MECHANICAL PROPERTIES AND FAILURE ANALYSES OF BEMBAN FIBER REINFORCED THERMOSETS MATRIX COMPOSITES

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DECLARATION

I declare that this thesis entitled “Mechanical Properties And Failure Analyses of Bemban Fiber Reinforced Thermosets Matrix Composites” 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.

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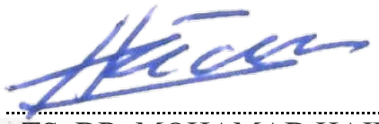
APPROVAL

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 (BMMV) with Honours.

Signature : 

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DEDICATION

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

I dedicate this project to my beloved parents,

Noryatim Bin Ahmad & Fauziahanim Binti Haji Jaffar, and my siblings.

To my supervisor, Ts. Dr. Mohamad Haidir bin Maslan for guiding me through this PSM.

To my special person, Muhammad Rozhan bin Rosdin, for his encouragement who believed in me without hesitation.

ABSTRACT

The purpose of this research is to look into the mechanical properties and failure analysis of Bemban fibre and thermoset polymer turned to composite. The objective is to investigate the mechanical properties of Bemban-reinforced thermosets, to evaluate the effect of different mixture combinations on mechanical properties and the effect of water absorption, and to analyse the failure process of Bemban-reinforced thermosets. The main material used in this project is Bemban fibre and Polyester Resin for the thermoset. Bemban is processed from raw material to get the fibre by using a manual extraction method. Thermoset used is a Polyester Resin. The mixture ratio of Bemban and Polyester Resin for this study is 1:10, 1:5 and 1:1 by using the hand layup method. After the hardening process, 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. The tensile properties of Bemban fibre and Polyester Resin can improve the durability of the composite mixture of natural fibre combined with the matrix.

ABSTRAK

Tujuan penyelidikan ini adalah untuk melihat sifat mekanikal dan analisis kegagalan serat Bemban dan polimer termoset bertukar kepada komposit. Objektifnya adalah untuk menyiasat sifat mekanikal termoset yang diperkuatkan dengan Bemban, untuk menilai kesan kombinasi campuran yang berbeza terhadap sifat mekanikal dan kesan penyerapan air, dan untuk menganalisis proses kegagalan termoset yang diperkuatkan dengan Bemban. Bahan utama yang digunakan dalam projek ini ialah serat Bemban dan resin poliester untuk termoset. Bemban diproses daripada bahan mentah untuk mendapatkan gentian dengan menggunakan kaedah perahan manual. Termoset yang digunakan ialah resin poliester. Nisbah campuran resin Bemban dan poliester bagi kajian ini ialah 1:10, 1:5 dan 1:1 dengan menggunakan kaedah letak tangan. Selepas proses pengerasan, dua sampel campuran komposit akan menjalani ujian tegangan untuk mendapatkan keputusan bagi sifat mekanikal berdasarkan piawaian ujian ASTM. Salah satu sampel akan menjalani kaedah penyerapan air. Sifat tegangan serat Bemban dan resin poliester boleh meningkatkan ketahanan campuran komposit gentian asli yang digabungkan dengan matriks.

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LIST OF SYMBOLS AND ABBREVIATIONS

NFPC	-	Natural Fibre Polymer Composite
ASTM	-	American Society for Testing and Materials
FRP	-	Fibre Reinforced-Polymer
CMC	-	Ceramix Matrix Composite
CFRC	-	Ceramic Fibre Reinforced Ceramic
MMC	-	Metal Matrix Composite
PMC	-	Polymer Matrix Composite
PP	-	Polypropylene
PVC	-	Polyvinyl Chloride
%	-	Percentage
E	-	Young Modulus
mm	-	millimetres
MPa	-	Mega Pascal
cm	-	centimetres

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays, natural composites have several advantages, including low production costs, low energy consumption, environmental friendliness, and overall contribution to sustainable development. Many years back, natural fibres were used for strength in a more traditional than technical way. Natural fibre as reinforcement has served multiple purposes for the use of material technology in recent years. Natural fibres are in high demand among scientists and engineers in developing countries because they can be used with proper technology to produce high-quality fibre-reinforced polymer composites for housing and other applications. Natural fibres are elongated substances produced by plants and animals that can be turned into filaments, rope, woven, knitted, and shoes. Hemp, jute, kenaf, flax, sisal, banana fibre, Bemban, and other fibrous materials can be mixed with thermoset and thermoplastic which are polymeric materials. Malaysia has a plant which is hemp, jute, kenaf, flax, sisal, banana fibre, pineapple, and oil palm are just a few examples of plants with high fibrous content. Many plants, such as rattan and Bemban, have yet to be discovered but have the potential to become good natural composites.

1.2 Background Studies

Bemban leaf is a herbaceous plant, which means that its stems are soft and do not form wood. Bemban grows in the wild along rivers and lakes, forests, and plantations. In wet areas, Bemban is easy to grow. Furthermore, Bemban can be found in bamboo forests. Plants native to Southeast Asia include those found in Indonesia, Malaysia, Thailand,

Cambodia, Vietnam, and the Philippines. Even Bemban can be found in the Taiwanese and Indian regions. Bemban, kenaf, flax, jute, abaca, banana leaf fibres, bamboo, wood, sisal, hemp, coconut, cotton, wheat straw, or other fibrous material can be used as the natural fibre component, and the matrix can be a polymeric material. Natural fibre reinforced polymer matrix has received considerable attention in recent years due to its superior properties and superior advantages over synthetic fibres in terms of its relatively low weight, low cost, less damage to processing equipment, good relative mechanical properties such as tensile modulus and flexural modulus, the improved surface finish of moulded parts composite, renewable resources, abundance, flexibility during processing, and biodegradability. NFPCs with high specific stiffness and strength can be made by incorporating tough and lightweight natural fibre into a polymer (thermoplastic and thermoset). Natural fibres, on the other hand, have significant flaws and properties deficiencies.

Figure 1.1: Bemban Plants

1.3 Problem Statement

Many studies have been conducted on natural fibre composites such as kenaf, jute, flax, hemp and coir according to reports. Because Bemban fibres have never been used commercially as composite materials, the goal of this study is to determine their future potential. The study focuses on the fundamental properties of this fibre composite in order to assess its potential. The main objectives of this study are to determine the mechanical properties of extracted Bemban fibres as well as Bemban fibre composites.

Bemban is a plant that has been used by the traditional community for roof construction, wardrobe and handcrafts. Bemban plant has high toughness and resistance to the tropical environment. So, it is the potential to make a good natural composite.

A tensile test will be performed on the specimen according to ASTM test standards to determine the research objectives, and the results will be used to analyse the mechanical properties of the short fibre composites of Bemban.

1.4 Objectives

The research for this project is organised and represented to achieve the following objectives, based on the project background and problem statement stated above:

1. To investigate the mechanical properties of Bemban reinforced thermoset.
2. To evaluate the effect of different mixture combinations on the mechanical properties of thermosets with Bemban and the effect of water absorption.
3. To analyse the failure process of Bemban reinforced thermoset.

1.5 Scope

The study was subjected to the following scope.

- Uses Bemban fibre as a composite reinforcement. Bemban fibre was self-processed from fresh Bemban stem.
- Thermoset (Polyester Resin) was used as a composite matrix. This is to study the effect of the different matrix-to-reinforcement ratios of 1:10, 1:5 and 1:1.
- A mechanical test was chosen which is to perform a tensile (ASTM D3039) on a mixture of Bemban fibre and thermoset polyester for effect before and after water absorption by using a Universal Testing Machine.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

There are a few things to clarify before this experimental study begins. In addition, data gathered from journals, books, and websites played a significant role in the study's success. This improves the precision and effectiveness of the research equipment while also adding to its fascination.

2.2 Composite

A composite is made up of two materials with diverse physical and chemical properties that are mixed together. When these two are mixed, they form a material that is made to do a specific function, such as becoming stronger, lighter, or more resistant to electricity. They do not entirely blend or lose their own identities; they merge and contribute their most useful characteristics to improve the outcome or final product. Composites are usually created for a specific purpose, such as increased strength, efficiency, or durability.

Composites also known as Fibre-Reinforced Polymer (FRP) are made from a polymer matrix that is reinforced with a man-made, engineered or natural fibre such as glass, carbon, aramid or any other reinforcing material. The matrix shields the fibres from external and environmental degradation while also transferring the load between them. The fibres give the matrix strength and rigidity, which helps it withstand cracks and fractures. Composites have numerous advantages. The important factors among them are strength, lightweight, corrosion resistance, design flexibility and durability.

- Strength – Composites are more durable than metals such as steel. Fibres and resins, the two main components of composites, contribute to their strength. The load is carried by the fibres, and the weight is distributed as needed by the resins throughout the composite part.
- Lightweight – In comparison to most woods and metals, composites are lighter.
- Corrosion resistance – Weather and corrosive chemicals can erode away at normal materials, but composites withstand this. As a result, they are ideal for applications that are subjected to prolonged exposure to seawater, hazardous chemicals, temperature swings, and other harsh environments.
- Flexible – Composites allow for a wide range of material combinations, allowing for design flexibility. The materials can be specifically designed to fit the application's requirements. Composites can also be easily shaped into complex shapes.
- Durable – Composite structures last a long time and require little maintenance. Many composite-based products, such as boats, have been in use for over half a century.

2.2.1 Type of Reinforcement

Fibres, fabric particles, or whiskers can all be used as reinforcement. These reinforcements are fundamentally used to enhance the mechanical or physical properties of the final composite material. There are two types of reinforcement that are most used, synthetic fibre and natural fibre.

Synthetic fibres are made from synthetic materials that are usually created using chemical processes. During the process, a spinneret which is a device that takes polymers

and forms fibres is typically used to extract fibres. The textile industry developed synthetic fibres as a less expensive and more easily mass-produced alternative to natural fibres. Because synthetic fabrics are made of man-made, artificial fibres, they have a number of 17 advantages for everyday use, including affordability and stain and water resistance. There are 5 examples of synthetic fibres;

1. Polyester - Polyester is coal and petroleum-based synthetic fibre. Polyester is known for its long-lasting properties. However, the material is not suitable for use in hot weather because it is not breathable and does not absorb liquids well.

2. Rayon - Rayon is a reconstituted wood pulp-based semi-synthetic fibre. Despite the fact that rayon is made from plant fibres, the chemicals used in the manufacturing process, such as sodium hydroxide and carbon disulfide, classify it as semi-synthetic. Rayon comes in the form of modal, viscose, and lyocell, and can be used to imitate silk, wool, and other fabrics.

3. Spandex – Known as Lycra or elastane, is a synthetic fibre with extreme elasticity. Spandex is a stretchy fabric that is blended with a variety of fibres and used in everything from jeans to athleisure to hosiery.

4. Acrylic fibres - Acrylic fibres are man-made fibres made from acrylonitrile or vinyl cyanide polymers. Because of its ability to retain heat, acrylic is frequently referred to as "fake wool." It's frequently used in the production of faux fur and also fleece.