
**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

# EXPERIMENTAL INVESTIGATION ON MECHANICAL PROPERTIES EFFECT FOR DIFFERENT ORIENTATION OF KENAF FIBER COMPOSITE THROUGH TENSILE AND IMPACT ANALYSIS

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours

by

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# DECLARATION

I hereby, declared this report entitled "Experimental Investigation On Mechanical Properties Effect For Different Orientation Of Kenaf Fiber Composite Through Tensile And Impact Analysis" is the results of my own research except as cited in references.

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Date : ……..

# APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours. The member of the supervisory is as follow:

……

(Project Supervisor: Mr. Mohd Afdhal Bin Shamsudin)

# ABSTRAK

Serat adalah bahan semula jadi atau sintetik yang jauh lebih panjang daripada luasnya. Serat sering digunakan dalam pembuatan bahan lain. Gabungan kedua-dua jenis medium memberikan fungsi khusus di mana serat bertindak sebagai tetulang dalam komposit untuk memberikan kekuatan untuk keseluruhan komposit. Baru-baru ini, pengeluaran sumber komposit memberi tumpuan kepada gabungan unsur-unsur yang digunakan mestilah ke persekitaran yang mesra teknologi, di mana ia boleh menjejaskan pencemaran kadar yang rendah untuk tempoh jangka panjang. Dalam kajian ini, serat kenaf dipilih dan dicampur dengan resin epoksi untuk membentuk komposit polimer bertetulang serat yang meningkatkan kekuatan komposit. Kemudian, serat kenaf disusun dalam kedudukan uni-arah dan dua arah. Sifat-sifat mekanik komposit serat atau polimer dianalisis dan dibandingkan antara orientasi uni-arah dan bi-arah untuk menggantikan serat sintetik. Hasil kajian menunjukkan bahawa modulus keanjalan meningkat dengan peningkatan komposisi serat tetapi selepas 40 wt% serat kenaf modulus keanjalan jatuh tetapi penyerapan tenaga kekal meningkat sehingga 70 wt.% dan menurun selepas 70 wt.%. Kesan orientasi berlainan serat kenaf dan epoksi diperhatikan dan berpotensi untuk menggantikan serat sintetik untuk mengurangkan penggunaan serat sintetik. Keseluruhan hasil kajian ini menunjukkan bahawa ikatan yang baik antara serat, pengagihan kekuatan yang betul, dan peratusan serat yang betul cenderung untuk mendapatkan sifat mekanik komposit serat yang baik.

# ABSTRACT

Fiber is a natural or synthetic substance that is significantly longer than it is wide. Fibers are often used in the manufacture of other materials. The combinations of the two types medium giving a specific function where the fiber act as the reinforcement in the composite to provide the strength for overall of the composite. Recently, the production of composite resource are focusing on a combination of elements used must be towards to technology-friendly environment, where it can affect low rate pollution for the long term durations. In this study, kenaf fibers is choosed and mixed with epoxy resin to form fiber reinforced polymer composites which improves the strength of the composites. Then, the kenaf fiber is sorted in uni-directional and bi-directional position. The mechanical properties of fiber or polymer composite are analyzed and compared between uni-directional and bi-directional orientation in order replace synthetic fibers. The result shows that the modulus of elasticity increased with increment of fiber composition but after 40 wt.% of kenaf fiber the modulus of elasticity was drop but the energy absorption remain increase until 70 wt.% and decrease after 70 wt.%. The effect of different orientation of kenaf fiber and epoxy was observed and potentially to replace synthetic fiber in order to reduce usage of synthetic fiber. Overall of this study output shows that the good bonded between fiber, proper strength distributions, and correct percentage of fibers are tend to obtain the good mechanical properties of the fiber composites.

# DEDICATION

To my beloved mother; Rohmah Binti Othman and for my beloved family who encourages me and involve in helping me to complete my project. Finally, a big thank to my supervisor who always encourage and guide me until the completion of the project.

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I would like to thank to Allah S.W.T because of His blessing. Apart from the efforts of me, the success of any project depends largely on the encouragement and guidelines of many others.

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# LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

| | | |
|---|---|---|
| MAPP | - | Maleic-Anhydride Grafted Polypropylene |
| ASTM | - | American Society for Testing and Materials |
| SEM | - | Scanning Electron Microscope |
| Tg | - | Glass Transition Temperature |
| FRP | - | Fiber Reinforced Polymer |
| RPM | - | Rapid Prototyping Machine |
| NEAC | - | National Economic Action Council |
| MEKP | - | Methyl ethyl ketone peroxide |
| KN | - | Kilo Newton |
| J | - | Joule |
| E | - | Modulus Young |
| mm | - | Milimeter |
| $\Delta l$ | - | Change of length |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background Of Study

Nowadays, natural fibers become an interesting option for the most commonly applied fiber in the composite technology. Several studies on natural fiber have been done such as oil palm, hemp, ramie, jute, bagasse and kenaf. Recently, the sustainable and renewable reinforced composites has been focused on fast expanding usage of composite components in automotive, construction, sports and leisure, and other mass production industries. The benefits of using the natural fiber composites are renewable, low density, environmental friendly, biodegradability plus flexible of usage.

Natural fiber had played important roles in developing the composites performance. Kenaf, Jute and Hemp namely as the widely applied natural fiber being reinforcement for composites. In addition, the versatile used materials because of the plant itself include the stalks (bast and core), leaves and seeds to be created as useful material in manufacturing industry has proved by researcher earlier as the performance of natural fiber especially kenaf.

Natural fibers are commonly comes from several parts of the plant such as fruits, bark, leaf and stem. The usually used plant fibers are banana, sisal, kenaf and coir then kenaf fiber is of one the plant that need to take out from bark of the tree. Then, the fiber is extracted from the bast and core of the bark. Kenaf fiber become popular among the researchers and also in Malaysia because they can utilize it in different polymer

composites due to industries and government regulations in other various countries and environmental awareness.

The research on kenaf plastic composite was extremely develop together with plastic industry's which require high demand for replacing the petroleum-based material. In order to increase the performances and properties of fabricated composites, the coupling agent should be introduced. Various type of chemical reagents have been used in earlier study by researchers such as silane, Maleic-Anhydride Grafted Polypropylene (MAPP), alkoxysilane and etc. In this study, Kenaf fibers are mixed with epoxy resin to form fiber reinforced polymeric composites which improves the strength of the composites. Then, the kenaf fiber will be sort in uni-directional and bi-directional position. The behavior of natural fiber or polymer composite will be analyze and compared to synthetic equivalent in order to draw the conclusion whether the natural fiber are technically qualified to replace synthetic fibers.

## 1.2 Problem Statement

It is important and possible to produce a new types of material that exhibit the environmentally and economically benefits for the applications in automotive, building, furniture and packaging industries. By relating the diverse resources, it is possible to blend, mix or process the natural fiber with other elements such as plastics, glass and synthetics material to fabricates the new categories of materials (Sanadi, 1990). Besides, the kenaf fiber have an alternative for partial replacement of conventional materials or synthetic fibers as reinforcement in composites as the natural fiber also can decreased the depending on synthetic fiber (Rashdi et. al, 2009).

The advantages of natural fibers provide over conventional reinforcement materials have recently attracted the attention of scientist and technologists. In term of strength, the natural fiber has similar characteristics of fiber glass compare to other

synthetic fiber. Other reasons for this rising interest on natural fibers is the similar specific modulus and higher specific strength than glass fiber (Bledzki and Gassan, 1999). These fiber great properties such as high specific strength in impact resistance, stiffness, modulus, and flexibility make them an attractive alternative over the traditional materials (Sgriccia, 2008). Specifically, the good properties of kenaf fiber include economical viability, good specific strengths and modulus, low weight and low density has make them as the reinforcement choice for industry.

Since the natural fiber is easy to disposed, the most interesting aspect of natural fibers is their positive environmental impact. Mohanty et. al, (2002) found that natural fibers are biodegradable and their production requires little energy as they are renewable resources. Biodegradable and environmentally acceptable materials have got highest interest in few decades to the researcher and manufactures due to the environmental pressure derived from depletion of petroleum-based materials, complexities in degrades in landfill and composting environments (Liu, 2007). Due to its substantial fraction by volume in the waste stream and its high resistance to the atmospheric and biological agents, it is seen as a toxic material although the synthetic fiber does not generate a direct hazard to the environment.

Natural fibers present a lot of advantages from the earlier study compared to synthetic fiber such as low density, low tool wear, cheaper cost, availability and biodegradability. The synthetic composite are verify as the harmful elements to environment. Therefore, in this study, the kenaf fiber will be reinforce with epoxy resin and sorting with uni-directional and bi-directional position to determine the modulus of elasticity as there is no evidence for other researcher had do this project.

## 1.3 Objective

The objectives of this research are:

1) To fabricate the new composition using kenaf fiber and epoxy resin.
2) To test and compare the new composition in order to obtain the mechanical properties of the composition.

## 1.4 Work Scope

The scope of project is important in order to support the development process of this project. The description of scope for this project as listed below:

1) Developing the new sample composition of kenaf fiber and epoxy resin with different orientation using molding technique.
2) Testing the sample by using tensile and Charpy impact testing machine according to ASTM D3039 and ASTM D6110.
3) Comparing the modulus of elasticity of the each composition due to the different orientation of the kenaf fiber.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

Composite materials can be classified in various ways. One possible classification distinguishes between traditional and synthetic composites. Traditional composites are those have been produced by civilizations or that occur in nature for many years such as concrete, wood and asphalt mixed with gravel that used in construction. Synthetic composites is the components are first produced separately and then combined in a controlled way to achieve the desired structure, properties, and part geometry then usually known as modern material systems and related with the manufacturing industries. These synthetic ingredients are the composites normally thought of in the context of engineered products.

Over the past few decades, (Saheb and Jog, 1999) found that polymers have substituted materials in various applications or several of the conventional metals. It is possible because of the benefits using polymers such as cost reduction, productivity, and ease of processing compared to conventional materials. These composites are finding applications in diverse fields from appliances to space crafts as the fiber-reinforced polymers have more advantages over other conventional materials when specific properties are compared. Figure 2.1 shows that the example of composite material such as car door panel.

Figure 2.1: The example of composite material. (Schuh, 2004)

## 2.2 Fiber classification

The fiber classification consists of two major types which is natural fiber and synthetic fiber as shown in Figure 2.3. Currently, natural fiber has reacted as the most fascinating alternatives to less depending on synthetic fiber in composite technology. According to Davoodi et.al, (2010), the natural fiber has a few advantages as shown in Table 2.1 compared to synthetics fiber which are better formability, renewable, abundant, possess tool wearing rates, cost effective, thermal insulation properties, acoustic properties, safer towards health and sufficient energy requirements. Therefore, composite manufacturing industries have to discovered for plant based natural fiber reinforcements, such as hemp, flax, sisal, jute, kenaf, banana as an alternative material which is suitable to substitute the synthetic fiber.

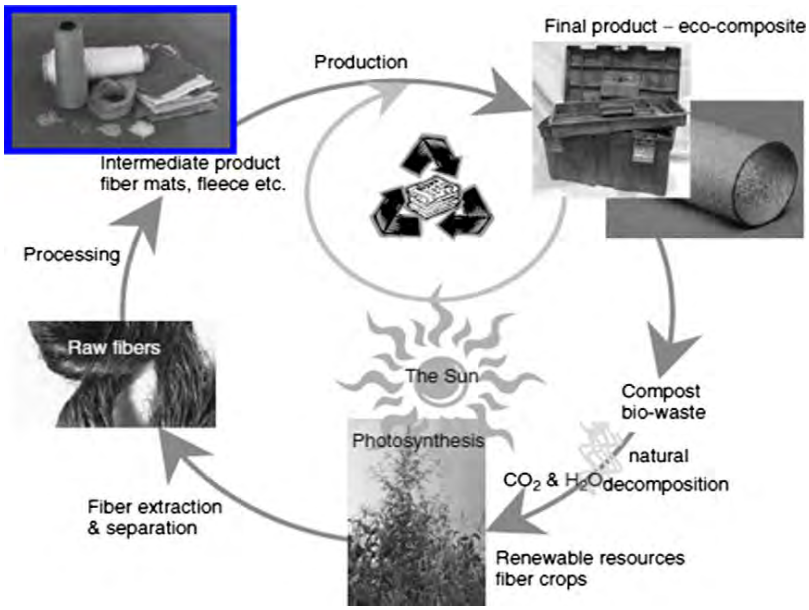


Figure 2.2: Life cycle of bio-composites (Akil et.al, 2011)

The mixing of bio-fibers like modern hemp, kenaf, oil palm, flax, jute, pineapple leaf fiber, henequen, wood, sisal and different grasses with polymer bases from both non-sustainable (oil based) and inexhaustible assets to make composite materials. The Figure 2.2 illustrate the life cycle of bio-composites. Bio-composites are aggressive with manufactured composites, for example, glass– epoxies and glass– polypropylene that accepting a consideration in the course of the most recent decade.. Therefore, a cellulosic fibers reinforced with hybrid composites are recurrently combined with synthetic fibers such as glass fibers can show a good mechanical performance (Abu Bakar et.al, 2005). A hybrid reinforcement with polymer composites exclusively constituted of natural fibers are less common, but potentially useful materials with respect to environmental concerns (Athijayamani Thiruchitrambalam et.al, 2009).

Table 2.1: Advantages and disadvantages of lignocellulosic fibers. (Sreekumar, 2008)

| Advantages | Disadvantages |
|---|---|
| Low specific weight results in a higher specific strength and stiffness than glass.<br>Renewable resources.<br>High electrical resistant.<br>Good thermal and acoustic insulating properties<br>Biodegradable | Lower strength especially impact strength.<br>Variable quality, influence by weather.<br>Poor moisture resistant which causes swelling of the fibers.<br>Lower durability<br>Poor fire resistant.<br>Poor fiber / matrix adhesion |

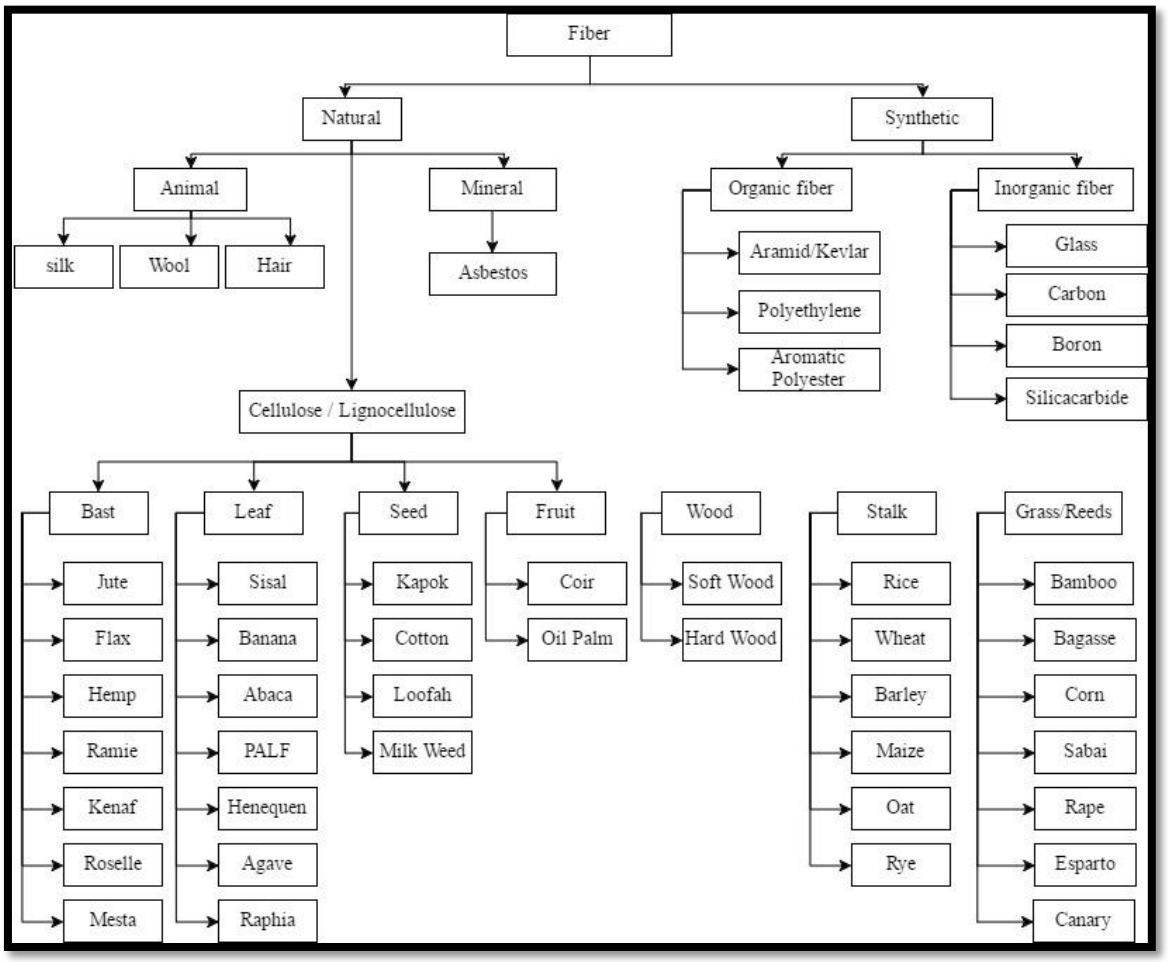


Figure 2.3: Classification of natural and synthetic fiber (Lilholt and Lawther, 2002).

The study of fiber reinforced plastics began in 1908 with cellulose material in phenolics, than continuing to urea and melamine and reaching the product status with glass fiber reinforced plastics. The East German Trabant car is one of the earliest examples in year 1950 which is the frame was constructed from polyester reinforced with cotton fibers (Jawaid, and Abdul Khalil, 2011).

## 2.3 Natural fiber classification

Natural fiber is a fresh generation of reinforcements and supplements for polymer based materials and a kind of renewable sources. According to Saheb and Jog, (1999), natural fibers has an advantages over conventional glass and carbon fibers as it can be an alternative reinforcement in polymer composites that attracted the attention of many researchers and scientists. The animal-based fibers consists of wool, silk, and natural fibers plant-based includes coir, sisal, jute, ramie, pineapple, bamboo, kenaf, banana and many more. (Li et.al, 2009). The group of different categories for natural fibers can be separated based on their origin, animal and mineral types, derivations of plant which are depicted from Figure 2.4 (Bledzki et.al, 2002).

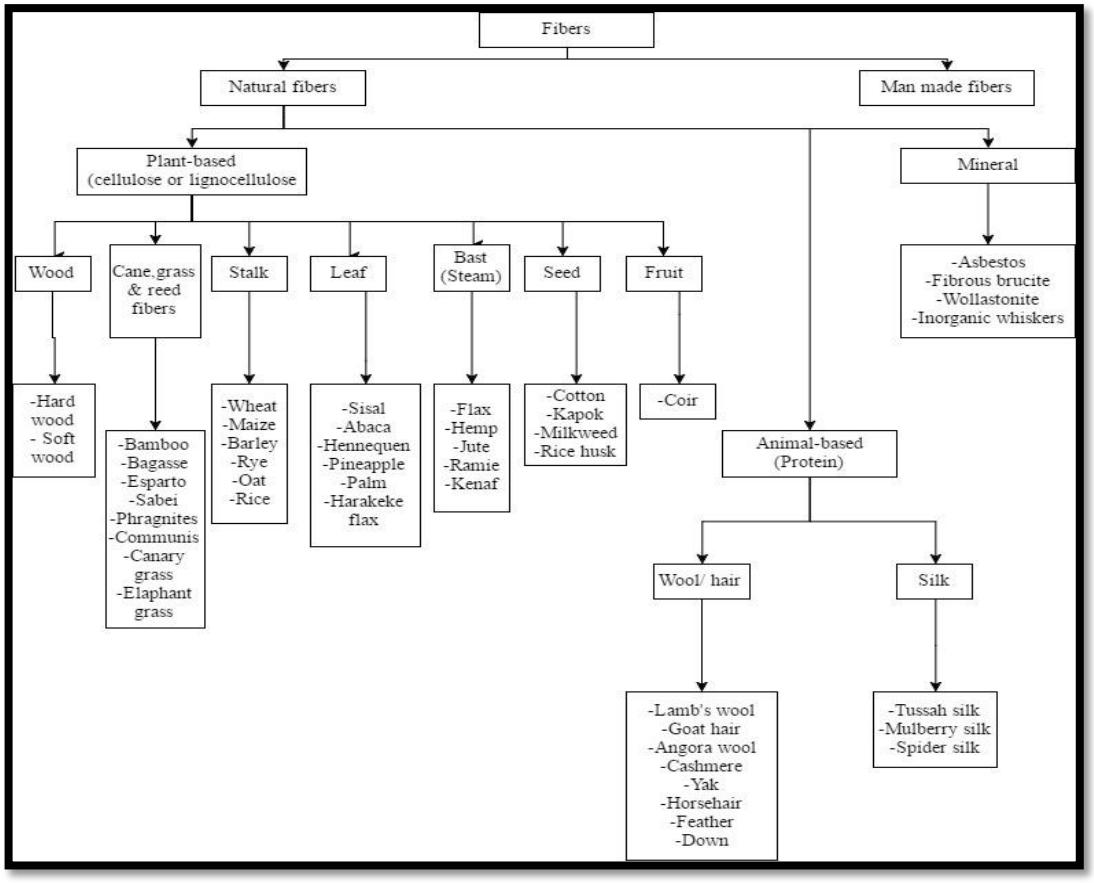


Figure 2.4: The classification of different natural fiber (Mei-po Ho and Hao Wang, 2012)

The classifications of animal fiber types are contain with a high particular of protein, the special advantage characteristics in term of fineness, softness, shining and rarely combine with another types of fibers, for some case, it adding a chemical to make fiber features to more shining and soft in especially hair fiber phase (Shakyawar et al., 2013). The types of these fiber usually are wool and silk, for the wool fiber industry are familiar with the domestic sheep in popularity by using with hand spinners in the waving surface and scales pattern ,the properties of these fiber are curly and soft and popular in the textile manufacturing and wool that use in fabrics are having a better insulations, elastic and durable, for the silk they are produced from the insect fiber with the build of protein structure, where it comes from silk worm by spinning by itself to form a cocoon, one cocoon can produce around 1600 long meters.