UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PRELIMINARY STUDY ON ELASTICITY PROFILE OF KENAF FIBER AND POLYESTER RESIN AS COMPOSITE FIBER SUBSTITUTION

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Automotive Technology) (Hons.)

by

NUR SHAZWANI BINTI SAMSUDDIN

B071310400

911026-02-5132

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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 (Automotive Technology) (Hons). The member of the supervisory is as follow:

………………………………

(Mohd Afdhal Bin Shamsudin)

ABSTRAK

Alternatif yang sesuai untuk menggantikan sintetik dan jenis tetulang yang berbeza adalah, serat semula jadi merupakan sumber yang boleh diperbaharui. Bahan mentah seperti serat kenaf digunakan untuk menggantikan kayu dalam pulpa dan kertas untuk mengelakkan kemusnahan hutan. Serat kenaf adalah kos rendah, ringan, mudah pengeluaran dan mesra alam sekitar. Poliester (PE) telah dipilih kerana ia mempunyai sifat-sifat mekanikal yang baik. Komposit adalah bahan-bahan yang diperbuat daripada resin polimer diperkuat oleh serat, menggabungkan prestasi mekanikal dan fizikal yang tinggi gentian dan permukaan, ikatan bersama-sama dan diperkaya dengan ciri-ciri fizikal polimer. Oleh itu, tujuan kajian ini adalah untuk mengkaji dan menganalisis komposisi gentian kenaf baru diperkukuhkan dengan resin PE ke arah ujian tegangan. Gentian kenaf dan resin PE digunakan dalam peratusan yang berbeza untuk mendapatkan komposit terbaik. Proses masa gel PE dengan pengeras MEKP perlu dilakukan sebelum proses fabrikasi kerana, untuk menentukan masa pengerasan resin diambil pada suhu bilik. Dari mencampurkan 5% sehingga 70% serat kenaf, PE, dan pengeras MEKP dengan menggunakan teknik pengacuan dengan meletakkan menggunakan tangan dikenali sebagai proses fabrikasi. Masa pengerasan bagi setiap sampel adalah 6-8 jam sebelum ujian tegangan. Selepas proses pengerasan, sampel diuji dengan ujian tegangan untuk menentukan modulus keanjalan bagi sampel itu. Yang paling tinggi modulus keanjalan adalah 60% daripada gentian kenaf dengan 40% resin poliester. Peningkatan serat kandungan selepas 60% daripada gentian kenaf tidak meningkatkan modulus keanjalan sampel itu. Morfologi keratan rentas pada kawasan patah pada sampel ujian tegangan boleh diperhatikan dengan menggunakan SEM. 60% kandungan serat pada sampel adalah yang terbaik di antara sampel yang lain untuk modulus keanjalan adalah 3.97GPa.

ABSTRACT

The relevant alternative candidate to replace the synthetic and the different types of reinforcement was, the natural fiber by a reason it was a renewable resource. A raw material such as kenaf fiber been used to be replaced such as wood in pulp and paper industries to avoid the devastation of forests. Kenaf fiber was low cost, lightweight, easy production and friendly to the environment. Polyester (PE) was chosen because it was as well as good mechanical properties. Composites were materials made of a polymer resin reinforced by fibers, combining the high mechanical and physical performance of the fibers and the appearance, bonding together and enriching the physical properties of polymers. Therefore, the purpose of this research was to study and analyzed the new composition of kenaf fiber reinforced with PE resins towards the tensile test. Kenaf fiber and PE resin used in different percentage to get the best composite. The gel time process of the PE with MEKP hardener be done before fabrication process due to, to determine the curing time taken of resin at room temperature. From mixing the 5% until 70% kenaf fiber, PE, and MEKP hardener by using hand lay-up molding technique was known as fabrication process. The curing time for each sample will take 6 – 8 hours before the tensile test. After the curing process, the sample was tested for tensile testing and the modulus of elasticity for the samples was determined. The highest of a modulus of elasticity was 60% of kenaf fiber with 40% polyester resin. The increase of content fiber after 60% of kenaf fiber did not increase the modulus of elasticity. The morphology cross-section on the fracture area of the sample tensile test been observed by using SEM. The 60% fiber content of sample was the best in range for modulus of elasticity is 3.97GPa.

DEDICATION

I dedicated this report to my beloved parents, supervisor and friends for their support, and great guidance to complete the bachelor degree project successfully.

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ASTM	-	American Society for Testing and Materials
BPO	-	Benzoyl peroxide
CAE	-	Computer-aided Engineering
CSIRO	-	Australia's Commonwealth Scientific and Industrial Organisation
GPa	-	Gigapascal
Malvaceae	-	Mallow
MEKP	-	Methyl ethyl ketone peroxide
MPa	-	Megapascal
PE	-	Polyester resin
SEM	-	Scanning Electron Microscope
USDA	-	United States Department of Agriculture
USSR	-	Union of Soviet Socialist Republics
WW II	-	World War II
A	-	Cross Section Area
E	-	Modulus of Elasticity
F	-	Force
N	-	Newton
mm	-	Milimeter
1-acre	-	4,000 m^2
t_{gel}	-	Gel time
Δs	-	Change of stress
Δe	-	Change of strain
σ	-	Stress
ε	-	Strain

CHAPTER 1

INTRODUCTION

1.1 Background of study

In general, the fibre acts as a reinforcement in reinforced plastic will be synthetic or natural. Plastic or fibre composites are universally used in many industries such as the aircraft, automobile, electronic, medical industries and etc . There has been a slightly increase used of natural fibers for creating a friendly for environment and biodegradable composite materials (these composites are “Green Composites”). The potential advantages of natural fibres compared to synthetic fibres, such as low cost, low density, availability, higher thermal, and biodegradability.

A variety of natural fibres have been examined for use in plastic/fiber composites. As a result, the demands for natural fibre reinforced composites has increased dramatically over the past few years for various commercial applications in the industrial sector. Nowadays, the increasing demand for green products within the field of composites has limited the usage of synthetic materials in many engineering applications. The cellulose or lignocellulose are the most popular used as reinforcement in fibre reinforced composites is to enhance the mechanical properties of the materials.

There are many different type of natural resources, kenaf plants as a cellulose source with both economic and ecological advantages. Kenaf fibres are becoming increasingly popular in Malaysia as one of the natural materials that can make contributions to the development of environmental friendly resources for the automotive, food packaging, furniture and sports industries. The research in kenaf plastic composite is developing extremely together with the plastic industry's high demand for it for producing petroleum-based material.

Kenaf long fiber plastic composite could be used for a wide variety of applications if the properties had been found to be comparable to existing synthesis composites. Since kenaf available in long fiber form, the mechanical properties determined can be use in many industrial applications such as insulators seals. In this study, it is important to analyse the behaviour of natural fibre or polymer composite in comparison to its synthetic equivalent in order to draw a conclusion to whether natural fibres are technically capable to replace synthetic fibres.

1.2 Problem statement

The advantages of natural fibers provide over conventional reinforcement materials have recently attracted the attention of scientists and technologists. Kenaf is comparatively commercially available and economically cheap amongst other natural fibre reinforcing material. Kenaf is the new composite by using kenaf fibre can use as a raw material to be the replacement for wood in pulp and paper industries to avoid the devastation of forests . Customarily kenaf denoted as industrial kenaf due to of its great interest for the production of industrial raw materials.

Possibilities for extended kenaf fiber and pulp manufacturing are proper in view of developing concerns about environmental pollutants and dwindling woodland assets. Kenaf fiber is a biodegradable and environment-friendly raw material suitable for woven and non-woven fabric, geo-textiles and laminated sheets of packaging and paneling. Increase kenaf plantation will boost employment and raise up the rate of economic growth.

Besides that, using kenaf can reduce the cost to disposed is cheaper than synthetic fiber. Kenaf fibers has already been used in commercial applications such as composite boards, automotive panels, insulation mats, and geo-textiles. Major global corporations such as Toyota Motor Corporation and Panasonic Electric Works have taken the lead in the global kenaf industry.

Toyota has developed kenaf fibers for automotive interior applications and Panasonic a structural wall board to replace timber-based plywood. In 1996 interior automobile panel from kenaf fiber has applicated for Ford Mondeo. Similarly, the hybrid kenaf or glass-reinforced composites have been studied by (Jeyanthi and Rani., 2012) for utilization in passenger car bumper beam.

Natural fibres present many advantages compared to synthetic fibres such as low tool wear, low density, cheaper cost, biodegradability and availability. The synthetic material are harmful to environment. In this study, the sampel of kenaf fibre with PE resins will be tested by using tensile testing machine.

1.3 Project objective

The objective of the project

i. To develop new composite by using kenaf fiber with PE resin

ii. To test the new sample in order to obtain the best in range of a modulus of elasticity.

iii. To observe the fracture of cross section area of the sample by using Scanning Electron Microscope (SEM)

1.4 Work Scope

The Scope of project is very important in order to support in the build and development process of this project. Listed below are the descriptions of scope for this project:

i. Developing the new composite by using the kenaf fiber as reinforced material with PE resin by using molding technique.

ii. Testing the sample by using universal testing machine tensile test according ASTM D3039 to find the modulus of elasticity.

iii. Observation on the morphology the fracture of cross-section area of the sample by using Scanning Electron Microscope (SEM)

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

As demand for wood based product increased greatly worldwide, wood based industry in another country including Malaysia are destined towards a future shortage of wood. The fact that the world is fronting a shortage in wood supply due to deforestation and demotion of the forest is forcing the industry to find alternative and suitable replacements for wood. Figure 2.1 shows that deforestation. The most effective ways to meet the demand for wood is making more plantations that focus on fast-growing tree species to replace wood as a raw material. Then, the demand on the natural forest was decreased and at the same time keep protect the natural resources. Based on the results of these studies discovered that fast-growing tree species such as kenaf can be harvested two times annually and minimum care are the answer to solving the problem was mentioned.

Figure 2.1: Deforestation

2.2 Fiber classification

Fiber can divided into two major types : natural fiber and synthetic fiber. Nowadays natural fibers an interesting alternative for the generally applied fiber in the composite technology. According to (N.Abilash et al., 2013) explained that natural fiber are cheap and have a better stiffness. Figure 2.2 shows that the example of natural fiber such as silk, cotton, coir and wool. Secondly, the environmental impact is smaller since the natural fiber can be thermally recycled and fibers comes from a renewable resource. Synthetic fiber used in polymer composites is ageing because they are expensive and non-biodegradable.

(a) **(b)** **(c)** **(d)**

Figure 2.2: The example of natural fiber, **(a)** Silk **(b)** Cotton **(c)** Coir **(d)** Wool

They are pollute the environment and limited in advanced of applications. Recently, the industry such as composite component in automotive, sports, construction and other mass production industries has been focused on unending and renewable reinforced composites. The interest encompasses a wide variety of materials varying from synthetic fiber to natural fiber , in order to fulfill the required of making composites with desired properties (H. M. Akil et al., 2011).

(a) **(b)** **(c)**

Figure 2.3: The example of synthetic fiber, **(a)** Acrylic **(b)** Rayon **(c)** Polyester

The example of synthetic fiber is presented in Figure 2.3.Traditionally, natural fibers have been polished and used greatly for non-structural applications such as multipurpose rope, broom, bag, fish net and filters (A.Ticoalu et al., 2010). This fiber has also been used in housing as roof material and wall insulation. The natural fiber is derived from animal, cellulose or lignocelluloses and mineral. Animal fiber such as wool, hair, silk etc generally comprises proteins; it is taken from animals or hairy mammals. Mineral fibers are naturally occurring fiber or hardly modified fiber derivative from minerals. And asbestos is the only naturally occurring mineral fiber (N.Abilsh et al., 2013).

According to study, cellulose or lignocelluloses fibers are most popular of the natural fibers used as reinforcement in fiber reinforced composites. Cellulose is a long chain of linked sugar molecules that gives wood it amazing strength. The cellulose molecule is presented in Figure 2.4. It is the main component of plant cell walls, and the basic building block for many textiles and for paper. Cotton is the purest natural form of cellulose.

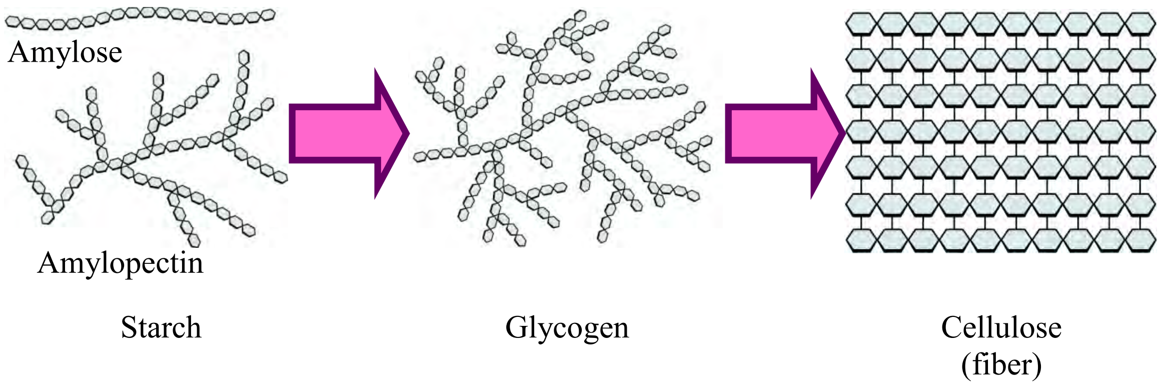

Figure 2.4: Cellulose molecule

Lignocelluloses is a complex of lignin and cellulose present in the cell walls of woody plants. Lignocelluloses fibers possess many advantages of being financially reasonable to manufacture such as lightweight, eco-friendly, harmless to health, high stiffness, and specific strength which provides a probable alternative to the synthetic fibers (N. Saba et al., 2015). These fiber can serve as an excellent reinforcing agent for composites. Lignocelluloses fibers are renewable materials and have capability to be recycled.

Cellulose or lignocelluloses are comprised mainly of cellulose; examples include bast, leaf, seed, fruit, wood, stalk, grass/reeds and other types of fibers. Seed fiber is a fiber collected from the seed and seed case such as cotton. Cotton fiber is one of the oldest fibers were used in the textile industries. They choose cotton fiber because it is durable, easily fold and good arrange. It very smooth when touching the fiber and can absorb moisture. A drawback of cotton fiber takes time to dry and must iron before used. Coir is the example of fruit fiber.

According to (A. Ticoalu et al., 2010) coir fibers are fibers obtained from the husk of coconut fruit. Coir fiber was light, elastic, low light resistance, high durability and high of initial strength. The coir fiber as shown in Figure 2.5. The coir is harvested when tender produces in white colored fiber. If the coir is harvested when maturity produces in brown colored fiber. Stalk fiber or grass/reed fiber is a fiber from the stalks of the plant such as straws of wheat, rice, barley, corn, bamboo and other crops. Tree wood is a fiber. The wood fiber has two types: soft wood and hard wood.

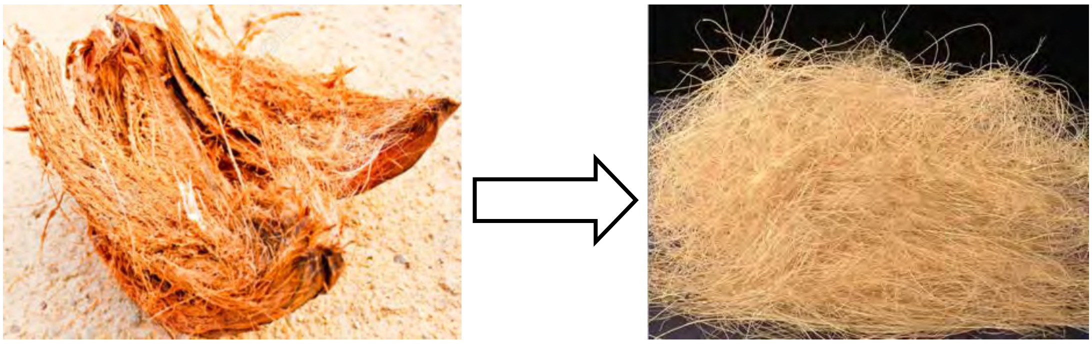

Figure 2.5 : Coir fiber

Among the various natural fibers, wood fibers have interested attention in the fields of both fundamental research and applications because wood fiber composites have properties similar to those of glass fiber composites. One of the alternatives for the demand of wood by creating the more plantations fast-growing tree to replace wood as raw materials and for the same time protect the natural resources and reduce the deforestation of natural forest (M. Jawaid et al., 2011). Leaf fiber from the leaves of plants some examples are sisal, banana, pineapple leaf fiber (PALF) and several others. Sisal fibers are stiff and have approximately coarse texture even though less coarse than coir fibers.

Bast fiber or skin fiber are collected from the skin or bast surrounding the stem of their respective plant. According to (N. Abilash1 et al., 2013) these fibers have higher tensile strength than other fibers. From Figure 2.6, these fibers are used for durable yarn and fabric such as flax, jute, hemp, kenaf and other fibers. The flax plant can produce linen fiber and has been used since ancient time ago in textile industries. Linen fiber features are lightly close to cotton fiber but heavier than cotton. This fiber was durable, wrinkles easily, have to iron and absorb moisture like a cotton. Linen fiber is normally used in summer clothes manufacturing and household linen. Sometimes, linen is designed to be an extensive fabric. Nowadays, linen is competitive in price with another fabric.

(a) **(b)** **(c)**

Figure 2.6 : The example of fiber, **(a)** flax **(b)** jute **(c)** hemp

Kenaf represented as industrial kenaf by reason of its great interest for the manufacturing of raw material industries. The kenaf plant is composed of many useful parts (e.g stalks, leaves, and seeds). A kenaf bast fiber as showed in Figure 2.7. Kenaf bast fiber have a very high tensile strength, which has made a material to be selected for a various range of extruded, molded and nonwoven products. The kenaf bast fiber or skin fiber possess characteristic mechanical properties, it is suitable reinforcing materials to replace glass fibers as reinforcing materials in polymer composites (M. Ramesh, 2016). Kenaf fiber demonstrated higher cellulose content and biodegradable.

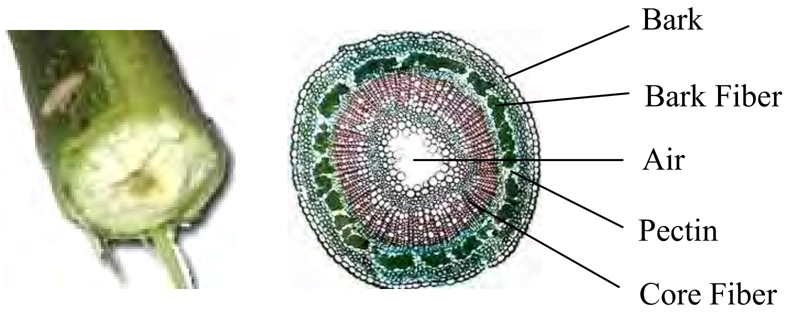

Figure 2.7 : Kenaf bast fiber

Cellulose or lignocelluloses fibers possess many benefits of being economically sensible to manufacture such as lightweight, eco-friendly, harmless to health, high stiffness, and specific strength which reasonable replacement to the synthetic fiber. Synthetic fiber is created by force, extrusion, fiber forming materials through holes (spinnerets) into the air and water to form a yarn. In fact, synthetic fiber such as nylon, rayon, aramid or kevlar and carbon are greatly used for the reinforcement of plastic.

According to (A. Ticoalu et al., 2010) these materials are expensive, less biodegradable and non-renewable resources. They pollute the environment and limited in advanced applications. Due to need environmental friendly materials, natural fiber is the alternative has been shifted to synthetic products. Advantages and disadvantages of natural fibers are shown in Table 2.1 (M. Jawaid et al., 2011).