# INVESTIGATION ON THE EFFECT OF RECYCLING PALM FIBER COMPOSITE ON THE MECHANICAL PROPERTIES

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**SUPERVISOR DECLARATION**

"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 degree of Bachelor of Mechanical Engineering (Structure & Materials)."

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Date : .............................................

DECLARATION

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

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

*Specially dedicated to my beloved mother Siti Hapiah Bte Abd Karim, brothers, sisters, to all family members, lecturers and friends.*

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## ABSTRACT

This report describes the effects of recycling on the mechanical properties of composites based on oil palm fiber in a polypropylene (PP) matrix. Composites, containing 30wt% fiber with 3wt% maleated polypropylene (MAPP) as a coupling agent, were recycling up to six times. For this composite, tensile strength (TS) and Young modulus (YM) were found to decrease with increased numbers of recycling by up to 9.6% for TS and 4.7% for YM (after recycled six times). Flexural test were also carried out for this composites and flexural strength were found to decrease by 23.8% with increase number of times recycled. The recycled processed had influenced the hardness of the palm fiber composites. The hardness numbers of the composites were found to increase with increased number of times the materials were recycled. The fiber composites showed an average hardness number of 72.10 which increased by 7.43% after being recycled six times to 77.89.

# ABSTRAK

Laporan ini menerangkan kesan kitar semula ke atas sifat mekanik komposit berasaskan gentian kelapa sawit menggunakan polipropilene (PP) sebagai matrik. Komposit, yang mengandungi 30wt% serat 3wt% polipropilene maleated (MAPP) sebagai agen gandingan, telah di kitar semula sehingga enam kali. Untuk komposit ini, kekuatan tegangan (TS) dan Young modulus (YM) didapati menurun dengan peningkatan bilangan kitar semula sehingga 9.6% untuk TS dan 4.7% bagi YM (selepas dikitar semula enam kali). Ujian lenturan juga telah dijalankan bagi komposit ini dan kekuatan lenturan didapati berkurangan sebanyak 23.8% dengan peningkatan bilangan kitar semula. Proses kitar semula telah mempengaruhi kekerasan komposit gentian sawit. Nombor kekerasan komposit didapati meningkat dengan meningkatnya bilangan kitar semula ke atas komposit gentian. Komposit gentian menunjukkan bilangan kekerasan purata 72.10 yang meningkat sebanyak 7.43% selepas dikitar semula enam kali ke 77.89.

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# CHAPTER I

# INTRODUCTION

Concern for the environment, both in terms of limiting the use of finite resources and the need to manage waste disposal, has led to increasing pressure to recycle materials at the end of their useful life. In the metals industries, for instance, materials recycling operations are already well established and are driven by economics (Pickering, 2006). In the recent decades, growing environmental awareness has resulted in renewed interest in the use of natural fibers for different applications (Espert et al., 2004).

Some stringent policies have forced industries to use more biodegradable, less harmful natural fibers as the reinforcement material instead of traditional inorganic reinforcements to manufacture composite material. Several studies have shown that natural fibers have a slight impact on the environment when compared with the inorganic fibers such as glass fiber due to their biodegradability. Most of researchers agree that healthier ecosystem can be attained with the natural fibers while their low cost and high performances are very interesting for industry and the researchers (Mustafa et al., 2012). Pervaiz et al. (2003), studied on the energy consumption of glass and natural fibers. They investigated that a 60% per-ton-of product energy savings could be achieved by using natural fibers rather than glass fibers. Another advantage of using natural waste in the composite production is their recyclability. Many studies have been done about the natural fiber reinforced composites. For example, Iannace et al. (2001) used sisal fibers in the composites for their researches while Migneault et al. (2008) studied the wood fiber as natural fiber reinforcement or filler element in polymeric matrix to minimize the usage of plastics. Utilization of wastes in this way is expected to be both economical and environmentally useful in the near future.

This research is carried out to investigate the effect of recycling polypropylene (PP) reinforce with oil palm empty fruit bunch (OPEFB). Oil palm also known in scientific as Elaeis guineensis (Kwei et al., 2007). Malaysia is the world's largest producer and exporter of the oil palm, accounting for approximately 60% of the world's oil and fat production. The oil palm industry in Malaysia, with its 6 million hectares of plantation, produced over 11.9 million tons of oil and 100 million tons of biomass (Abdul Khalil et al., 2010). Therefore, as the world largest country that produces the oil palms also will lead produced waste materials in large quantity. By exploiting this kind of waste materials will helps preserve natural resources and maintain ecological balance (Teo et al., 2006). The OPEFB fibres are clean, biodegradable, and compatible than many other fibres 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 (Yusoff et al., 2009).

In this work, recycle oil palm fiber have been used as the reinforcement element to develop a polymer matrix composite. This research is to investigate the effect of recycling palm fiber composite (PFC) on its mechanical properties. Polypropylene (PP) will be used as matrices and the oil palm fiber as the reinforcement with Maleated polypropylene (MAPP) as a coupling agent to produce palm fiber composite (PFC).

## 1.1 Problem Statement

In recent decades, growing environmental awareness has resulted in renewed interest in the use of natural materials for different applications Espert et al. (2004). Concern for the environment, both in terms of limiting the use of finite resources and the need to manage waste disposal, has led to increasing pressure to recycle materials at the end of their useful life. In the metals industries, for instance, materials recycling operations are already well established and are driven by economics (Pickering, 2006). This study will look into the effects of recycling of PP reinforced with palm fiber on the mechanical properties.

## 1.2 Objectives

The main objectives of this thesis are:

1. To investigate the tensile properties of recycled palm fiber composite.

2. To investigate the flexural properties of recycled palm fiber composite.

3. To investigate the hardness properties of recycled palm fiber composite

## 1.3 Scope

The scope of this research is to investigate the effect of recycling palm fiber composite (PFC) on its mechanical properties. Polypropylene (PP) will be used as matrices and the palm fiber as the reinforcement with Maleated polypropylene (MAPP) as a coupling agent to produce palm fiber composite (PFC). The composites will be recycled up to six times and characterized using tensile testing, three point bend testing, and hardness testing at each stage of recycling

# CHAPTER II

# LITERATURE RIVIEW

This chapter, look into the material used in composites and the preparations undertaken in the study. Literature review is the most important step to retrieve information related to the topic. This step will systematically examine all sources and describes the procedure undertaken. This would enable other researchers to reproduce the method and to determine objectively whether to accept the result of review or not.

## 2.1 Composite

Nowadays, composite materials are used in a wide variety of applications. Composites are materials made from two or more materials with significantly different physical or chemical properties and which remain separate and distinct on a macroscopic level within the finished structure. Composite is expected to improve mechanical characteristics such as the stiffness, toughness as well as ambient and high temperature resistance (Callister et al., 2003). Typical fibres used are glass, carbon, aramid and natural fibres. Epoxy, polyester and polypropylene are common resins used in composite fabrication. By this combination, poor capabilities and drawbacks of the individual components will disappear. For instance, composites have a high stiffness and strength with a low weight and their corrosion resistance is often excellent (Callister et al., 2003). Composites are now part of everyday life and have entered nearly all major industrial sectors, including aerospace, ground transport, packaging, sports industry and civil engineering.

There are four types of matrix 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) 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) Callister et al. (2003) and Matthews et al. (2002). For good reinforcement, few thing should be a concern such as high elastic modulus, high strength, low density, and easy wetting by matrix. The fibre can be designed in three 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 (Matthews et al., 2002). Thus, PMC which utilized the OPEFB and polypropylene as filler reinforcement material and the matrices will be developed and further emphasizes in this study.

### 2.1.1 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 and does not required high temperatures as well as utilize the sample fabrication development. For these reasons polymer matrix composites developed rapidly and soon become accepted for the structural applications. Today glass-reinforced polymers are still by far the most popular composite materials in terms of volume advantages with the exception of concrete (Matthews et al., 1994). There are also disadvantages in PMCs. The main disadvantages are their low maximum working temperatures, high coefficients of thermal expansion, dimensional instability, and sensitivity to radiation and moisture. Absorption of water from the environment may cause harmful effects which degrade the mechanical performance, including swelling, formation of internal stresses and lowering of the glass transition temperature (Matthews et al., 1994).

## 2.2 Matrices

Matrices can be classified into two types which are thermoset and thermoplastic. Thermoset resins include polyesters, vinylesters, epoxies, bismaleimides, and polyamides. Thermoset polyesters are commonly used in fiber-reinforced plastics, and epoxies make up most of the current market for advanced composites resins. Initially,