



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**PRELIMINARY STUDY ON ELASTIC PROFILE OF MIX  
COCONUT FIBRE AND POLYESTER RESIN AS COMPOSITE  
FIBRE SUBSTITUTION**

This report submitted in accordance with 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 –Preliminary Study on Elastic Profile of Mix Coconut Fibre and Polyester Resin as Composite Fibre Substitute” is the results of my own research except as cited in references.

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## **APPROVAL**

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

.....

(Project Supervisor)

## **ABSTRAK**

Kajian ini tertumpu kepada kajian awal pada profil keanjalan gentian kelapa campuran serat dan komposit resin poliester sebagai pengganti. Ini adalah disebabkan oleh kesan persekitaran di mana menggunakan gentian sintetik yang boleh merosakkan alam sekitar dan serat semula jadi adalah sebagai pengganti. Gentian asli boleh ditakrifkan sebagai bahan yang dihasilkan oleh tumbuh-tumbuhan dan haiwan yang boleh diputar ke dalam filamen, benang atau tali untuk menghasilkan tenunan, rajutan, atau Kusut dan terikat. Tujuan kajian ini adalah untuk menghasilkan komposit baru dengan tambahan bahan buangan biodegradable dan untuk menguji dan membandingkan penghasilan komposit baru untuk mendapatkan nilai modulus keanjalan yang terbaik berdasarkan nisbah serat dan poliester. Nilai modulus terbaik keanjalan telah didapati berdasarkan nisbah serat kelapa dan resin poliester. Untuk mendapatkan saiz yang seragam dan sama, semua persiapan sampel dan acuan telah dirujuk melalui ASTM D3039. Universal testing machine (Instron) telah digunakan untuk mendapatkan nilai modulus keanjalan yang terbaik antara lima belas sampel. Ujian simulasi juga dijalankan bagi menganalisis kesan penghasilan acuan terhadap sampel. Di akhir kajian, komposisi yang sempurna dengan nilai yang paling terbaik modulus keanjalan ditemui. Berdasarkan keputusan dan perbincangan 45% serat kelapa adalah nilai modulus keanjalan yang terbaik berbanding lima belas sampel untuk serat panjang manakala 40% serat kelapa adalah nilai modulus keanjalan yang terbaik berbanding lima belas sampel bagi gentian pendek. Dalam kesimpulan keputusan menunjukkan bahawa dengan penambahan serat kelapa dapat meningkatkan sifat-sifat mekanikal komposisi.

## **ABSTRACT**

This study focused on the preliminary study on elasticity profile of mix coconut fibre and polyester resin as composite fibre substitution. This is due to the environment effect where using synthetic fibre that can harm the environment and natural fibre is as a substitute. Natural fibers can be defined as substances produced by plants and animals that can be spun into filament, thread or rope in order to produce woven, knitted, and matted or bound. The purpose of this research is to develop new composite with the addition of biodegradable waste and to test and comparing the new develop composite in order to obtain the best in range value of modulus of elasticity among the sample. The best in range value modulus of elasticity was getting based on the ratio of the coconut fibre and polyester resin. The molding of the sample was fabricated to get the uniform size of the sample following the ASTM D3039. Universal testing machine (INSTRON) was used to get the highest modulus of elasticity among the sample. Simulation testing was conduct to analyzed effect of fabricated mold on sample fabrication and compare with the sample fabrication. In the end of the research, a perfect composition with the best in range value of modulus of elasticity was found. Based on the result and discussion 45% coconut fibre is the best in range value of modulus elasticity for the long fibre while 40% coconut fibre is the best in range value of modulus elasticity for short fibre. In the conclusion the result show that with the addition of the coconut fibre was improve the mechanical properties of the composition

## **DEDICATION**

To my beloved mother Mrs Siti Aisah Bt Md Saman and my beloved father Mr Ibrahim  
Bin Ahmad

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## LIST ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

GPa	-	Gigapascal
MPa	-	Megapascal
$\text{g/cm}^3$	-	Gram Per Cubic Meter
ASTM	-	American Society for Testing and Material
PET	-	Polyethylene Terephthalate
$\mu\text{m}$	-	Micrometer
mm	-	Millimeter
$\text{kg/m}^3$	-	Kilogram per meter cube
PEEK	-	Polyetheretherketone
PPS	-	Polyphenylene Sulfone
E	-	Modulus Young
$\sigma$	-	Stress
F	-	Force
A	-	Cross sectional Area
$\epsilon$	-	Strain
$\Delta l$	-	Change of Length
$l$	-	Length
LGM	-	Lateral Gage Middle
AGM	-	Angle Gage Middle
XGM	-	Multimode Gage Middle
LIT	-	Lateral inside Grip/Tab Top
GAT	-	Gage at Grip Top
LAT	-	Lateral at Grip Top
MEKP	-	Methyl-ethyl-ketone peroxide
NaOH	-	Sodiumhydrox

# CHAPTER 1

## INTRODUCTION

### 1.1 Natural fibre

Natural fibre is fibre that produced mostly by plant and animal. Basically, natural fibre produced in a filament form and will be spun produce a rope or thread. According to Sapthagiri et, al (2010) stated that a fibre is a material which produces in a long filament within range 10 microns. The utilization of the natural fibre has many advantages toward the product that produce in industrial and also an environment. Besides that, natural fibre is easily available and easy to obtain less harmful to nature and also the material that can renewable. According to Satsivi &Ramesh, 2013 stated that there are has some advantage of using natural fibre compared to glass fibre such as natural fibre have low density, and also are recyclable and biodegradable. Numerous natural fibres traditionally employed in weaving, sacking, and ropes present various potentials to be used as reinforcement element in composite.

Composite is defined as hybrid material that made the polymer resin reinforced with fibre. According to Sen, et al (2011) reported that when the fibre is reinforced with composite will give the high mechanical and physical properties of fibre and the appearance, bonding and physical properties of the polymer. Nowadays the utilization of natural fibre reinforced with composite is increased in many sectors According to Jeyanthi, S. et al (2012) reported that the interest of natural fibre reinforced composites is increased due to their high performance in term of mechanical properties, low cost, processing advantage and also low density. Other than that, the use of natural fibre reinforced composite also increases in automotive, cosmetic, and plastic lumber

application due to its offer an economical and environmental advantage (Bujang, et al (2007).

Natural fibre can be classified into an animal fibre, cellulose fibre, and mineral fibre. The type of animal fibre is silk, wool, and hair while the example type of cellulose fibre is bast, seed, fruit, and wood. Lastly mineral fibre only has one type namely asbestos. Every type of fibre has different mechanical properties and appearance. Natural fibre is produced by a variety form and size depends on the user. For example, sometimes natural fibre produced in powder, long fibre, and short fibre. The application of natural fibre is usually produced ropes, mats, carpet, and also sometimes used for production yarn (Sen et al 2011). According to Onuegbu et, al (2013) reported that the application of natural fibre reinforced composite is usually used in a variety of engineering application in different fields such as in aerospace, oil and gas process industries and it proved efficient and economical for used.

Based on the research about natural fibre it can conclude that in the production of composite resources at present, a combination of elements used must have the most friendly technology, where it can effect low rate pollution for long term duration. This research also focused on the coconut fibre by mixing polyester resin with a different ratio of each sample by using molding technique. The sample then will test by using universal testing machine tensile test.

## **1.2 Problem statement**

Coconut is a type of fruit that can produce a coconut milk and planting the coconut tree is the agricultural activity that carried out of many farmers in Malaysia over the years. Habitually, mostly people will just take the coconut flesh to produce coconut milk while the outer husk of coconut will through away or used as fuel. Pollution can reduce by using the coconut fibre as a new composition and also is able to reduce waste from disposal of coconut fibre. Furthermore, in order to maintain the condition of the environment, it is necessary to find the economically feasible solution to the increasing



the utilization of natural fibre waste. According to Monteiro, et al, 2005 stated that this is can be achieved through the understanding of natural fibre as recyclable material, which could be used in the different application, ranging from creation reinforcement element for the composite material.

The application that can apply to re-use the waste of coconut fibre is can produce the product, for example, the bicycle helmet. Normally the outer shell of the helmet is produced from PET (Polyethylene terephthalate). PET is in plastic classification. This is also can reduce the use of plastic that can cause the pollution. Plastic is the non-biodegradable material. According to Web.H.K., et al (2012) reported that waste of plastic is the cause of the pollution that can cause the several hazardous and every piece of plastic can lead animal life threatened.

In this way, it also can increase the demand of coconut and it also helps increase the income for coconut farmers. Besides that, this is also as the alternative way in reducing the usage and utilization of synthetic fibre in any sector. Nowadays, the utilization of natural fibre reinforced in polymer composite has attracted the interest of the user compared to synthetic fibre. This is due to Mulinari, (2007) stated that there is an increasing environmental consciousness and awareness of the need for sustainable development. By using coconut fibre it can less harmful to our environment because synthetic fibre is made of chemical processes. The chemical process can effect to the environment. According to Samuel. et al (2012) reported that due to high cost when to use the synthetic fibre and dangerous to health the exploration about natural fibre is required. Nowadays the use of synthetic fibre is still used in building industry. The cause of pollution to the environment is a utilization of non-biodegradable material such as synthetic fibre that can increase the carbon dioxide (Abdullah. et al 2011). The increasing the carbon dioxide will cause the global warming.

### **1.3 Objective**

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

1. To develop new composite with the addition of biodegradable waste.
2. To test and compare the new develop composite in order to obtain the best in range value of modulus of elasticity between long and short fibre.

### **1.4 Scopes**

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

1. Developing the new composite by using the coconut fibre as reinforced material with polyester resin by using molding technique
2. Testing the sample by using the universal testing machine tensile test according to ASTM D3039 to find the modulus of elasticity.
3. Comparing the highest modulus of elasticity from the ratio of mixture coconut fibre and polyester resin between long and short fibre.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This literature review chapter will explain about two type of fibre that widely used nowadays that can provide to the industrial product. There are two types of fibre that exists, such as natural fiber and synthetic fibre. All information about fibre is analyzed through journal, previous thesis, reference book and article from the internet. This chapter includes the overview about polyester resin that used to mix with coconut fiber.

#### **2.2 Comparison natural fiber and Synthetic fibre**

Nowadays utilization of fibre is very widely used in many major in industrial. According to Chandramohan.D & Marimuthu.K (2011) stated that the interest in utilization of natural fibre reinforced polymer composite material is very widespread in term of their industrial application and the advantages such as they are renewable, low cost and completely recyclable. Fibre is usually found in many form and appearance which long fibre, small and also sometimes produced into powder. Fibre also classified as a hair material because similar to the piece of thread. According to Shivnand.H.K & Inamdar P.S. (2010) reported that fibre is a material which made into a long fibre that

has a diameter generally within 10 microns and the ratio of length to diameter starting from thousand to infinity. So it proved that fibre can produce in many size and shape based on suitability of the product. There are two types of fibre that are often used, which is natural fiber and synthetic fiber.

Most of the natural fibre is a based on plant and also can easily to find and available throughout the world. The use of natural fibre in the product diversity has many advantages on product, humans and the environment. According to M.Sakthivei &S.Ramesh (2013), stated that the advantages of using natural fibre are environment-friendly, sustainable energy, low density, can easily be obtained and also are recyclable and biodegradable. Natural fibre is divided into three types which are mineral, animal, and cellulose. Usually, there are has a different in each fibre based on their appearance and their surface such as certain fibre has a smooth surface and certain fibre has a rough surface. According to T.Sen et, al (2011) reported that natural fibre usually in employed in weaving, sacking and ropes present various potentials to be used as reinforcement element in composites. Natural fibre usually used for reinforcement in composite because of their own advantage in mechanical properties. According to M.Sakthivei &S.Ramesh (2013), stated that natural fibre is renewable raw material and have relatively high strength, high stiffness and also low density and it allow to producing composite and that combined good mechanical properties with a low specific mass.

Synthetic fibre is material produced from man-made instead of natural fibre and in synthetic fibre is the contained chemical mixture to produce it. Synthetic fibre are based on a polymeric structure and however synthetic fibres are being produced or synthesized often from oil, and at the time come from coal or natural gas (C.B.Weinberger, 1996). Synthetic fiber is dividing into several types such as carbon fibers kevlar, spandex, polyester, nylon, acrylics, rayon, nomex. Synthetic fibre usually used in oil and gas industry as a rope. Manufactured fiber mooring ropes have been used by the oil and gas industry for the station keeping of offshore equipment and platforms. The advantage of using synthetic fibre as a mooring is as low cost, light and load-extension properties that can be harnessed to reduce peak loading (S.weller et al 2013). Other than that synthetic fibre is does not easily to moisture and also has the rough

surface. The differentiation between synthetic fibre and natural fibre is the yarn the natural fibre more curly than synthetic fibre. There are two techniques to make sure the synthetic fibre more curly, one is to pass the yarn between two heated gears which can impart a permanent crimp to the yarn, the second is to produce the synthetic filaments from two different polymers passing out of a common hole, or die (C.B.Weinberger, 1996).

After understand all about synthetic fibre and natural fibre it can conclude that usage of natural fibre has more advantage compare to synthetic fibre. This is because natural fibre is a biodegradable. The utilization of plastic in synthetic fibre implies that it's not remotely as biodegradable as a natural fibre. Natural fibre has recently attracted the consideration of examining due to their advantage over established material. By using the natural fibre also it can less harmful in an environment. In the last decade utilization of synthetic fibre to reinforcement with a composite is widely used in automotive and aerospace industrial as it's a high strength and stiffness, but recently the utilization of natural fibre is more than synthetic fibre due to increasing of environment concern (L.Yan et all 2012). According to M.Sakthive & S.Ramesh, (2013) reported that the utilization of natural fibre is able to reduce weight by 10% and lower the energy needed for production by 80% while the cost of the component is 5% lower than the comparable fibre glass-reinforced component. So it proved that by using the natural fibre used as reinforcement material to produce composite has a plenty advantage compare that synthetic fibre. There is much application of natural fibre reinforced composite, for example, can produce furniture such as chair and table (D.Chandramohan & K.Marimuthu., 2011). The specific application of this composition is to produce the bicycle helmet. This is alternative way to replace the utilization of biodegradable material.

## **2.3 Natural fibre classification**

The utilization of natural fibre is more increased nowadays due to having many advantages as mention earlier. There is several type of natural fibre that used in the industry to produce a product and each type of natural fibre possesses distinctive characteristics. Natural fibre is a material that continues filament and is in discrete elongated shape, same with a thread. The example of natural fibre is based on animal, cellulose and mineral.

### **2.3.1 Animal fibre**

Animal fibre is under the natural fibre classification that produces from an animal. Animal fibre can obtain from a certain animal such as goat, sheep, camels, horse and cattle. The fibre that categorized under the animal fibre is wool and silk. The application of a wool fibre is usually can produce a textile for example coat and cloth. The surface of the product that produces from a wool fibre is curly and soft. According to D.B Shakyawar et al (2013) reported that the product that produces from animal fibre has some unique quality in term of fineness, softness and shining compared to the others fibre.

The other fibre that classified in animal fibre is silk. Silk is a very special natural fibre because silk is produced by an insect such as spider and caterpillar. The silk that produces by caterpillar is very commercial on the market because of their surface. Silk fibre spun by some species of arthropods have existed normally for hundreds of million years and the ecological element of the silk fibre is close with their properties such as produce a variety of different silks with diverse properties, each tailored to achieve a certain task (L.Xinfang & Z.Ke-Qin, 2014).

### 2.3.2 Cellulose

Cellulose fibre or vegetable fibre is the basic structure material that contains in the most plant and can be found from various natural plant-based resources. Cellulose fibre is employed in the manufacture of paper and textile, and dietary fibre is an important component of human nutrition. There are several types of cellulose fibre such as bast, leaf, seed, fruitwood, and stalk. According to D.Chandremohan & K.Marimuthu, (2011) reported that cellulose fibre serves in the manufacture of paper and cloth.

Bast fibre also known as skin fibre is gathered from the skin or bast which includes the stem of their particular plant. Bast fibre also divides into several types such as jute. Jute is the fibre that is removed from the strip of the stem. The small fibers, 5mm are gotten by successively retting in water, beating, stripping the fiber from the core of drying and a single jute fiber is a three-dimensional composite created mainly cellulose, hemicelluloses, and lignin with a minor measure of protein, extractive and inorganic (T.Sen & H.N.Jagannatha Reddy, 2011).

Leaf is one of the organs for a vascular plant and is the key parallel member of the stem. Sisal also looks like a giant pineapple leaf and is one of the categorized leaf fibres. According to I.O.Oladele et al (2014) stated that the specific name of the sisal is *Agave Sisalana* that provides a yield stiff fibre used to produce rope and twine. Sisal leaf usually has a giant size and the way to harvest the leaf it should be cut as close to the ground as possible. Nowadays, sisal constitutes the first fiber in a commercial application, in which it is assessed in more than half of the total of all natural fibers utilized (T.Sen & H.N.Jagannatha Reddy, 2011). There are many applications of using the sisal fibre such as it is mainly used for ropes, mats, and carpets. Figure 2.1 shows the sisal leaf before the process to become a fibre.



Figure 2.1 Figure Sisal leaf Oladele *et al* 2014

Seed fibre is originated and collected from seeds or seed cases and acquired from a seed of the plant species. The example of seed fibre is cotton. Cotton constitutes the most used textile fibre in the world due the fibre properties and low cost. According to M. Sfiligoj Smole *et al* (2013) stated that seed fibre is consist of comprising of unicellular seed hairs of the bolls of the cotton plant that when Cotton organic product blasts when developed, uncovering a group of filaments with the length from 25 to 60 mm and widths fluctuating somewhere around 12 and 45  $\mu\text{m}$ . The other characteristic of cotton fibre is comfortable Soft hand and good absorbency. The application of cotton is most used as apparel and also can produce home fashion. The example the cotton fibre can produce the apparel such as jackets and sweaters.

Wood fibre is under cellulose fibre were extracted from tree to produce a paper, roof, wall and floor. Wood is a strong, lightweight, available in everywhere, non-hazardous and not expensive due wood is easier to find. Wood fibre also come in different species and many species wood originally growth in Malaysia forest. The mechanical properties of wood fibre are soft and light with a density of 370-465  $\text{kg/m}^3$  and the thickness and wide usually in range 0.2 to 0.5 mm thick and 1.5 to 5 mm wide (M.S. Mahzabin *et al*, 2013) . Usually, the wood fibre from this species used in the