UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EXPERIMENTAL INVESTIGATION ON COCONUT FIBRE COMPOSITION PROFILING WITH RESPECT TO THE MODULUS OF RIGIDITY

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

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DECLARATION

I hereby, declares this report entitled "Experimental Investigation on coconut fibre composition profilling with respect to the modulus of rigidity" is the results of my own research except as cited in references.

Signature :
Author"s Name :
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‟s Degree in Mechanical Engineering Technology (Maintenance Technology) with Honours. The member of the supervisory is as follow:

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(Project Supervisor)

ABSTRAK

Serat adalah salah satu elemen yang telah digunakan sebagai bahan tetulang untuk menghasilkan komposit. Serat ini biasanya hadir dalam fasa filamen yang mempunyai ciri-ciri mekanikal yang luar biasa dari segi kekuatan dan kekukuhan bahan. Sabut kelapa atau serat kelapa boleh diklasifikasikan sebagai salah satu daripada serat semula jadi yang merupakan sebahagian daripada serat buah-buahan. Dalam usaha untuk mengurangkan sisa pertanian, serat kelapa digunakan untuk menggantikan bahan lain dalam bidang pengeluaran perindustrian. Jumlah sisa pertanian yang semakin meningkat ini jika tidak dibuang dengan sempurna, boleh menyebabkan pencemaran alam sekitar. Eksperimen ini dijalankan untuk mengkaji ke atas komposisi serat kelapa dengan modulus ketegaran. Selain itu, tujuan kajian ini adalah untuk membuat komposit baru dengan penambahan bahan buangan. Kemudian, kajian ini telah diuji dan dibandingkan dengan komposit baru dalam usaha untuk mendapatkan nilai julat yang terbaik. Bekas acuan telah direka berdasarkan ASTM E143. Kesan dan kecacatan pada bekas acuan telah dikesan dengan menggunakan simulasi kerja pepejal. Dalam usaha untuk mendapatkan modulus ketegaran, eksperimen kilasan telah dijalankan dengan menggunakan mesin ujian kilasan. Berdasarkan kepada keputusan dan perbincangan, 40% serat kelapa panjang dengan campuran resin poliester dan 25% daripada serat kelapa pendek diperkukuhkan dengan resin poliester menghasilkan keputusan yang terbaik dalam lingkungan modulus ketegaran dalam kajian ini berbanding peratusan yang lain. Berdasarkan hasil daripada nilai modulus ketegaran yang diperolehi daripada ujian menunjukkan bahawa serat panjang adalah hasil yang terbaik berbanding dengan serat pendek. Serat panjang lebi anjal dan mempunyai kekuatan yang baik daripada serat pendek. Serat panjang memberikan prestasi yang lebih tinggi dan sifat mekanikal yang baik ke arah resin poliester.

ABSTRACT

Fibre is one of the elements that have been used as reinforcement material to produce composites. This fibre usually present in the filament phase which having an extraordinary mechanical feature in term of strength and stiffness of properties. Coconut fibre can be classified as one of the natural fibre which is a part of fruit fibres. In order to reduce the agriculture waste, coconut fibre is used to replace other material in the industrial production field. A Large quantity of this waste, if not properly disposed of, can cause to environmental pollution. This experimental investigates on coconut fibre composition profiling with respect to the modulus of rigidity. Furthermore, the purpose of this study was to develop new composite with the addition of biodegradable waste. Then, this research was tested and compared the new develope composite in order to obtain the best in range value of modulus of rigidity between long and short fibre. The mold of the sample has been fabricated based on ASTM E143. The effect of the fabricated mold of the sample has been detected by using the solid work simulation. In order to get the modulus of rigidity, torsion experiment was conducted by using torsion testing machine. Based on the result and discussion, 40% of long coconut fibre reinforced with polyester resin and 25% of short coconut fibre reinforced with polyester resin gave the best in the range of the modulus of rigidity in this research compared to the others percentage. Based on the result of the modulus of rigidity that obtained from the testing show that long fibre is the best result compared to the short fibre. The long coconut fibre was more elasticity and has a good strength than the short coconut fibre. The long coconut fibre gives the higher performance and good mechanical properties towards the polyester resin.

DEDICATIONS

To my beloved mother Mrs Hasna binti Taib and my beloved father Mr Abdullah bin Hussin.

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To all my friends and family for helping in service all the stress from this year and not letting me to give up. To my teammate, special thanks and appreciation for advisor, support, patience and understanding for pushing me further than i expected.

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ASTM	-	American Society for Testing and Material
MPa	-	Megapascal
GPa	-	Giga pascal
Kg/m^3	-	Kilogram per metre cube
g/cm^3	-	Gram per centimeter cube
mm	-	Milimetre
N/mm^2	-	Newton per milimetre square
G	-	Modulus of rigidity
T	-	Shear stress
%	-	Percentage
Pa	-	Pascal
MEKP	-	Methyl-ethyl-ketone peroxide

CHAPTER 1
INTRODUCTION

1.1 Natural fibre

Fibre is a substance that can be characterize into natural fibre and synthetic fibre. Natural fibre have many advantages compared to the synthetic fibre (Oneugbu et al., 2013). It has been utilized as a part of the variety of building applications in various field such as aviation and process industries. Today, these fibres are considered as environment-friendly that refers to their biodegradability and renewable characteristics (Naveen and Raju, 2012). Proper use of natural fibres like coconut husk can give strength along with elasticity (Saifee et al., 2015).

The usage of natural fiber as reinforcement in polymer composites was inspected from the outlook of position and expectations of natural fibers. Comparing natural fiber and glass fiber reinforced composites found that natural fibers were the best composite in industrial application. Moreover, due to the usage of natural fibers in different engineering application and construction industries, it provides way for economic development in rural areas.

The composites material has been used from centuries ago, and it all started with natural fibres (Naveen and Yasaswi, 2013). Composites is identified as a mixture between two or more materials. One of the material is reinforcing phases such as fibres and sheets and the other material was matrix phase such as polymer and ceramic.

According to Ramesh (2013) reported that natural fibre has a few advantage such as it is renewable resources and have marketing appeal. Natural fibres are divided into three categories such as mineral based, plant based and animal based.

An example of natural fibre classification material is coconut fibre. Coconut fibre is identifies as the reinforcement strength element to making new composites.

1.2 Problem Statement

Coconut fibre is one of the examples of natural fibre. It is extracted from the outer layer of the fruit of coconut tree. According to Elizabeth (2013), state that coconut fibre is an agriculture waste because most people only use coconut milk in cooking food. Coconut fibre will be discarded and not used again. The waste of coconut fibre if not properly disposed of will cause to environmental problems. To reduce the waste of coconut fibre, the researcher has proved that coconut fibre is suitable for construction materials as a partial material for cement in concrete production. Nowadays concrete is becoming the major backbone of infrastructural development in every country. Concrete is one of the construction material basically made by mixing cement, water, fine and coarse totals. There is an increasing rise in the cost of concrete and consequently has slow down infrastructural development in developing countries. Cement production causes green house effect, which is a major contributor to environmental hazards.

Natural fibre as an undesirable waste results in its burning or disposal on landfills. In any case, this practice will contribute to the pollution. Therefore, in order to preserve the environment, it is necessary to find economically feasible solutions to the increasing amount of natural fibre wastes. This can be achieved through the understanding of natural fibres as recyclable materials, which could be used for different applications, ranging from handicraft to reinforcement elements for composite materials (Monteiro et al., 2005).

The natural plant fibres have a lot of advantages compared to the synthetic fibres because synthetic fibres are harmful to the environment while natural fibre are biodegradable and environment-friendly materials (Sabinesh et al., 2014). So that the useful of biodegradable product is concerns to the environment. Furthermore, natural fibre reinforced composite materials are one of the material which replaces

the synthetic materials for the others application where there require less weight and energy conservation. Expanding worry about an Earth-wide temperature boost and exhausting petroleum holds have made researchers concentrate more on the utilization of natural fibre. coconut fibre is an alternative as effective reinforcement and bonded in polyester matrix to get a better mechanical performance.

1.3 Objectives of Research

From the background and the problem statement that have been stated, the objectives of this research are:

i. To develop new composite with the addition of biodegradable waste.
ii. To test and compare the new develope composite in order to obtain the best in range value of modulus of rigidity between long and short fibre.

1.3 Scopes of Research

In order to achieve the objectives, several scopes have been determined.

i. Developing and preparing the new composite by using the coconut fibre as reinforced material with polyester resin by using molding technique.
ii. Testing the sample by using torsion testing machine according to ASTM E143 to find the modulus of rigidity.
iii. Comparing the highest modulus of rigidity from the ratio of mixture coconut fibre and polyester resin between long and short fibre.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The literature review chapter will describe about composite structure and the types of reinforcement fibre. Reference options are guided from the journals, previous thesis, reference book and article from the internet. This chapter includes overview properties of coconut fibre as reinforcement with polyester resin as matrix.

2.2 Natural fibre

Natural fibres source can be extracted from the content that produces by plants and animals that can be revolved to be a filament, thread or rope and also for the process of becoming a woven, knitted, or bound. Now natural fibre is an alternative for composite productions because the ability to renew are low rated density (Tudu, 2009). Natural fibre reinforcing materials can have at low cost and low levels of energy by using local manpower and technology (Shajan, 2012). Natural fibre composite is emerging as realistic alternatives reinforced composites and metals. A few decade ago, natural fibre have attracted the attention of scientist and technologists because of the advantages that contain in the natural fibres. There are a few advantages of natural fibres which is low-cost fibres and high specific properties. This fibres are also biodegradable and non-abrasive (Tanwer, 2014).Table 2.1 shows the properties of natural fibre in different types which are sisal, roselle,banana, date palm, coconut and reed.

Fibre is one of the components that have been used as reinforcement material to produce composites. According to Fizal et al., (2016), this fibre generally present in the fibre stage which having an extraordinary mechanical feature in term of

strength and stiffness properties. This fibre is obtained as a segment of composites materials. Fibre can be classified into two categories which are natural fibre and synthetic fibre.

Table 2.1 Properties of natural fibres (Fizal et al., 2016)

Fibre type	**Density (kg/m^3)**	**Water absorption (%)**	**Modulus of elasticity,E (GPa)**	**Tensile strength (MPa)**
Sisal	800-700	56	15	268
Roselle	800-750	40-50	17	170-350
Banana	950-750	60	23	180-430
Date palm	463	60-65	70	125-200
Coconut	145-380	130-180	19-26	120-200
Reed	490	100	37	70-140

2.3 Comparison between natural fibre and synthetic fibre

Natural fibre can be easily obtained in numerous tropical and accessible all through the world. According to Bujang et al., (2007), natural fibre is considered as environment-friendly materials refers to their biodegradability and renewable characteristic. There are three types of natural fibre which are animal fibre, mineral fibre and cellulose fibre.

There is a few advantage of natural fibre which is renewable, can be thermally recycled, fewer issue concerning health and good specific properties. Plant fibre, is coming from the natural fibre that have recently attracted the consideration due to their advantages. There are light compared to other materials such as glass and aramid fibres. By using plant fibre as a composite material, it can contribute to a healthy ecosystem. With the low cost and high performance of plant fibre, it will fullfill the economic interest in industry applications (Onuegbu et al., 2013).

According to Hussain et al., (2011) state that natural fibre composites have good electrical resistance and higher resistance to fracture. Others advantage of

natural fibres are low weight, acceptable specific properties and biodegradable. Natural fibre is also renewable and have relatively high strength and stiffness.

2.4 Natural fibre classification

Natural fibre materials source can be extracted from the content that produced by plants and animal that can revolve to be a filament, thread or rope and also for the process to becoming a woven, knitted, matted or bound. Now, they are an alternative for composite productions because the ability to renew and low rated density with the (Tudu, 2009).

2.4.1 Animal fibre

Animal fibre contains of silk, wool and hair. Example of animal fibre are sheep‟s wools and goat hair. Figure 2.1 show the image of wool fibre. Silk fibre is coming from dried saliva of bugs and insects during the preparation of cocoons which include silk from silk worms. While wool fibre is coming from birds for example feathers. The animal fibres such as chicken feather and cow hair are usually depicted as a waste by its product which is adding to ecological contamination because of their disposal problems.

Burning and burying are the methods that usually used to remove animal fibres which both of the fibres have a negative impact to the environment. In Nigeria, the skins of cow are used to make shoes, mats and outfits. It is obvious that there is very little research into using cow hair as fibre reinforcement for polymers. Thus, the usage of these animal fibres will make a better utilisation as opposed to the environmental concerns to their methods of disposal (Oladele et al., 2015).

Figure 2.1 Wool fibre (Source: http://phys.org/news)

2.4.2 Mineral

Mineral fibre is a minor modifications process from a mineral source that can be characterised into the following structures (Saxena et al.,2011). Asbestos contain in a group of minerals that happen in a bundle of fibres. The asbestos are resistant to heat and bad conductor of electricity. It is known as silicate compound that contain silicon and oxygen in the structure of the asbestos. There are six types of asbestos which is amosite asbestos, tremolite asbestos, actinolite asbestos, anthophyllite asbestos, crocidolite asbestos, and chrysotile asbestos. Amosite asbestos is the second type of asbestos that have been found in building materials. In another hand, its called brown asbestos or "grey" asbestos. Figure 2.2 shows the example for the mineral fibre that called asbestos.

The colour of the amosite asbestos is coming from the natural presence of magnesium and iron. Generally, amosite was used as a fire retardant in thermal protection item as a fire resistant. Crocidolite asbestos that called blue asbestos was the slightest utilised as a part of business items.

Pure magnesium tremolite is smooth white in shading, however because of the expanding iron substance shading evaluations to dull green. Then, it will become toxic and converts to diopside while at high temperature. Another type of asbestos is actinolite. Actinolite routinely found in transformative rocks like cooled meddling

volcanic rocks. While Anthophyllite is called as amphibole mineral that happens by transformative nature of magnesium-rich rocks and dolomite shales. It is also known as an amphibole mineral. Chrysotile asbestos additionally is known as white asbestos. It is a delicate, stringy and silicate mineral of phyllosilicates. It is the most generally utilised types of an individual from the serpentine asbestos family. This fibre is long, empty barrels and extremely solid.

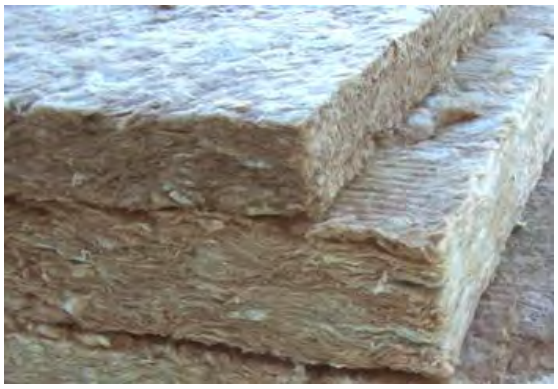

Figure 2.2 Mineral fibre (Source: http://www.soundservice.co.uk/)

2.4.3 Cellulose

Cellulose is one of the major component of the cell wall that contain in the plants (Wada et al., 2008). It is likewise created by a few algae, bacteria, fungi and sea animal. Cellulose is not just an essential material in the textile and wood fibre industries, yet it likewise assumes imperative parts in nourishment quality, biobased and agriculture. Table 2.2 show the chemical composition of some typical cellulose containing material. There are seven types that are coming from cellulose include of bast, leaf, seed, wood, stalk, grass and fruit.

Table 2.2 Chemical composition of some typical cellulose containing material (Klemm. D, 2002)

Source	Composition(%)			
	Cellulose	**Hemicellulose**	**Lignin**	**Extract**
Hardwood	43-47	25-35	16-24	2-8
Softwood	40-44	25-29	25-31	1-5
Coir	32-43	10-20	43-49	4
Cotton	95	2	1	0.4
Jute	71	14	13	2
Sisal	73	14	11	2
Wheat straw	30	50	15	5

Bast fiber or skin fiber will be fiber gathered from the phloem surrounding the stem of a specific plant. Jute fibre (figure 2.4) also known as Corchorus sp is an example of bast fibre that extracted from the ribbon of the stem (Wang et al, 2008) while jute plant (figure 2.3) is long, soft and shiny.

Basically, the jute plant grows up to a tallness of 2.5m and its fibre length is around 2m. It is known as a ligno-cellulosic fibre that contain partially textile fibre and incompletely wood. Jute fibre is obtained mainly from two important species namely white jute and Tossa jute. It is use as bundling material, for example wall decoration, rope, and bags (Sen and Jagannatha, 2011). According to (Smole and Hribernik, 2013), jute fibre is one of the least expensive fibre than others.

Figure 2.3 Jute plant (Bongarde and Shinde, 2014

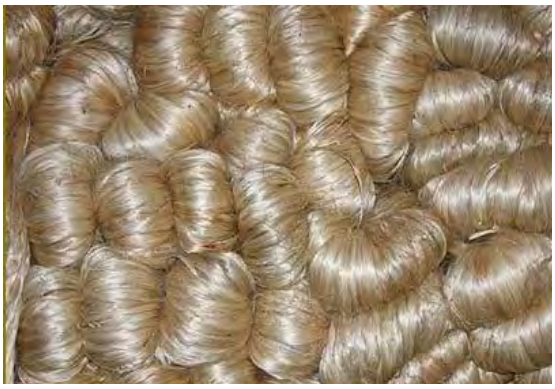

Figure 2.4 Jute fibre (Bongarde and Shinde, 2014)

Leaf fibres is a hard fibre that is extracted from the leaves (Smole and Hribernik, 2013). One of the examples of the leaf fibre is sisal plant. Sisal fibre as shown in figure 2.6 was obtained from the sisal plant leaves or also known as Agave sisalan as shown in figure 2.5 (Sakthivei and Ramesh, 2013). Sisal plants look like giant pineapples. This plant has high specific strength, low price and easy availability. During harvest, the leaves were obtained by cutting the leaves as shut to the ground for 2 weeks to allow fermentation to take place (Oladele et al., 2014). According to Sen and Reddy, (2011), sisal was produce strong and sturdy fibres.

The sisal plant has 7-10 year life go and frequently conveys 200-250 economically usable takes off. Sisal is utilized by industry as a part of three evaluations. The lower grade fibre is used to make the paper industry because of its high substance of that contains cellulose and hemicellulose while the medium grade fibre used for making ropes, baler and binders twine. The higher grade fibre after treatment is change over into yarns and use by the carpet industry. Different items that are gotten from sisal fibre incorporate cat scratching, slippers posts, rugs, and cloths. Products that produced using sisal fiber are gotten all through the world and for use by the military, colleges, places of worship and healing facilities (Chandramohan and Marimuthu, 2011).

Figure 2.5 Sisal plant (Oladele et al, 2014)

Figure 2.6 Sisal fibre (Dimesh et al, 2013)

Cotton fibre also known as Gossypium Hirsutum is a natural fibre that comes from seedpod of the cotton plant (Smole and Hribernik, 2013). Cotton plant (figure 2.7) is grown in more than 70 countries, including Australia, China, Egypt, India, Pakistan and Uzbekistan. More than 150 countries are included in import and export of cotton. Cotton fibres (figure 2.8) have three wall structure. The outer layers protect the primary wall, the secondary wall consists of three distinct layers (Sabinesh et al., 2014).

Cotton is mainly cultivated for the production of those elongated single-celled fibres valued worldwide too much and which sustain one of the worlds largest industries. The growth of cotton plant begins with germination of seed and it depends on the acessibility of soil, temperature, moisture and oxygen. Cotton is harvested as „seed cotton" which is then „ginned" to isolate the seed and lint. The long „lint" fibres are further processed by turning to create yarn which is knitted into fabrics.