
# 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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# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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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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# 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 pemeriksa 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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# 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., *et al*.** | 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 divided into two classes which are thermoplastic and thermoset. Thermoplastic refers to polymer that can be melting processed by a variety of methods, including extrusion and molding. The most commonly used thermoplastic matrix materials are polyolefinics (polyethelene, 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.