UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EFFECT OF MIXING RATIO ON THE MECHANICAL PROPERTIES OF POLYPROPYLENE COMPOSITE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Process) (Hons.)

by

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TAJUK: **Effect of Mixing Ratio on the Mechanical Properties of Polypropylene Composite**

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Process) (Hons.). The member of the supervisory committee is as follow:

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ABSTRAK

Projek ini memberi perhatian kepada kesan nisbah pencampuran di atas sifat mekanik komposit polipropilena. Objektif eksperimen ini adalah untuk menyiasat sifat-sifat mekanikal bahan menggunakan ujian tegangan. Eksperimen telah dijalankan di Makmal Polimer dan Makmal Bahan yang terletak di Fakulti Kejuruteraan Permbuatan, UTeM. Tiga nisbah kenaf gentian-PP komposit digunakan ialah: 10%: 90%, 30%: 70% dan 50%: 50%. Bentuk spesimen yang digunakan adalah berbentuk tetulang anjing. Mesin *hot press* telah digunakan untuk menghasilkan komposit kenaf gentian-PP. Sifat-sifat mekanik kenaf gentian-PP komposit dan polipropilena diperolehi dari ujian tegangan. Daripada kajian ini, didapati bahawa modulus tegangan meningkat dengan peningkatan jumlah kenaf. Walau bagaimanapun, polipropilena tulen menunjukkan nilai bacaan yang lebih tinggi dalam kekuatan tegangan tetapi nilai bacaan yang rendah dalam modulus tegangan berbanding komposit polipropilena. Di samping itu, pemanjangan pada waktu patah untuk PP komposit (K10:0.610%, K10/1:1.033%, K10/3:1.233%, K105:1.237%, K30:0.407%, K30/1:0.513%, K30/3:0.617%, K30/5:0.817%, K50:0.200%, K50/1:0.407%, K50/3:0.407% and K50/5:0.510%) menunjukkan keputusan lebih rendah daripada polipropilena tulen, 0.613%. Oleh itu, sampel PP komposit dengan pengikat adalah lebih baik dalam kekuatan tegangan, modulus tegangan dan pemanjangan pada waktu patah daripada mereka yang tidak mempunyai pengikat.

ABSTRACT

This project focuses on the effect of mixing ratio on the mechanical properties of polypropylene composites. The objective of this experiment is to investigate the mechanical properties of material using tensile test. The experiment was performed at Polymer Laboratory and Materials Laboratory located in Faculty of Manufacturing Engineering, UTeM. Three ratios of the kenaf fibre-PP composite were used: 10%: 90%, 30%:70% and 50%:50%. The shape of the specimen used was dog bone shape. The hot pressing machine for producing kenaf fibre-PP composite samples was used. The mechanical properties of kenaf fibre-PP composite and polypropylene were obtained by tensile test. From this study, it is found that the tensile modulus increases with increasing the kenaf loading. However, pure polypropylene shows higher reading value in tensile strength but low reading value in tensile modulus compared to polypropylene composite. Further, the elongation at break for PP composites (K10:0.610%, K10/1:1.033%, K10/3:1.233%, K105:1.237%, K30:0.407%, K30/1:0.513%, K30/3:0.617%, K30/5:0.817%, K50:0.200%, K50/1:0.407%, K50/3:0.407% and K50/5:0.510%) shows lower results than pure polypropylene, 0.613%. Thus, the samples of PP composite with binder were better in tensile strength, tensile modulus and elongation at break than those without binder.

DEDICATION

To my beloved parents Hilmi bin Jusoh and Zalilah binti Bedullah.

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A_o	-	Cross-sectional area
ASTM	-	American Standard Testing Material
EFB	-	Empty Fruit Bunch fibre
g	-	Gram
KFRP	-	Kenaf fibre reinforced polypropylene
K-PP	-	Kenaf fibre-Polypropylene
l	-	Length
L_f	-	Final gauge length
L_o	-	Original gauge length
MAPP	-	Maleated polypropylene
mm	-	Milimeter
MPa	-	Megapascals
P	-	Load
PP	-	Polypropylene
RIM	-	Reaction injection molding
SEM	-	Scanning electron microscopy
T_g	-	Glass-transition temperature
UTeM	-	University Technical Malaysia, Malacca
UTS	-	Ultimate Tensile Strength
Wf	-	Fibre weight
σ	-	Stress
e	-	Strain
˚C	-	Degree Celsius

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CHAPTER 1

INTRODUCTION

Chapter 1 describes the introduction of the project. In this project, the effect of mixing ratio on the mechanical properties of polypropylene composite is studied. This chapter includes the background, problem statement, objectives and the scope of this project.

1.1 Background

Nowadays, various composites made from natural fibre are commercialized. The natural fibres are widely used as the reinforcement in making composites. The natural fibres have their advantages which they are low cost, lightweight, easy to find and high strength to weight ratio. Therefore, the demand of natural fiber in the manufacturing industry is increasing. It is because lack of sources and the increasing construction materials which based on mineral sources such as steel, aluminium and forest trees.

This project focuses on the effect of mixing ratio on the mechanical properties of polypropylene composites. The purpose of this project is to find out the mechanical properties of polypropylene composite and pure polypropylene using Tensile Test. Thus, the results obtained can be extracted and analyzed. Compounds of the polypropylene composites are mixed with different mixing ratio. Therefore, the effect of the mixing ratio on polypropylene composites can be identified clearly.

The materials used in this project were Polypropylene (PP) and Kenaf fibre. To ensure mixing ratios between kenaf fibre and PP are fully mixing, coupling agent Polypropylene-graft-maleic anhydride (MAPP) was used.

In this project, polypropylene composite sample mixed between Kenaf fibre-Polypropylene (K-PP) composites were employed. The polypropylene composite samples were prepared by hot press machine. The results obtained from the tensile test was compared with polypropylene composites and the pure polypropylene which the differences can be seen clearly.

1.2 Problem statements

The mixing ratio can affect the mechanical properties of composite. Thus, this project was carried out to study the effect of the mixing ratio on the mechanical properties of the polypropylene composite. Tensile test was carried out in order to obtain the mechanical properties of the polypropylene composite. The project has been carried out in the Polymer Laboratory which is in University Technical Malaysia Malacca (UTeM) at Durian Tunggal, Melaka. The laboratory is equipped with an mixer machine, hot press machine and sample cutter machine. For the tensile test, it was conducted at the Materials Laboratory which in UTeM. The materials laboratory is equipped with a Universal Testing machine to conduct the mechanical test.

1.3 Objectives

The aim of this project is to study the effect of mixing ratio on the mechanical properties of polypropylene composite. The main objectives are:

1. To prepare polypropylene composite samples that are different in mixing ratio.
2. To find out the mechanical properties of material using tensile test.
3. To compare on mechanical properties of polypropylene composite.
4. To compare on mechanical properties of pure polypropylene and polypropylene composite.

1.4 Scopes of the research

This project focuses on the effect of mixing ratio on the mechanical properties of polypropylene composites. In this project, only one natural fiber uses that is kenaf fibre. The machines that used in this project were hot press machine, blender, vibratory sieve-shaker machine, universal testing machine, mixer machine and sample cutter machine. Three ratios of the kenaf fibre-PP composite used were: 10%: 90%, 30%:70% and 50%:50%. The polypropylene composite that is made in this project is kenaf fibre-polypropylene (K-PP). The mechanical properties that observed in this project was tensile test. The shape of the specimen is dog bone shape or so called dumbbell shape.

1.5 Organizational of the report

To keep close the aim and objectives of this study, this report is organized in five chapters as follows:

- Chapter 1 – provides background and gist of the study.
- Chapter 2 – presents literature review of composites, natural fibre and testing.
- Chapter 3 – gives information on materials, testing procedures that involve in the experiment.
- Chapter 4 – reports on the results and discussion of experimental works.
- Chapter 5 – summarize the results and discussion as well as conclusions of the case study.

CHAPTER 2

LITERATURE REVIEW

This section basically shows the analysis of relevant journal, book and testing standard to the case study purpose. In this chapter, it contains few sections which are introduction to engineering materials, composites, polymer, natural fibres, hot press machine and tensile test.

2.1 Engineering Materials

Ashby et al. (2011) state that the engineering materials can be classified into the six broad families as show in Figure 2.1. Six broad families of engineering materials are metals, polymers, elastomers, ceramics, glasses, and hybrids. The members of a family have certain features in common: similar properties, similar processing routes, and, often, similar applications. The hybrids are the combinations of two or more materials in predetermined configuration and scale. They combine the attractive properties of the other families of materials while avoiding some of their drawbacks.

The family of hybrids includes fibre and particulate composites, sandwich structures, lattice structures, foams, cables, and laminates: almost all the materials of nature – wood, bone, skin, and leaf – are hybrids. Fibre-reinforced composites are, of course, the most familiar. Most of those at present available to the engineer have a polymer matrix reinforced by fibres of glass, carbon, or Kevlar (an aramid). They are light, stiff, and strong, and can be tough.

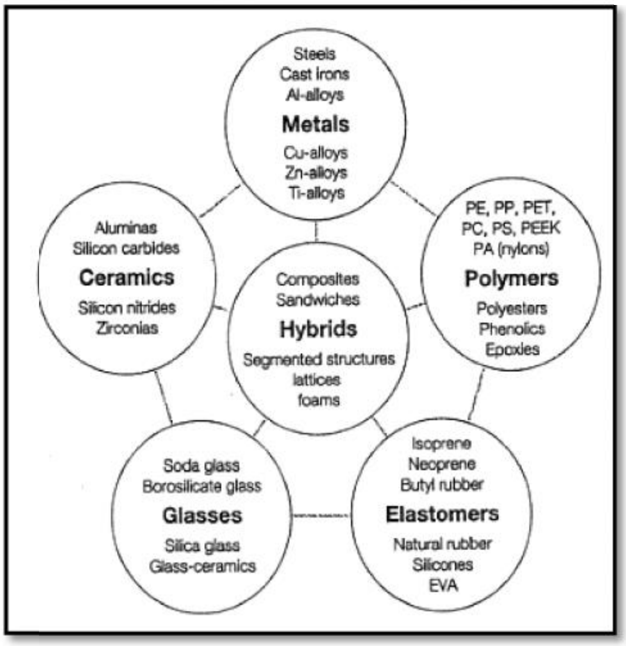

Figure 2.1: Figure classification of engineering materials (Ashby 2011).

According Ashby et al. (2011), it states that metals are stiff. They have relatively high elastic moduli. Most, when pure, are soft and easily deformed. They can be made strong by alloying and by mechanical and heat treatment, but they remain ductile, allowing them to be formed by deformation processes. Certain high-strength alloys (spring steel, for instance) have ductilities as low as 1%, but even this is enough to ensure that the material yields before it fractures and that fracture, when it occurs, is of a tough, ductile types. Partly because of their ductility, metals are prey to fatigue and of all the classes of material. They are the least resistant to corrosion.

Ceramics, too, have high moduli, but unlike metal, they are brittle. Their “strength” in tension means the brittle fracture strength; in compression it is the brittle crushing strength, which is about 15 times greater. And because ceramics have no ductility, they have a low tolerance for stress concentrations (like holes or cracks) or for high-contact stresses (at clamping point, for instance).

Glasses are noncrystalline (“amorphous”) solids. The most common are the soda – lime and borosilicate glasses familiar as bottle and ovenware, but they are many more. Metals, too, can be made noncrystalline by cooling them sufficiently quickly.