MECHANICAL PROPERTIES OF COCONUT FIBRE REINFORCED COMPOSITES

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This report is submitted

in fulfillment of the requirement for the degree of

Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2018

DECLARATION

I declare that this project report entitled “Mechanical Properties of Coconut Fibre Reinforced Composites” is the result of my own work except as cited in the references.

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APPROVAL

I hereby declare that I have read this project report 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.

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DEDICATION

To my beloved father and mother

ABSTRACT

Composite materials have grown rapidly by volume and number of applications to break through and capture new markets. These composite materials include a variety of natural ingredients such as dried fruit, rice husk, wheat husk, straw and hemp fibres can be used to provide gentle-reinforced polymer composites for commercial use for agricultural wastes. Besides, the problem statements in this study are coconut composites will be low in their cohesion and ductility when coconut fibre increases. This study was conducted to determine the mechanical properties of coconut fibre composite matrix composites and the effect of the polymer matrix volume on the mechanical properties of the composite matrix composite of the fibre reinforced polymer. The use of fibres made of coconut fibre as an amplifier in the composition of the polyester matrix is evaluated by used long fibre. Various composite formulations were prepared using fibres by 10%, 20%, 30%, 40% and 60% coconut fibre as reinforcement. For tensile strength, the sample is provided according to ASTM D3039 and the standard sample voltage strength is measured and using universal tensile machine, INSTRON 8872 at a fixed speed of 5mm min-1, for the micro hardness, the sample is induced using Durometer following Procedure ASTM No. D2240 type D and reading are calibration scales. It has been noted that Ultimate Tensile Strength (UTS), Modulus of elasticity and extension to break. The amount of coconut fibre at 10% has highest modulus of elasticity and then decreased significantly by 20% weight of fibre. However modulus of elasticity continued to increase with an increase in the number of coconut fibre at 20% fibre weight. The results showed the Young's modulus and the final tensile strength increased after increasing the rate of coconut fibre at 20% fibre weight. Meanwhile, hardness for coconut fibre reinforced composites is higher at 10% by weight and the hardness was decrease with the increasing the fibre weight. In conclusion, the increase in coconut fibre reinforces the polyester matrix composite and the maximum tensile strength is achieved at about 10% and 60% by weight of the coconut fibre content and the result showed that the increase in fibre ratio in composites can make composite materials more stable. While the tensile load is higher, composite hardness decreases along with the increase in the content of coconut fibre.

ABSTRAK

Bahan-bahan komposit telah berkembang dengan pesat oleh jumlah dan bilangan aplikasi untuk memecah dan menangkap pasaran baru. Bahan komposit ini termasuk pelbagai bahan semulajadi seperti buah kering, sekam padi, sekam gandum, serat dan rami hemp boleh digunakan untuk menyediakan komposit polimer diperkuat lembut untuk kegunaan komersil untuk sisa pertanian. Selain itu, pernyataan masalah dalam kajian ini adalah komposit kelapa akan rendah dalam kohesi dan kemuluran apabila serat kelapa meningkat. Kajian ini dijalankan untuk menentukan sifat mekanik komposit matriks komposit serat kelapa dan kesan volum matriks polimer pada sifat mekanik komposit matriks komposit bagi polimer bertetulang gentian. Penggunaan serat yang terbuat dari gentian kelapa sebagai penguat dalam komposisi matriks poliester dinilai oleh serat panjang yang digunakan. Pelbagai formulasi komposit disediakan menggunakan serat sebanyak 10%, 20%, 30%, 40% dan 60% serat kelapa sebagai tetulang. Untuk kekuatan tegangan, sampel disediakan mengikut ASTM D3039 dan kekuatan voltan sampel piawai diukur dan menggunakan mesin tegangan sejagat, INSTRON 8872 pada kelajuan tetap 5mm min-1, untuk kekerasan mikro, sampel itu diinduksi menggunakan Durometer berikut Prosedur ASTM No. D2240 jenis D dan bacaan adalah skala penentukuran. Telah diperhatikan bahawa Kekuatan Tegangan Tepat (UTS), Modulus keanjalan dan lanjutan untuk pecah. Jumlah serat kelapa pada 10% mempunyai modulus keanjalan tertinggi dan kemudian menurun dengan ketara sebanyak 20% berat serat. Walau bagaimanapun modulus keanjalan terus meningkat dengan peningkatan bilangan serat kelapa pada berat serat 20%. Hasilnya menunjukkan modulus Young dan kekuatan tegangan akhir meningkat selepas meningkatkan kadar serat kelapa pada berat serat 20%. Sementara itu, kekerasan untuk komposit bertetulang gentian kelapa lebih tinggi pada 10% berat dan kekerasan berkurangan dengan peningkatan berat serat. Kesimpulannya, peningkatan serat kelapa mengukuhkan komposit matriks poliester dan kekuatan tegangan maksimum dicapai pada kira-kira 10% dan 60% berat kandungan serat kelapa dan hasilnya menunjukkan peningkatan nisbah serat dalam komposit dapat membuat bahan komposit lebih stabil. Walaupun beban tegangan lebih tinggi, kekerasan komposit berkurangan seiring dengan peningkatan kandungan gentian kelapa.

ACKNOWLEDGEMENT

The successful and result of this 'final year' project requires a lot of guidance and assistance from many people. I am very grateful to Allah SWT for the health and wellbeing while completing this final year project. Everything I do is simply because of the oversight and assistance from various parties and I will never forget to thank them.

Thank you to the respected person Dr. Kamarul Arifin Bin Zakaria for the never ending support, guidance and trusting me for completing this project. To have him as my supervisor is a very grateful thing because of his good personality of giving good support, guidance although he was busy arranging his own affair in order to help me during this project.

I wish to express my sincere thanks to all the teaching staff especially Dr. Siti Hajar who taught me Advance Composite and Materials subjects that helped us gained knowledge of composites which are very harmony and significant with my project. I am fortunate enough to get continuous encouragement, support and guidance from them. Additionally, I would like to extend sincere value to all laboratory staff for their support and time while dealing with the laboratory equipment.

I also want to take this opportunity to express gratitude to all the department faculty members including by course mate for their help and support. I also want to thank my parents and siblings who have been always support me in various aspects of development.

Also, do not forget to thank my parents and siblings who have always been supporting the various aspects of development. Particularly to my late mother, Pn.Rokiah Binti Ismail, who always gives me encouragement during this project.

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LIST OF ABBREVIATIONS

MMC	Metal Matrix Composite
CMC	Ceramic Matrix Composite
PMC	Polymer Matrix Composite
FRP	fibre reinforced polymer
PRP	particle reinforced polymer
MMC	Metal Matrix Composite
TS	tensile strength
UTS	ultimate tensile strength
ASTM	American Society for Testing and Materials

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CHAPTER 1

INTRODUCTION

1.1 Background Study

Today, plastic and ceramics have the dominant for a new material for composite materials. Composite materials have grown rapidly by volume and number of applications to break through and capture new markets. These composite materials include a variety of natural ingredients such as dried fruit, rice husk, wheat husk, straw and hemp fibres can be used to provide gentle-reinforced polymer composites for commercial use for agricultural wastes. Bio-based products have a great opportunity to thrive in the world market. This is because, natural fibres have a basic interest amongst them the advantages of weight and fibre matrix adhesion,. There are various types of natural fibres in the world, consisting of sisal, hibiscus cannabinus, eucalyptus grandis pulp, malva, ramie bast, pineapple leaves, kenaf leaves, coconut, sansevieria leaves, hemp leaves, vakka, banana, jute, hemp, ramie , cotton and sugarcane fibres (Ali et al., 2012). In this project, composite materials made from polyester matrix strengthened with coconut fibre will be carried out.

Natural composites such as sisal, jute, coir, and palm oil have been shown to have the best reinforcement in thermosets and thermoplastic matrices (Bujang et al., 2007). Additionally, applications involving automotive, cosmetics and plastic wood have had high demand in its use for natural-sided composites compared to non-traditional fillers and pure demand. Natural composite materials will have a high demand and will definitely be one of the most important sources of excellent renewal and high environmental friendliness in the development of the coconut fibre biodegradable composites (Kong et al., 2016). In this study, coconut fibre was modified into composite materials to form panels with matrix difference and reinforcement materials. In this study the test that will be carried out is a tensile test and hardness test.

According to Bujang et al., (2007) of the mechanical test results such as strength, ductility, hardening, elastic modulus, and tensile strength are the most appropriate way to determine the physical properties of the material as a result of the test. This test covers the constant tension in specimens consisting of coconut fibre and measuring loads. The Universal Testing Machine is used with tensile speed of 10 mm / min and the distance between the clips is defined at 115 mm. Furthermore, the tensile strength will increase due to increased fibre weight breakdown (Wambua et al., 2003). More than one specimen is available in the study for each fibre percentage to get more accurate results. In addition, for hardness tests, fibres that add composite modulus will also increase the composite hardness, because function of fibre volume and modulus is relatively to the hardness (Kong et al., 2016). Violence has been defined as the contradiction of the material to the permanent penetration of other hard materials and is also defined as the resistance of the material to various forms of permanent change and penetration by other hard materials (Aydemir et al., 2011).

1.2 Problem Statement

Natural fibres are fibres made up of plants, animals, and geological processes. In this study coconut fibre will be found as natural fibre. Among natural fibres, coconut fibre is a fibre that has strong strength (Ali et al., 2012). However, coconut composites will be low in their cohesion and ductility when coconut fibre increases. Therefore, to overcome this problem, its project will focus on the amount of resin used to remove composite materials. Furthermore, the increase in fibre weight breaks yields the same increase in tensile strength.

1.3 Objectives

1. To fabricate coconut fibre reinforced polymer matrix composite.
2. To determine mechanical properties of coconut fibre reinforced polymer matrix composite.
3. To study the effect of polymer matrix volume on mechanical properties of coconut fibre reinforced polymer matrix composite.

1.4 Scope of Project

The scopes of project are:

1. Cutting the coconut fibre into long fibre.
2. Prepare the resin with difference percentage before casting the material.
3. Do an experiment in order to identify composite materials toughness by using tensile and hardness test.
4. Compare the result with all stage percentage difference.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction of Composite

The composite material is a microscopic mixture of two or more different materials and they are categorized as "matrix" or "reinforcement" (ACMA, nd), which is usually a continuous phase called a matrix, and another is a non-sustainable phase called reinforcement. In general, loose terms such as "ingredients consist of two or more identified voters". Additionally, composites with high strength and strength are the main advantages when these composites are combined with low fiber density. In addition, when compared with bulk materials it allows weight loss in the finished part. Beghezan (Verma et al., 2013) is defined as "Composite is a compound material different from alloy by the fact that individual components retain their features but are so incorporated into composites to use their features instead come short of them ", to solve the better material.

Composite materials derived from natural resources are a concern about the lack of renewable resources. Because of this, natural composite materials have gained significant drawbacks in recent years due to environmental awareness in themselves. Among the major advantages of natural fibres against synthetic fibres are low cost, lightweight weight, high specific strength, and biodegradable humidity. In composites, properties, volume fraction and connectivity of individual phases are very important. Basically the matrix phase is a continuous phase, and the other phase is said to be a phase spread. Therefore, terms such as "metal-matrix" show the metallic materials used to form a continuous phase (Donald R.Askeland et al., 2010).

2.1.1 Need of Composite

There are several materials that need to improve desired properties. All the desired properties are difficult to find in a single material. For an example, a material which needs high fatigue life but not to cause cost high. The basic elements in a composite retain their identities while acting in concert to provide a host of benefits (ACMA, n.d.). Table 2.1 below shows the advantages of composite.

Table 2.1: The Advantages of Composites

Advantages of Composite	
• Strength • Stiffness • Toughness • High corrosion resistance • High wear resistance • High chemical resistance	• Reduced weight • High fatigue life • Thermal& electrical insulation or conductivity • Energy dissipation • Reduced cost

The Table 2.1 lists of desired properties are in-exhaustive. It should be noted that the most important characteristics of composite material is that their properties are satisfied, that is one can design the required properties.

2.1.2 Type of Composite

Based on composite matrix composite materials can be classified into three groups comprising three groups: Metal Matrix Composite (MMC), Composite Matrix Composite (CMC), and Polymer Matrix Composite (PMC). The best types used in matrix composites are PMC. In fact, polymer is not enough for many purposes of mechanical properties structures. Therefore, their strength and stiffness are low compared to metals and ceramics. The polymer composites can be classified into two types' fibre reinforced polymer (FRP) and particle-reinforced polymer (PRP).

High transverse strength, higher corrosion resistance and higher specific modulusfor have good properties on monolithic metal for Metal Matrix Composite (MMC). According to this attribute, MMC is widely used in covers, tubes, cables, heat exchangers, structural members. The weakness of MMC is its high density and consequently lower mechanical properties than polymer matrix composites and the fabrication requires high energy.

For Ceramic Matrix Composites (CMC) or ceramic fibers it is known for its resistance to temperature. Ceramic fiber is available as alumina and silicon carbide and has an advantage in very high temperature applications, as well as where environmental attacks are an issue. Because ceramic has weak properties in tension and shear due to its fragile nature, most applications use it as reinforcement in particulate form (Poornesh et al., 2017). CMC Used in extremely high temperature environments, this material uses ceramics as a matrix and strengthens it with short fibers, or mustaches such as those made from silicon carbide and boron nitride.

Particles of one or more materials are suspended in the matrix of other substances to make the substance stronger composed by particle composites. Particle types will be considered when adding a matrix module and reducing the ductility of the matrix. Ceramics and glass are included for particles used to reinforce. The ordinary fibre reinforced composite comprises a combination of fibre and composite and it has two types of fibres used are short fibres and long fibres and it can be attributed to fibre reinforced composites. There is one ingredient embedded in a combined matrix with another material that turns out to be very strong. From that, fibres composites will carry loads along their longitudinal direction from composites.

2.2 Type of Matrix Composite

The combination of fiber reinforcement and resin matrix is known as composite (Fibermax Composites, n.d.). The system can hold everything together and can transfer mechanical loads through fiber to the whole structure known as matrix or resin system. In addition, the structure that has been merged or has been bonded with resins can protect the material from abrasion, corrosion, impurities, other environmental factors and rough handling and also can expand the life of materials structure. The resin system comes in various chemical families and is each designed and commissioned to serve industries that provide certain advantages such as economics, structural performance, and resistance to various factors, and compliance with the law. Only the most suitable resins that can be used are Polyester (ortophthalic and isophthalic), vinyl ester, epoxy, and phenolic.

Carbon and ceramics are typically used for high temperature applications for composite matrices in the form of thermosets. Thermosets such as epoxy and polysulfide and thermoplastics such as ketone polyether's and polyimide polyether are used as having high strength and performance are pioneers for research and industrial applications. Recent advancements have a high aspect ratio and better electrical, mechanical and thermal properties that can be made for various purposes known as nano-composites (Chauhan et al., 2012)..

From this research we found that there are two major groups of resins that we can called it as polymer materials where known as thermosets and thermoplastics. These types of resins are made of polymer. Furthermore, to make best composites thermoset resins had been used. When used to produce finished goods, the thermoset resin is "cured" with the use of catalysts, heat or a combination of both. After healing, a solid thermoset resin can not be changed back to its original liquid form. Regular thermosets are polyester, vinyl ester, epoxy, and polyurethane. Table 2.2 and Table 2.3 below show advantages and disadvantages for thermoplastic resin and thermoset resin.

Table 2.2: Advantages and disadvantages for Thermoplastic

Thermoplastic Resin	
Advantage	Disadvantage
• Highly recyclable • High-Impact resistance • Reshaping capabilities • Chemical resistant • Hard crystalline or rubbery surface options	• Expensive • Can melt if heated

Table 2.3: Advantages and disadvantages for Thermoset

Thermoset Resin	
Advantage	Disadvantage
• More resistant to high temperatures • Highly flexible design • Thick to thin wall capabilities • High levels of dimensional stability • Cost-effective	• Cannot be recycled • More difficult to surface finish • Cannot be re-moulded or re-shaped

2.2.1 Thermoplastic

Thermoplastic polymer resins are very ordinary, and they come in contact constantly with thermoplastic resins. Thermoplastic resins are most commonly unreinforced, meaning, the resin is formed into shapes and have no reinforcement providing strength. List below shows of several thermoplastic resins used today, and some products manufactured by them:

- PET - Water and soda bottles
- Polypropylene - Packaging containers
- Polycarbonate - Safety glass lenses
- PBT - Children's Toys
- Vinyl - Window frames

- Polyethylene - Grocery bags
- PVC - Piping
- PEI - Airplane armrests
- Nylon – Footwear

Short-term fibres are used for the strengthening of thermoplastic products. The best reinforcement is fibre glass and carbon fibre. The mechanical properties found in fibre reinforced fibres can be technically improved. However, continuous reinforced reinforcing fibres will produce different strengths with composite reinforced fibres.

In general, composite FRP is a reference to the use of fibre or fibre reinforcement with a length greater than ¼ "or the same. Thermoplastic resins have been used with continuous fibres to produce a composite product structure. There are several advantages and disadvantages found in thermoplastics composite and thermoset. Based on Chuhan et al., (2012) paper, the Eucalyptus urograndis pulp used as a reinforcement for the canopy thermoplastic shows a high tensile height increase of which 100% and more than 50% in modulus with starch thermoplastic is not reinforced.

2.2.2 Thermoset

Combined Polymer Composite Made Of Traditional Fibre, or FRP Composite for the short term, it uses thermoset resin as a matrix. This matrix holds a strong structural fibre on this composite mechanical. Commonly used thermoset resins include:

• Polyester resins

• Vinyl Ester Resin