MECHANICAL PROPERTIES AND FAILURE ANALYSIS OF BEMBAN FIBRE REINFORCED THERMOPLASTIC MATRIX COMPOSITE

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A thesis submitted
in fulfillment of the requirements for the degree of
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2022

DECLARATION

I declare that this thesis entitled " Mechanical Properties And Failure Analysis On Bemban Fibre Reinforce Thermoplastic Matrix Composite" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature	:	
Name	:	Dayang Ma'asitah binti Abang Abdul Razak
Date	:	8th June 2022

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology with Honours.

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Date : 20 Januari 2023

DEDICATION

In the name of Allah S.W.T, the most gracious and merciful,

I dedicate this project to my beloved parents,

Abang Abdul Razak bin Bujang Amin & Kalsum Bee binti Mohd Yusuf,

And my siblings.

To my one and only husband, Syed Amir Syahmi bin Syed Abdullah for his support.

Not to be forgotten, my supervisor,

Ts. Dr. Mohamad Haidir bin Maslan

for guiding me through this PSM.

ABSTRACT

The purpose of this research is to look into the mechanical properties and failure analysis of Bemban fibre and thermoplastic polyamide turned to composite. The main objectives for this of this this research is to study the mechanical properties of Bemban mix with thermoplastic and effect of water absortion, to investigate the effects of various mixture combinations on the mechanical characteristics of thermoplastics with Bemban and the effect of water absorption and to investigate the failure process of Bemban reinforced thermoplastic. The main material used in this project is Bemban fiber and thermoplastic. Bemban fiber is processed from raw material to get the fibre by using a manual extraction method and grinding the fiber in order to get perfect short size fiber. Mixture ratio of Bemban and polyamide is 1:10, 1:5 and 1:1 by using hot press machine by using moulded with size of 250 mm x 250 mm x 3 mm. After the composites is ready to be cut, two composite mixture samples will undergo a tensile test to get the result for mechanical properties based on ASTM test standards. One of the samples will undergo a water absorption method. It is expected that tensile properties Bemban fibre will increase with increase of fibre fraction. In this study, ratio with 1:1 shows the best plotted line graph and help matrix in strengthen the composite. In this study, matrix itself is already strong enough even without the help of fiber.

ABSTRAK

Tujuan penyelidikan ini adalah untuk melihat sifat mekanik dan analisis kegagalan serat bemban dan poliamida termoplastik yang berubah menjadi komposit. Objektif utama penyelidikan ini adalah untuk mengkaji sifat mekanikal campuran bemban dengan termoplastik, untuk menyiasat kesan pelbagai kombinasi campuran pada ciri mekanikal termoplastik dengan bemban dan kesan penyerapan air dan untuk menyiasat proses kegagalan termoplastik bertetulang bemban. Bahan utama yang digunakan dalam projek ini adalah serat bemban dan termoplastik. Serat bemban diproses dari bahan mentah untuk mendapatkan serat dengan menggunakan kaedah pengekstrakan manual dan mengisar serat untuk mendapatkan serat ukuran pendek yang sempurna. Nisbah campuran bemban dan poliamida adalah 1:10, 1: 5 dan 1: 1 dengan menggunakan mesin tekan panas dengan dibentuk dengan ukuran 250 mm x 250 mm x 3 mm. Setelah komposit siap dipotong, dua sampel campuran komposit akan menjalani ujian tegangan untuk mendapatkan hasil untuk sifat mekanikal berdasarkan standard ujian ASTM. Salah satu sampel akan menjalani kaedah penyerapan air. Dijangkakan bahawa sifat tegangan Serat Bemban akan meningkat dengan peningkatan pecahan serat. Dalam kajian ini, nisbah dengan 1: 1 menunjukkan graf garis plot terbaik dan matriks bantuan dalam menguatkan komposit. Dalam kajian ini, matriks itu sendiri sudah cukup kuat walaupun tanpa bantuan serat.

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I would also like to express my gratitude to my parents, Abang Abdul Razak bin Bujang Amin and Kalsum Bee binti Mohd Yusuf for their patient and sacrifice in raising my siblings and I. Thank you for not only being a great parent to me but also being a teacher and a mentor. You are the reason for all the successes in my life!

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LIST OF SYMBOLS AND ABBREVIATIONS

ASTM	-	American Standards Testing and Materials
FRP	-	Fibre-Reinforced Plastic
MMC	-	Metal Matrix Composite
PMC	-	Polymer Matrix Composites
CMC	-	Ceramic Matrix Composite
C/C	-	Carbon-Carbon (C/C) Composites
NFPC	-	Natural Fiber Polymer Composites
°F	-	Fahrenheit
%	-	Percentage
E	-	Young Modulus

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Composites has been used since long time ago, and it all started with natural fibres. During the ancient Egypt time which back to 3000 years ago where the uses of straw and clay were mixed to help to build the walls (W.D. (Rik) Brouwer, 2003). Bledzki and Gassan (1999) has reported that the natural fibres were used during 1908 in the fabrication of sheets, where paper or cotton was used to reinforce sheets made of phenol- or melamine-formaldehyde resins. Over the last decade, the polymer composites reinforced with natural fibre have been demanding from the academic world and industries. Natural fibers are sustainable materials which are available in nature. Natural fibres also known with low-cost material, lightweight, renewability, biodegradability and high specific properties compared to synthetic composites. Natural fibre composites combine plant-derived fibres with a polymeric matrix. The natural fibre component may be wood, sisal, hemp, coconut, cotton, kenaf, flax, jute, abaca, banana leaf fibres, bamboo, wheat straw or other fibrous material, and as for the matrix can be a polymeric material like thermoset and thermoplastic.

In today's environment scientists around the world are concerned to the protection of the atmosphere and the pollution, engineers and scientists are increasingly turning to natural fibre as a reinforcement polymer matrix composite to create low-cost construction materials and for environment safety. Researchers has been done to develop new material for construction, furniture, packaging and automotive industries. Malaysia riches with natural fibre plant that already been discovered, meanwhile there is a lot potential of natural fibres that still under research such as Bemban and Rattan. Bemban stem are included in the stem fiber. In this experiment Bemban will be reinforced with thermoplastic to analyse the failure of the mechanical properties by tensile test.

1.2 Background of The Studies

Bemban is also known as Donax Canniformis *(Wikipedia January 2022)*. Bemban characteristics comes with dark greenish stem with diameter of 1 – 2.5m and with height of 1 – 2.5m which the sizes of the leaves can grow up to 10–25 x 10-45cm *(Flora of China)*. This plant usually grows in swampy areas and wet land areas. Bemban area popular in some of countries, especially Asian countries such as Malaysia, Thailand, Cambodia, Indonesia, Philippines, Taiwan and up to west area which is India.

Bemban stem are included in the stem fiber. The bemban reed thrives in wetland areas along streams or on hilly terrain. Water or marsh bemban (bemban air or bemban paya) grows closer to water, is more delicate, and is only used in mats. A closely related species, the Bemban batu or Bemban bukit (stone or hill bemban), is tougher and can be found at higher ground and it used to make basket. This plant usually grows in swampy areas and wet land areas. Figure below shows the Bemban plant.

Figure 1.1: Bemban Plant

The traditional beliefs of Bemban always have been use in certain ways which is the roots will be boiled and the water are used as antidote for snake bites and for blood poisoning. Other than that, juice from young curled up leaves used for sore eyes, juice from crushed roots used for fungal infections and infusion of young shoots drunk for treatment of fever (Philippines Medical Plants 2022 May).

Bemban also famous in Borneo Malaysia, the women loves to to make good Bemban mats with awesome patterns. In order to have the beautiful mat that comes from Bemban, there are few steps need to be done. Initially the stem's of Bemban need to be cut from the main stem of the plant. The outer surface of the stem were ripped for weaving purposes.

Figure 1.2: Stem Of Bemban Weaving Into Basket

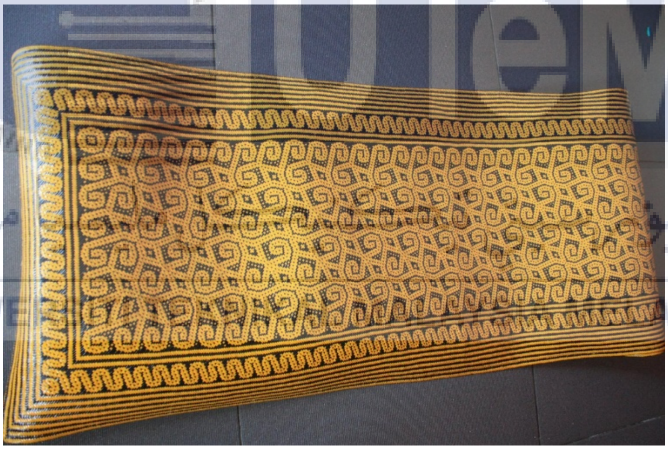

Figure 1.3: Bemban Matress

1.3 Problem Statement

The advantages of using natural fibre composite are cost-effective, the sustainability and strengthness. Bemban's are one of the natural fibre. Bemban is a potential natural fibre that still under research for future reference. Bemban are easy to get in Malaysia especially in Borneo, Sabah and Sarawak. It is cheap and affordable. This plant has been used by traditional community for roof construction, furniture and handcrafts. Bemban plant has a high strengthness and resistance to tropical environment, this advantages make the Bemban to be a good natural composites. In order to commercial this composite, few tests need to be run to identify the mechanical characteristics and to analyse the failure of Bemban reinforce with thermoplastics.

A tensile test will be done to examine the failure of this composite by using following the criteria of America society for Testing and Materials (ASTM). The results will be used to analyze the mechanical properties of unretter long fibre composites. However, the problem arises during extraction of the Bemban stem, the fibre will get split, these splits in the cuticle can travel up the rest of the length of the fibre and lead to breakage Therefore, the desire requirement for the length from ASTM cannot be fulfilled. There are few methods to extract the fibre which is by mechanical extraction, chemical extraction, retting process. In these experimental studies, manually extraction process are the suitable and cheapest that can be used to.

1.4 Objectives

1. To study the mechanical properties of Bemban fibre reinforced thermoplastic and effect of water absorbtion.
2. To investigate the effects of various mixture combinations on the mechanical characteristics of thermoplastics with Bemban and effect of water absorbtion.
3. To investigate the failure process of Bemban reinforced thermoplastic.

1.5 Scope of Research

1. This study uses Bemban fibre as composite reinforcement. Bemban Fiber was self - processed from fresh Bemban stem.
2. Thermoplastic was used as composite matrix. This study the effect of different matrix to reinforcement ratio from 1:10, 1:5 and 1:1 also it will be compared with samples that soak in water for 24 hours.
3. Two mechanical test were choosen, the tensile and impact test upon mixture of Bemban fibre with thermoplastic ASTM D3039 by using Universal Testing Machine.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In order to get a smooth outcome in this chapter, multiple readings must be taken before beginning the experiment tensile and impact test on Bemban + Thermoplastics. This literature review will ensure that any data on Bemban and thermoplastics is gathered from any relevant sources to ensure that the experiment run smoothly.

2.2 Composites

A composite is made up of two materials that have distinct physical and chemical properties. When these two ingredients are combined, a material is created that is designed to do a specific task, such as becoming stronger, lighter, or more resistant to electricity. It is combined and offer their most beneficial features to improve the result or final output. Composites are typically designed to achieve a certain goal, such as enhanced strength, efficiency, or durability.

Composites, also known as Fibre-Reinforced Polymer (FRP), are constructed of a polymer matrix reinforced with a man-made, manufactured, or natural fibre such as glass, carbon, or aramid, or another reinforcing material. The matrix protects the fibres from external and environmental damage while also distributing the load. The fibres provide strength and rigidity to the matrix, allowing it to endure cracks and fractures.

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Composites provide a lot of benefits. Strength, lightweight, corrosion resistance, design flexibility, and durability are all essential factors.

- **Durability** - Composites last longer than metals like steel. The two primary components of composites, fibres and resins, contribute to their strength. The load is carried by the fibres, and the weight is dispersed throughout the composite portion as needed by the resins.

- **Corrosion resistance** - Ordinary materials can be eroded by weather and corrosive chemicals, whereas composites can survive this. As a result, it is a suitable for applications that are exposed to salt water, dangerous chemicals, temperature changes, and other hostile environments for extended periods of time.

- **Lightweight** – Composites are lighter in compared to most woods and metals.

- **Versatile** – Composites allow for a wide range of material combinations, giving designers more design options. The materials can be customized to meet the needs of the application. Composites can also be easily shaped into complicated shapes.