EXPERIMENTAL ANALYSIS ON MECHANICAL PROPERTIES OF PINEAPPLE LEAF REINFORCED POLYESTER RESIN

SIVANESWARAN A/L MANOKARAN

B091910254

BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY (PROCESS AND TECHNOLOGY) WITH HONOURS

2023

Faculty of Mechanical and Manufacturing Engineering Technology

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A thesis submitted
in fulfilment of the requirements for the degree of
Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I declare that this project entitled “Experimental Analysis On Mechanical Properties Of Pineapple Leaf Reinforced Polyester Resin”, it is the result of my own research except as cited in the references. It has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature	:	
Name	:	*SIVANESWARAN A/L MANOKARAN.*
Date	:	9 January 2023

APPROVAL

I, at this moment, declare that I have checked this project. In my opinion, this project is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours.

Signature : ....

Supervisor Name : *DR. ISKANDAR BIN WAINI.*

Date : 9 January 2023

DEDICATION

Thanks to God for providing me with the strength, patience, direction, and knowledge to accomplish this study. I am grateful to God Almighty for allowing me to join this programme. A special award, this thesis I dedicated to my parents, Manokaran A/L Vadiveloo and Aravalli A/P Gurusamy, who have always been there for me. Finally, I'd like to thank my supervisor, Dr. Iskandar Bin Waini and my co-supervisor, Dr. Khairum Bin Hamzah, for all his help, guidance, and a advice in completing this thesis.

ABSTRACT

Being biodegradable and user-friendly, the unique composite formed of natural fibres has amazing potential for weight reduction in materials while also lowering the cost of materials due to its low cost. However, natural fibres has a lower strength than polyester resin 100 percent, which is a disadvantage. Many research investigations have been conducted on two-hybrid composites that include natural and synthetic fibres. A fresh investigation of the mechanical behaviour of pineapple leaves reinforced by polyester resin (PLPR) composites was reported in the current work. Five eco-friendly ratios of natural and synthetic materials were produced utilising the mixing composites, which were constructed using the hand lay-up technique. These composites have the following weight ratios: 20% pineapple leaf and 80% polyester resin (20PL80PR), 40% pineapple leaf and 60% polyester resin (40PL60PR), 50% pineapple leaf and 50% polyester resin (50PL50PR), 60% pineapple leaf and 40% polyester resin (60PL40PR), and 80% pineapple leaf and 20% polyester resin (80PL20PR). Tensile, flexural, and impact tests were used to investigate the mechanical properties of the pictures of the powdered pineapple leaf obtained using a stereo microscope. Statistics were used to assess the data that had been collected. The mechanical behaviour of the PLPR composites according to the five ratios is seen through numerical calculations and graphical examples. The mechanical behaviour of PLPR composites will have an impact on the various ratios. The results showed that the composite with 60% pineapple leaf had better mechanical behaviour than the other composites due to the synergistic effect of reinforcements.

ABSTRAK

Sebagai terbiodegradasi dan mesra pengguna, komposit unik yang terbentuk daripada gentian semula jadi mempunyai potensi yang menakjubkan untuk pengurangan berat bahan di samping mengurangkan kos bahan kerana kosnya yang rendah. Walau bagaimanapun, gentian semulajadi mempunyai kekuatan yang lebih rendah daripada resin poliester 100 peratus, yang merupakan kelemahan. Banyak penyiasatan penyelidikan telah dijalankan ke atas komposit dua-hibrid yang termasuk gentian asli dan sintetik. Penyiasatan baru tentang tingkah laku mekanikal daun nanas yang diperkuat oleh komposit resin poliester (PLPR) telah dilaporkan dalam kerja semasa. Lima nisbah mesra alam bagi bahan semula jadi dan sintetik telah dihasilkan menggunakan komposit pencampuran, yang dibina menggunakan teknik letak tangan. Komposit ini mempunyai nisbah berat berikut: 20% daun nanas dan 80% poliester resin (20PL80PR), 40% daun nanas dan 60% poliester resin (40PL60PR), 50% daun nanas dan 50% poliester resin (50PL50PR), 60% nanas daun dan 40% resin poliester (60PL40PR), dan 80% daun nanas dan 20% resin poliester (80PL20PR). Ujian tegangan, lentur dan hentaman digunakan untuk menyiasat sifat mekanikal gambar daun nanas serbuk yang diperoleh menggunakan mikroskop stereo. Statistik digunakan untuk menilai data yang telah dikumpul. Kelakuan mekanikal komposit PLPR mengikut lima nisbah dilihat melalui pengiraan berangka dan contoh grafik. Kelakuan mekanikal komposit PLPR akan memberi kesan kepada pelbagai nisbah. Keputusan menunjukkan bahawa komposit dengan 60% daun nanas mempunyai tingkah laku mekanikal yang lebih baik daripada komposit lain kerana kesan sinergistik tetulang.

ACKNOWLEDGEMENTS

Thanks to God with His permission and blessing, my Creator, my Sustainer, for everything I received since the beginning of my life. I have finally completed the bachelor’s degree Project 1. Thank you, appreciation, to the Universiti Teknikal Malaysia (UTeM) for providing the research platform.

This investigation could not have been completed without the knowledge of Dr Iskandar Bin Waini, my supervisor. A debt of gratitude is also owed to Dr Khairum Bin Hamzah, my co-supervisor, for pointing out and providing us with the guides for our framework.

Lastly, thank you to my beloved parents MR. Manokaran A/L Vadiveloo and Mrs Aravalli A/P Gurusamy, without them, none of this would indeed be possible.

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LIST OF SYMBOLS AND ABBREVIATIONS

ANOVA	-	Analysis of varience
ASTM	-	American Society for Testing and Materials
DOA	-	Departure of agriculture
D,d	-	Diameter
etc	-	Other similar things
GFREC	-	Glass fibre reinforced epoxy composite
HFREC	-	Hybrid fibre reinforced epoxy composite
J	-	Joule
Nfs	-	Natural fibers
Mt	-	Mechanical testing
MPa	-	MegaPascal
PLA	-	Polylactic acid
PL	-	Pineapple leaf
PR	-	Poyetser resin
PLPR	-	Pineapple leaf reinforced polyester resin
PALF	-	Pineapple leaf fiber
RFREC	-	Ramie fibre reinforced epoxy composite
RM	-	Ringgit Malaysia
UP	-	Union pacific

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CHAPTER 1

INTRODUCTION

1.1 Background

Nowdays, there are very high demand for eco-friendly materials based on recycling is in line with the industrial demand that affects the potential of the characteristic features from it. The development of technology and population, as well as changes in habits in society, have resulted in a substantial rise. Therefore, the issue of poor management becomes one of the significant factors faced by the modern society of this compilation. Waste to the environment can help the industry produce an environmentally friendly product.

Natural wastes such as agricultural and industrial waste are too much in Malaysia. The waste can be recycled and reused. The increase in population will indirectly increase waste. In addition, there is also waste that does not decompose easily and will remain in the environment. In Malaysia, there are various environmental materials such as oil palm, wood, rice, coconut, rubber, pineapple leaf, etc. This material can potentially replace the primary material from the waste due to its hard and non-perishable composition.

Agricultural waste from agro-based industries such as palm oil, rubber, and wood processing plants has more than tripled. Selangor, Perak, and Johor account for 65.7 percent of all identified pollution sources in the manufacturing and agro-based sectors (DOE, 2010).

Increasing pineapple demand contributes to massive pineapple production, resulting in large waste. Approximately 80% of pineapple parts are discarded during pineapple processing, transportation, and storage, including the crown, peels, leafs, core, and stems. Malaysia, one of the leading agricultural commodity producers in Southeast Asia, produces 335,488 tonnes of pineapple, as well as 67,098 and 137,550 tonnes of leaf and peel wastes. These wastes contain high levels of moisture, sugar, albumins, lipids, and vitamins that are susceptible to microbial degradation, contributing to environmental issues.

Material required for this composite is pineapple leaf. Pineapple leaf composite is more attractive because of their incredible strength, small weight, and less density. They are ecological and eco-friendly. Pineapple leaf is a common natural filler found in forest nations. For example, Asian countries, as Indonesia, Malaysia, Thailand, and India are among the countries involved. Pineapple leaf are also easy to obtain, low cost and easy to process. Pineapple plantations occupy a large portion of Malaysia's agricultural area. The operations of the Malaysian pineapple industry contribute a little amount to the Malaysian economy, with a 0.08 percent contribution to export revenues in 2008.

In Malaysia, pineapple is a former industrial crop that has been around for nearly a century. Pineapple cultivation provides a lucrative income for growers, especially when high planting density is established on the farm and cultivars with a stable yield and high disease resistance are used. The Department of Agriculture (DOA) reported that 272,570 (Mt) of pineapple were produced throughout the year in 2015. Table 1.1 shows the details of pineapple planted area, production, and value of production.

Table 1.1 Planted area and harvested area, production, and value of production of pineapple in Malaysia, 2015-2017

YEAR	**Planted Area (Ha)**	**Harvested Area (Ha)**	**Percentage of Harvested Area (%)**	**Productio n (Mt)**	**Value of Production (RM)**	**Average Yield (Mt/Ha)**	**Potetial Productio n (Mt/Ha)**
2015	10,847.0	8,975.3	82.7	272,570.0	386,140,8	30.4	62.0
2016	13,148.9	10,354.1	78.7	391,714.4	515,248.7	37.8	62.0
2017	12,898.44	10,130.76	78.54	340,721.9	668,666.8	33.63	62.0

Among thermosetting polymers, polyester resins are the most prevalent used in our daily lives and in industry. Polyester resins are a popular type of thermosetting resin used in the coatings and adhesives industries, with global production estimated at 2 million tons in 2010. Polyester resins are typically cured by thermal, chemical treatments and irreversibly cross-linked products. The cured polyester resins have remarkable physicochemical qualities, including outstanding chemical resistance and mechanical attributes. Consequently, polyester resin is a binder used to bond glass fiber and pineapple leaf.

Natural fibers have several advantages over synthetic fibers, including eco-friendliness, biodegradability, lower density, and abundant availability. At the same time, a few disadvantages include strong polarity, greater hydrophilicity due to the presence of hydroxyl groups, and limited compatibility with polymer-derived matrices (particularly thermos-plastics). However, the excellent price-performance ratio at low weight, combined with the environmentally friendly character, became a critical factor in natural fiber acceptance in large volume engineering markets such as the automotive and construction industries (Kumar et al., 2020).

According to one study, the addition of PALF filler to the epoxy matrix resulted in an increase in strain value for most of the filler loading compared to the base matrix. This behaviour is caused by the composite's decreased plasticity and increased elasticity due to the reinforcement of PALF fillers in the epoxy matrix. The inferior plasticity of the composite reduced its brittleness, resulting in more excellent elongation at break. The lowest and highest tensile strain values are obtained for 10% and 5% filler loading, respectively, at different crosshead speeds (Kumar et a., 2020).

Another study compares the tensile properties of jute, pineapple leaf, and glass fiber. Reinforced hybrid composites were created by ASTM D 638M. The composite specimens were 165 mm long, 12.7 mm wide, and 3 min thick. The specimens were tested using a

Tensile testing machine supplied by Associated Scientific Engg. Works, New Delhi, at a crosshead speed of 2.5 mm/min. (Indra Reddy et al., 2018).

Finally, the flexural strength and tensile strength comparison revealed a similar pattern. The addition of glass fibre increased flexural strength by 89.14 percent, and the flexural strength of the hybrid specimen increased by 164.66 percent when compared to the PALF-vinyl ester specimen. This demonstrates that adding glass increased the shear resistance of the composite, reducing shear failure. In general, the hybrid composite attribute is determined by the properties of the reinforcement (Zin et al., 2018).

1.2 Problem Statement

Malaysia's manufacturing industry has recently grown. As a result, the use of materials in the manufacturing industry, as well as in everyday life, will increase. The manufacturing industry's high demand for recycled materials will continue. There will also be an increase in demand for coarse aggregate.

It is also not appropriate in this situation to realy solely on one source because it is feared that there will be a shortage and that we will be unable to meet demand in the future. As a result, some new alternatives must be developed to cover the future. Several studies have been conducted as a result of the observations made in order to meet the material requirement. A large number of materials are produced from. recycled or from environmentally friendly such as stones, discarded durian skins, and so on.

In this study, pineapple leaf was used as an alternative made from environmentally friendly waste. Most Malaysians consume pineapple daily. Pineapple leaves are frequently thrown away and burned. Because of its complex and not easily damaged composition, pineapple leaf has the potential to replace waste aggregate.

Furthermore, the recent lack of garbage collection points is a major source of environmental issues, and garbage disposal is becoming increasingly important as natural resources become scarce. Furthermore, the properties of various raw materials. Cutting performance is a problem for eco-composite materials. Natural materials have multiple properties such as strength and elongation. Then, to determine an excellent composite ratio, it must be compared to the tested material. The strength of the pineapple leaf material in relation to the goal to be achieved.

1.3 Research Objective

The primary goal of this study is to look at the mechanical properties of pineapple leaf waste that has been strengthened with polyester resin. The following are the specific objectives follows:

a) To fabricate the pineapple leaf composite using hand lay-up method.

b) To perform the mechanical testing of pineapple leaf reinforced polyester resin.

c) To determine the significant differences in different ratio of the reinforced composites by using the statistical analysis

1.4 Scope of Research

The focus of this study will be on the mechanical properties of pineapple leafs reinforced with polyester resin. Pineapple leaf and polyester resin are used in this project. In order to fabricate the pineapple leaf recycling trash. The hand-mixed lay-up technique will be used to create this pineapple leaf. The procedure of cutting specimens is to be tested using a cnc router machine. Tensile, impact, and flexural testing will be used to evaluate the mechanical properties of the experimental material. Anova will be used to analyse the data from the experiment specimen. Based on three separate testing processes, we'll choose the best result for quality, strength of material ratio, and mechanical properties of specimen material.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

It was a description of the development of the composition of natural material from the waste material, such as pineapple leaf. In addition, the strength of pineapple leaf is also discussed in this chapter. My study had focused on the result of defects on the agro-culture waste material by different processes. Therefore, discuss two ways of drying process of waste material. The main analysis of the research is to observe the most strength and calculate quality defect using ANOVA.

2.2 Composite

Composite materials with natural fibres are those in which at least some of the reinforcing fibres are derived from resources that are carbon-neutral and renewable, such as plants or wood. The composite is referred to as a polymer matrix composite if the matrix is a polymer. The continuous stage is referred to as the matrix, but the intermittent phase is called the reinforcement since it is often tougher and stronger than the continuous stage. Polymeric, metal, or even ceramic might be used to make the matrix. Over the past ten years, the usage of green materials has become more widespread. There are sincere efforts being made around the world to find bio-based resources and biodegradable products that take climate change mitigation seriously (Saha et al., 2021).

2.3 Bio composite

Bio composite products made with reinforcing with natural cellulose fibres and a in matrix recently piqued the interest of researchers. Its availability, renewability, high