenaf Fibers on Steel Mould b) Layer of Kenaf Fibers being Coat with GP Resin c) Resin Layer Pressed by Aluminium Roller	44

3.7	Combination layer in Composite Sample	44
3.8	Illustrated of Sample	45
3.9	Universal Testing Machine (tensile test)	46
3.10	The Specimen Dimension for Tensile Test	46
3.11	The Illustrated of Specimen Dimension Area	47
3.12	Flow of the Tensile Test Process	48
3.13	Universal Testing Machine (Flexural Test)	49
3.14	Impact Testing Machine	50
3.15	Flow of the Tensile Test Process	50
3.16	Type of Indentor that been use in Shore Durometer	51
3.17	Sample before Flexural Test	52
3.18	Sample after Flexural Test	52
4.1	Tensile Stress (MPa) of Kenaf / Polyester with difference type of Elongation	54
4.2	Tensile Stress (%) of Kenaf / Polyester with difference type of Elongation	55
4.3	Young Modulus (GPa) of Kenaf / Polyester with difference type of Elongation	55
4.4	Stress-Strain Curve of Sample Type C	56
4.5	Stress-Strain Curve of Sample Type H	57
4.6	Tensile Strength of Difference Elongation	58
4.7	Maximum Tensile Strain of Difference Elongation	59

4.8	Young Modulus of Difference Type of Elongation	60
4.9	The sampling of Tensile Before and After Testing	62
4.10	Flexural Modulus (GPa) of Kenaf/Polyester Composite	64
4.11	Flexural Strain (%) of Kenaf/ Polyester Composite	64
4.12	Flexural Strength (MPa) of Kenaf/ Polyester Composite	65
4.13	Flexural Modulus and Flexural Strength for Difference Reinforcement Of Kenaf/Polyester Composite	66
4.14	Graph of the Strongest for Flexural Test	67
4.15	Graph of the weakness for Flexural Test	68
4.16	Sample before Flexural Test	69
4.17	Sample after Flexural Test	69
4.18	Impact Test for Difference Fiber Orientation	70
4.19	Sample Image after Done Impact Test	71
4.20	Hardness Test for Difference Fiber Orientation	72

## LIST OF TABLES

2.1	Comparison from Previous Researcher	6
2.2	Typical Properties of some Thermoplastic and Thermosetting Matrices	9
2.3	Some Advantages and Disadvantages of using Thermoset and Thermoplastic Matrices	11
2.4	Type of Polymer Based on Group	12
2.5	Properties of Selected Thermoset and Thermoplastic Material	14
2.6	Comparison of Typical Range of Property Value for Thermoset and Thermoplastics	16
2.7	Comparison Between Natural and Glass Fiber	20
2.8	Changes in Fiber Properties of Kenaf at Difference Stages of Plant Growth	24
2.9	Flexural Test Parameter	32
2.10	Dimensions of Izod-Type Test Specimen	35
3.1	The Dimensional and Value According to The Code for Tensile Test	47
4.1	Tensile Result	54
4.2	Flexural Result	63

# LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

ASTM	-	American Society for Testing and Material
CMC	-	Ceramic Matrix Composite
DSC	-	Differential Scanning Calorimetry
ESEM	-	Environmental Scanning Electron Microscopy
FS	-	Flexural Strength
HL	-	Hand Lay Up
MEKP	-	Methyl Ethyl Ketone Peroxide
MMC	-	Metal Matrix Composite
NaOH	-	sodium Hydroxide
PA	-	Polyamide
PP	-	Polypropylene
PE	-	Polyethylene
PMC	-	Polymeric Matrix Composite
ROM	-	Rule of Mixture
TS	-	Tensile Strength
UTS	-	Ultimate Tensile Strength
%	-	Percent



# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Research in mechanical properties on biocomposite of kenaf fiber frequently required certain modification in order to develop certain properties. These days, people always search the new material to make an improvement of the existing product. The composite is offer a good combination of material to reduce maintenance compare to steel and concrete. Over recent decades many new composites have been developed, some with very valuable properties. With carefully selected the reinforcement, the matrix, and the manufacturing process that brings them together, engineers can tailor the properties to meet specific requirements. For example, make the composite sheet very strong in one direction by aligning the fibers that way, but weaker in another direction where strength is not so important and the selected properties such as resistance to heat, chemicals, and weathering by choosing an appropriate matrix material.

A composite can be defined as any combination of two or more resources held together by some type of mastic or matrix. The mastic or matrix can be as simple as physical entanglement of fibers to as complex as system based on thermosetting and thermoplastic-polymer production. The composite material that always does in research basically had been produce with certain modification in order to make an improvement into the composite properties. In term of this combination of the material, the compensation of the composite is, it can take the benefit of the properties which material had been include during the combination. So it can take the

properties of both types of resources. The combination of the materials will differ in form or composition at the macro scale, for the purpose of improving or enhancing properties. There are two type of constituent which is matrix and reinforcement.

The research work will focus on the study of the composite in relation of mechanical properties in the laboratory scale. As for the processing technique, it will involve several type of fiber elongation and the sample will be proceduce by hand lay-up method. Follow by this, the testing stage will be conduct in order to investigate the mechanical properties and analytical testing of the product despite by the arrangement of the reinforcement fiber during the process. Analysis of the finding will be compared with the existing material used in order to verify that this new composite has the potential to be commercialized for the substitution material in structural application.

## **1.2 Problem Statements**

Metal is one of the major structural applications on many fields in decades. Even though the metal is one of the outstanding mechanical properties, the cost of their raw material somehow overweigh inherits benefits. Nowadays, people always change into the lightweight materials. This situation has open the prospect to discover the possibility of producing lightweight composite at the same time try to maintaining or improve the outstanding mechanical properties. The cost of manufacturing is also can be reduced significantly if the process of producing is in the simple step and they are produces locally within the country area which is Malaysia. In this research, the main focus is to use natural fiber which is kenaf as one of the substitute materials for the steel, as the reinforcement in the polymer matrix in order to produce a high strength composite but lightweight. Nowadays, the kenaf can be finding locally as one of the material to produce furniture like its counterpart the wood and bamboo. This scenario gives the opportunity to investigate on producing the lightweight composite since the cost for producing in Malaysia is in expensive compared to the metals. The exploration in the bio-composite industry has formulated its potential to be researched. So the usage of the metal is no longer viable due to the threat of over cost of the materials that heavily depend on natural source and mining activities.

Now, it has made an interest for researcher to find other substitution materials and kenaf is one of the potential materials to replace this role due to the functions as a good in a suitable matrix material.

### **1.3 Objectives**

The objectives for this research are:-

- a) To define the mechanical properties of kenaf fiber.
- b) To produce the hand lay-up process that makes an improvement in the mechanical properties at the maximum level regarding its reinforcement fiber structure.
- c) To define the polymer that can be use to bonding the kenaf fiber to be applied to the product that make the higher strength.
- d) To study the reinforcement fiber elongation.

### **1.4 The Methodology**

The methodology for research, needs take first step on collecting data, literature review; determine types of materials and determine the reinforcement material, determine what polymer suit to be use as matrix, practicing to develop a skill for fabricate process and testing the sample by some destructive testing methods. The destructive testing methods that will be used for testing of the sample is impact test, flexural test, hardness test and tensile test for determine the mechanical properties of polymeric matrix composite (PMC).

The fact that this type of the matrix and natural fiber composition had a different performance makes this research become significant. The analysis will shows, the different result for properties by rearrange the fiber composite into discontinuous fiber composite or continuous fiber composite in the end of this project. Then, a conclusion can be made on the higher strength to perform as polymer matrix composite as the kenaf fiber is being use as reinforcement agent and then, place the best application according to the mechanical properties results.

## **1.5 Scope**

This section states the choices made during the research process and the research will conduct by follow the criteria as stated below:

- a) Preparation of kenaf fiber and the polymer to bonding it together.
- b) The kenaf fiber is in long continuous and loose fiber forms.
- c) Use the polymer that can be processes in the room temperature.
- d) Use single manufacturing process that involve low cost investment of tool and equipment but capable to produce high performance materials.
- e) Testing that can be involved to identify the mechanical properties.

## **1.6 Structure of Thesis**

The structure of thesis as follows, Chapter 1 is about an introduction to the projects which are including background, objectives, significant of the project, and scope. In this chapter, it describes the background of the mechanical properties on biocomposite of kenaf fiber and application to commercial product for the case study.

Chapter 2 presents the literature review on type of composite material, natural fiber reinforce and processing in composite. Theories, related studies, testing involved and previous researches of kenaf fiber and matters involved will be reviewed. This is to make sure that the project will be well guided and avoid mistakes once the experiment takes place.

Chapter 3 will focus on the description of the methodology used in this project. It also includes the research flowchart, list of parameters, sample preparation, process applied, testing involved tensile test, flexural test and impact test. Then, it will follow by experimental procedures which contain the experiments used, methods involves and steps in record the data.

Chapter 4 mentions about the results and discussion for activities conduct in the previous chapter. In this chapter all the mechanical testing result will be discuss and the data is collected according to the mechanical testing experiments.

Chapter 5 provides the conclusion and recommendation for overall results. In this chapter will state the further recommendation also included for future work.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Composite

In this chapter, it will be discuss about the literature review on type of composite material, natural fiber reinforce and processing in this composite materials. Theories, related studies, testing involve and previous researches of kenaf fiber and matter involve will be reviewed. Other previous researches have been doing research on these kenaf fibers bio-composite. In their research, it will be conclude in the Table 2.1 below. Every researcher has difference type of processing and alignment of kenaf fiber reinforce.

**Table 2.1:** Comparison from Previous Researcher

Researcher	Title	Project development	Description
Ching, K. W (2008)	The Impact and Flexural Study of The Polymeric Bio-composite	Fiber with difference type of alkaline treatment	Based on this finding, the flexural properties was increasing gradually as the chemical concentration treatment in composite increased
We, C. Y (2008)	Tensile Properties and Morphology Study of Polymeric Bio-composite	The fibers were treated with different concentration and soaking time of sodium hydroxide and been compared with Resin Infusion Process	the tensile properties of RIP were better than HL no matter in treated or untreated composites because the results such as tensile strength,

			Young's modulus and maximum strain shown that the value was higher than HL in overall.
Moore, J., <i>et al.</i>	Kenaf Natural fiber Reinforced Polypropylene Composite: A discussion on Manufacturing problems and solution	The ability to successfully fabricated kenaf fiber into sheet form.	The kenaf composite manufactured in this study have higher Modulus and higher specific modulus than sisal, coir, and even E-glass thereby providing opportunity for replacing existing material with higher strength, lower cost alternative that is environmentally friendly.

A composite, in general, is define as a combination of two or more components differing in form or composition on macro scale, with two or more distinct phases having recognizable interfaces between them. (Akovali, G., 2001).The idea of blending several materials together to retain the benefits of each constituent in the final structure is not new. A composite material typically consists relatively strong. Many examples of composite materials, including bone and wood, occur naturally. The term of 'composite material' has a board meaning and refers to a structure made of two or more discrete components which, when combined, enhance the behavior of the resulting material. (Guell, D.C., 1997).

Composite usually consist of a reinforcement material embedded in a matrix (binder). The effective method to increase the strength and to improve overall properties is to incorporate dispersed phased into the matrix, which can be an engineering material such as ceramic, metal and polymer. There are 3 types of composite which are polymer matrix composite, metal matrix composite and ceramic matrix composite. However, only the polymer matrix composite will be discuss in this section since the matrix that will be used in this research.

### 2.1.1 Polymer Matrix Composite

The most common advanced composites are polymer matrix composites. These composites consist of a polymer resin as the matrix with fibers as the reinforcement medium (Callister, W.D., 2003). Polymer Matrix composite (PMC) is the material consisting of a polymer (resin) matrix combined with a fibrous reinforcement dispersed phase. It's very popular nowadays due to their low cost and simple fabrication methods.

Reinforcement of polymers by strong fibrous network permits fabrication of PMC characterized by the following properties:-

- a) High tensile strength
- b) High stiffness
- c) High fracture toughness
- d) Good abrasion resistance
- e) Good puncture resistance
- f) Good corrosion resistance
- g) Low cost

Basically, polymer matrix composite can be divided into two classes which are thermoplastic and thermoset. Thermoplastic refers to polymer that can be melted and processed by a variety of methods, including extrusion and molding. The most commonly used thermoplastic matrix materials are polyolefinics (polyethylene, polypropylene), vinylic polymers (polyvinyl chloride (PVC)), polyamides (PA), polyacetals, polyphenylenes (polyphenylene sulphide (PPS)), polysulphone and polyetheretherketone (PEEK). Some of their characteristic properties are presented in Table 2.2.