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"I hereby declare that I have read this thesis 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 (Structure and Materials)"

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TENSILE PROPERTIES OF OIL PALM EMPTY FRUIT BUNCH (OPEFB) FIBER REINFORCED POLYPROPYLENE (PP)/ POLY(LACTIC-ACID) (PLA) COMPOSITES

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DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged."

Signature : …………………………..
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Date : …………………………..

Specially dedicated to my beloved father Hj Abdullah Bin Yahya and beloved mother Hjh Zainab Hong Binti Abdullah, brothers and sisters, to all family members, lecturers and friends.

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ABSTRACT

This research is dedicated to the study of the tensile properties of oil palm empty fruit bunch (OPEFB) fiber reinforced polypropylene (PP) and poly (lactic-acid) (PLA) composites. From the previous study, the investigation on tensile characteristic was done by using biodegradable polymers poly (lactic-acid) (PLA) on oil palm fiber in chopped random form. In this research the particle size of OPEFB was used in range size, 0.25mm to 0.063mm reinforced the PP and PLA. There are two major types of specimens which are differ in the composition. First type of specimens contain 10wt% of OPEFB loading with different particle size 0.063mm and 0.25mm labeled as OPEFB0.063-PP/PLA and OPEFB0.25-PP/PLA respectively. For this type of specimens were prepared by using method B. Second type of specimens contain 0.25mm OPEFB particle size with different fibre loading, 20wt% and 30wt% labelled as OPEFB20%-PP/PLA and OPEFB30%-PP/PLA respectively. For this type of specimens was prepared by using method A. In order to investigate the tensile characteristic of the composites tensile test was carried out for each specimen respectively. From the result, for 10wt% of fibre loading obtain 22.36MPa of tensile strength for OPEFB0.25-PP/PLA that is 52% higher than OPEFB0.063-PP/PLA that is 10.73MPa of tensile strength. For 0.25mm OPEFB particle size obtain 19.54MPa of tensile strength for OPEFB20%-PP/PLA that is 14.1% higher than OPEFB30%-PP/PLA obtain 16.82MPa of tensile strength. This result influenced by the porosity occur in the composites that was proved by doing liquid immersion test. Hardness test also was carried out to investigate the hardness properties.

ABSTRAK

Penyelidikan ini mengkaji tentang sifat-sifat ketegangan tehadap gentian kelapa sawit diperkuat dengan Polypropylene (PP) dan Poly (lactic-acid) (PLA) komposit. Daripada kajian ilmiah kajian terhadap ciri-ciri ketegangan terhadap gentian kelapa sawit dalam bentuk gentian pendek diperkuat dengan Poly (lactic-acid) (PLA) telah dilakukan. Dalam penyelidikan ini akan mengkaji tentang sifat ketegangan gentian kelapa sawit OPEFB dalam bentuk sebuk dalam ukurun antara 0.25mm kepada 0.063mm diperkuat oleh PP and PLA. Terdapat 2 jenis spesimen utama yang berbeza komposisi digunakan dalam kajian ini. Jenis spesimen pertama mengandungi 10wt% OPEFB dengan saiz OPEFB yang berbeza yang dinamakan OPEFB0.063-PP/PLA dan OPEFB0.25-PP/PLA masing-masing. Bagi jenis spesimen ini disediakan dengan menggunakan Kaedah B. Jenis spesimen kedua mengandungi 0.25mm OPEFB saiz fibre dengan perbezaan wt% fibre loading that are 20wt% and 30wt% yang dinamakan OPEFB20%-PP/PLA dan OPEFB30%-PP/PLA masing-masing. Untuk jenis spesimen ini disediakan dengan menggunakan kaedah A. Mesin ujian tegangan digunakan bagi mengkaji cirri-ciri tarikan komposit. Spesimen yang dihasilkan akan diuji dengan mesin ujian tegangan untuk mengkaji cirri-ciri tarikan pada kompsit. Berdasarkan keputusan, komposisi 10wt% OPEFB iaitu OPEFB0.25-PP/PLA memperoleh 22.35MPa daya tarikan iaitu 52% lebih tinggi berbanding OPEFB0.063-PP/PLA iaitu 10.73MPa. Manakala untuk komposis 0.25mm OPEFB, OPEFB20%-PP/PLA memperoleh 19.54MPa daya tarikan iaitu 14.1% lebih tinggi berbanding OPEFB30%-PP/PLA iaitu 16.82MPa daya tarikan. Keputusan daya tarikan ini dipengaruhi oleh liang yang terdapat di dalam komposit yang telah dibuktikan melaui kajian kadar serap cecair. Ujian kekerasan juga turut dilakukan untuk mengkaji sifat kekerasan komposit.

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T_g	=	Glass Transition Temperature
T_m	=	Melting Temperature
m_0	=	Initial Mass
m_1	=	Final Mass

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CHAPTER 1

INTRODUCTION

1.1 Background Research

‘Projek Sarjana Muda’ (PSM) is compulsory for all student of UTeM in order to obtain a degree in the engineering field. From the PSM, every student will apply their subject learned from the classes into the final project. There are many applications that have to do such as theoretical, experimental, analysis, design and so on. Objective of this project is to produce professional and efficient graduate to complete engineering problem by literature and scientific study through research approach and development and through application of knowledge were studied and knowledge from some other field those concerning.

Nowadays, there is a growing public concern for reducing damage to our environment. This project will focus on composite that are created from natural fiber reinforced polymer matrix. Composites are hybrid materials made of polymer resin reinforced by fibres, combining the high mechanical and physical performance of the fibres and appearance, bonding and physical properties of polymers. The composites may become inconsistent fibre quality and can lead impact failure. Natural composites have various benefits such as due to its friendly characteristics that is no skin irritation and lightweight property of the products.

Natural fiber provide several benefits such as low cost, green availability, low densities, recyclable, biodegradable, moderate properties and usually produce in abundant amount at one time.

Fiber are classification into two group that are natural fiber and synthetic fiber. For natural fiber it is come from animal, vegetable, and mineral while for polymer, metal, and glass.

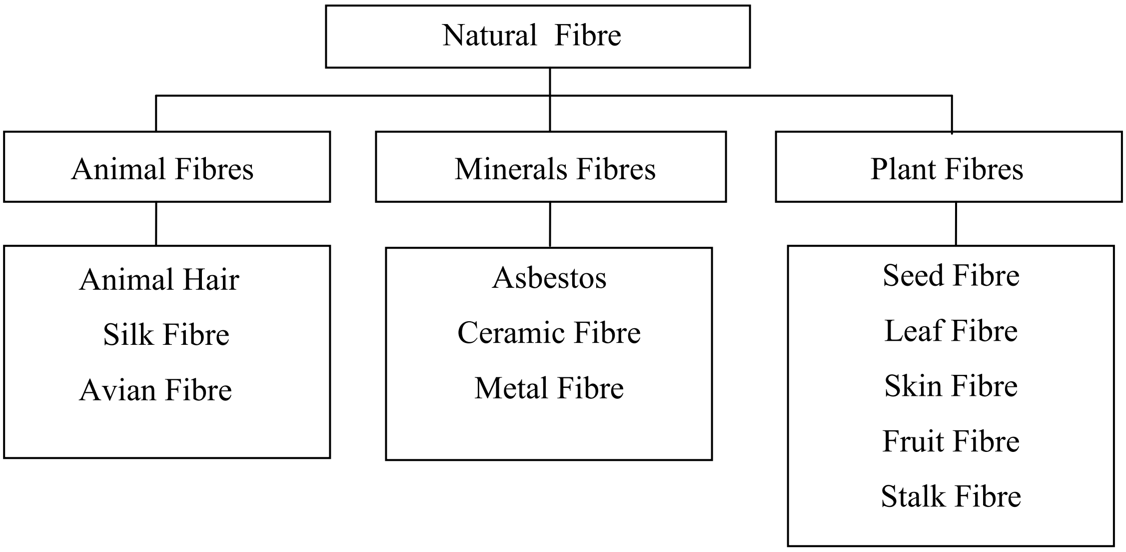

Figure 1.1: Classification of Natural Fibre [1].

Natural fibers include those made from animal, mineral sources and plant. Animal fiber generally comprise of animal hair, silk fiber, and avian fibre. For synthetic fibres comprise of asbestos, ceramic fibers, and metal fibers. While the example of the plant fibers are seed fiber, leaf and skin fibre [1].

This research is carried out to cover about the oil palm empty fruit bunch (OPEFB) fibre. OPEFB fibre also known in scientific as Elaeis guineensis [7]. This products including empty fruit bunches, fibre and shell but for this research directed towards the oil palm empty fruit bunch [8]. The OPEFB fibre are clean, biodegradable, and compatible than many other fibre from wood species. OPEFB fiber is extracted from palm oil empty fruit bunch (EFB) and during the manufacturing process of oil palm fibre, EFB is shredded, separated, refined, and dried. The fresh oil palm fruit bunch contains about 21% palm oil, 6-7% palm kernel, 14-15% fiber, 6-7% shell, and 23% empty fruit bunch [2]. On about 27million acres oil palm is produced in 42countries worldwide, Malaysia is the world largest producer and exporter of oil palm. Therefore, as the world largest producer increases the oil palm plantation in Malaysia and at the same time Malaysia also produced waste products in large quantity. By exploiting this kind of waste materials not only maximizes the use of oil palm but also helps preserve natural resources and maintain ecological balance [8].

Figure 1.2: Empty Fruit Bunch

There is an annual production of over 2 million tons of waste oil palm fibre [2]. In the past few years, empty fruit bunches are mainly incinerated to produce bunch ash to be used back to the field as fertilizer. By doing the conventional method that is burning these residues, it is normally creates an environmental problem and generates severe air pollution. So that, the OPEFB become more expensive to dispose. The OPEFB has been chosen to be the raw materials of producing composite in this research is due to its abundant and low cost than other source, clean, nontoxic abrasive renewable. From the previous research, the oil palm shell was used as structural concrete and found that the oil palm shell has good potential as a course aggregate for the production of structural lightweight concrete [8]. In other previous research, the OPEFB is used in Stone Mastic Asphalt. This investigation is to improve the service properties of the Stone Mastic Asphalt (SMA) mixes by forming plant to prevent drain-down of asphalt as to increase the stability and durability of the pavement mix [9].

For the matrix of the composites used in this project are Polypropylene and Poly(lactic-acid). Polypropylene is a semi-crystalline polymer that is used extensively due to its unique properties, cost and easy to fabricate. While Poly(lactic-acid)(PLA) is a biodegradable polymer derived from lactic-acid and made from 100% renewable resources such as sugar, wheat and starch. Therefore, from this research, can compare the properties between these both materials and do the research on the application suitable for the composite materials.

For this research, the tensile properties of this oil palm fiber reinforced with matrix Polypropylene and Poly(lactic-acid) (PLA) will be investigated and the tensile properties of the matrix Polypropylene and Poly(lactic-acid) (PLA) itself also will be investigated. The physical characteristics of high molecular weight PLA are to a great extent dependent on its transition temperatures for common qualities such as density, heat capacity, and mechanical and rheological properties. In the solid state, PLA can be either amorphous or semicrystalline, depending on the stereochemistry and thermal history. For amorphous PLAs, the glass transition (T_g) determines the upper use temperature for most commercial applications. For semicrystalline PLAs, both the T_g (~58°C) and melting point (T_m), 130°–230°C (depending on structure) are important for determining the use temperatures across various applications. Both of these transitions, T_g and T_m, are strongly affected by overall optical composition, primary structure, thermal history, and molecular weight.

Above T_g amorphous PLAs transition from glassy to rubbery and will behave as a viscous fluid upon further heating. Below T_g, PLA behaves as a glass with the ability to creep until cooled to its β transition temperature of approximately -45°C. Below this temperature PLA will only behave as a brittle polymer [5].

This research is due to the tensile strength of composite that is OPEFB fibre reinforced polypropylene and PLA. Below shows the tensile properties of single natural fiber for bamboo, banana and palm leaves.

Table 1.1 Tensile Properties of Single Natural Fibre [2]

Fibre	Tensile Strength (MPa)	Young's Modulus (MPa)
Banana	550±7	2000
Bundle of Bamboo	441	35900
Palm Leaves	97-196	2500-4700

From the table above, we can see that the tensile strength and the young's modulus for single natural fiber such as banana fibre, bamboo fibre and palm leaves fibre. Therefore, for this project oil palm fiber empty fruit bunch (OPEFB) was selected to be reinforced for the composite.

1.2 Objectives

The objective of this project is to investigate the tensile properties of oil palm fiber by loading OPEFB fibre into Polypropylene and Poly (lactic-acid). To identify the appropriate or optimum ratio of the OPEFB fiber in particle size to produce composite.

1.3 Problem Statement

To reduce the rate of the one of the main contributors to the nation's pollution problem this is due to the abundance of OPEFB as waste [7]. Being the world's largest producer and exporter of palm oil, Malaysia is well known for its palm oil industry and one significant problem in the large amounts of waste produced. By exploiting this waste oil palm can maximises the use of oil palm and helps preserve natural sources and also maintain ecological balance [8]. The synthetic fibres such as glass fibre, rock wool, or asbestos are concern with the possible health effects and it is required high standard practice to take safety precaution when installing or handling fibreglass or rock wool. Therefore, by using natural fibre we can reduce the possible health effect [10]. Natural fibre has excellent advantages that are it can be renewable, nonabrasive and cheaper. So that, this oil palm fibre can be an attractive reinforcement in making composite and can use in various application.

1.4 Scope

To achieve the objectives of this research, several scopes should be concern about that is investigating the composite's tensile properties through the tensile test and do liquid immersion test to identify the characteristic of tensile strength. Another scope is to identify the appropriate ratio of constituent materials and the methodology process according to the characteristic of each component in producing the OPEFB fibre reinforced Polypropylene and Poly (lactic-acid) composites.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

Literature review is the most important step to retrieve information related with the topic. Literature review can be done by searching all the information from internet, journals, books, magazines, and other sources. In this chapter, the information such as about the materials used in composites and the preparation were study in this chapter.

2.2 Composite

Composite is a structure made of materials which maintain their identities even after the component fully formed. Two main components in composites are matrix and reinforcement.

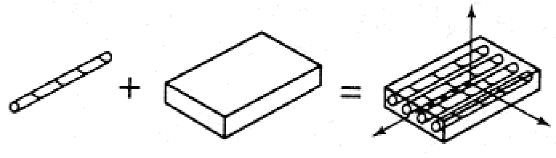

Figure 2.1: Composite Composition

The composite is expected to improve the mechanical characteristics such as the stiffness, toughness as well as ambient and high temperature resistance [19]. Typical fibres used are glass, carbon, aramid and natural fibres. Epoxy, polyester and polypropylene is a common resins used in the composite fabrication. By this joining, poor capabilities and drawbacks of the individual components will be disappeared. For instance, composites will have a high stiffness and strength with a low weight and their corrosion resistance is often excellent [19]. Composites are now a part of everyday life, and have entered nearly all major industrial sectors, including aerospace, ground transport, packaging, sports industry and civil engineering. Most current applications are modern; however, some are in fact quite ancient.

There are four types of matrix those are used in composites, namely polymer matrix composite (PMC) those are composed of a matrix from thermoset and thermoplastic and embedded glass, steel and fibres, metal matrix composite (MMC) that composites are composed of metallic matrix such as aluminium, magnesium, iron and copper, ceramic matrix composite (CMC) those are composed of a ceramic matrix and embedded fibres of other ceramic material and carbon carbon composite (CCC) [19 and 21]. For the good reinforcement, there are a few thing should be concern about such as high elastic modulus, high strength, low density, and easy wetted by matrix. The fibre can be designed in 3 designs unidirectional, biaxial and laminates or any combination of three of them. Besides, there are three main types of geometries of the reinforcement which are particle-reinforced, fibre-reinforced and structural composite [19]. Despite, fibre based reinforced composites will be emphasized in this study, whereby the OPEFB will be the filler in composites. Thus, (PMC) system which utilized the OPEFB as filler reinforcement material will be developed and further emphasizes in this study.

2.2.1 Polymer Matrix Composite

Polymer Matrix Composites (PMC) is also known as Fibre Reinforcement Polymers (FRP). The most common matrix materials for composites are polymeric materials. The reason for this is two-fold. First, in general the mechanical properties of polymers are inadequate for much structural purpose. In particular their strength and stiffness are low compared to the metals and ceramics. This meant that the reinforcement at least, initially did not have to have exceptional properties. Secondly, the processing of polymer matrix composite (PMCs) need not involve high pressures