UNIVERSITI TEKNIKAL MALAYSIA MELAKA

TENSILE TEST AND FLEXURAL TEST ANALYSIS FOR BANANA PLANT STEM FIBER BEING REINFORCED WITH POLYESTER RESIN COMPOSITES

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours

By

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK:Tensile Test and Flexural Test Analysis for Banana Plant Stem Fiber being Reinforced with Polyester Resin Composites

SESI PENGAJIAN: 2019/2020

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(Ts. Khairil Amri Bin Kamaruzzaman)

DEDICATION

For my beloved mother and father.

ABSTRACT

Plantation waste such as banana plant should have a proper way of disposal after the fruits was harvested.Environmental awareness and decreasing in the petroleum resources worldwide have enhances many researchers to fully utilizing the natural fibers as it is more environmental friendly and sustainable compare to the existing conventional materials. Natural fiber reinforced polymer composites have many benefits such as inexpensive, low hazard to health, approximately high modulus strength , easily available, biodegradable, light weight, and renewable. However, the processing of the natural fiber requires a lot on energy and process for extracting the pure fibers. However this applications have same limitations for example the natural habits of the plant fibers that could not be changed when reinforced with polymer matrix such as high water absorption, controlled processing temperature, poor dimensional stability and poor wettability. Therefore, this project gives review on the plant fiber reinforced thermosetting polymer. This composite specimen is fabricated through hand lay-up method at where four different composition of banana stem fiber which are 0%, 5%, 10% and 15% are being reinforced with polyester resin. The specimens produced is then conducted Tensile Test and Flexural Test to obtain the Young's Modulus and Modulus of Flexural Strength values. The results obtained is being compare with the facts that given by the previous researchers so that the project findings can be used for the implementation of composite product in daily life such as the water tank.

ABSTRAK

Kesedaran sisa perladangan seperti tumbuhan pisang perlu mempunyai cara pelupusan yang betul selepas buah itu dituai. Kesedaran alam sekitar dan pengurangan sumber petroleum di seluruh dunia telah meningkatkan banyak penyelidik untuk menggunakan serat semula jadi kerana ia lebih mesra alam dan berterusan berbanding dengan bahan konvensional sedia ada. Serat semulajadi bertetulang polimer rencam mempunyai banyak manfaat seperti murah, rendah bahaya kepada kesihatan, kekuatan modulus yang tinggi, mudah didapati, biodegradasi, berat ringan, dan boleh diperbaharui. Walau bagaimanapun, pemprosesan serat semulajadi memerlukan banyak tenaga dan proses untuk mengekstrak gentian tulen. Walau bagaimanapun, aplikasi ini mempunyai had yang sama contohnya tabiat semulajadi gentian tumbuhan yang tidak boleh berubah apabila diperkukuh dengan matrix polimer seperti penyerapan air yang tinggi, suhu pemprosesan terkawal, kestabilan dimensi yang lemah dan rendah basah. Oleh itu, projek ini memberi kajian pada gentian serat bertetulang termosetting polimer. Spesimen komposit ini direka melalui kaedah lay-up tangan di mana empat komposisi yang berbeza serat stem pisang iaitu 0%, 5%, 10% dan 15% diperkukuh dengan resin poliester. Spesimen yang dihasilkan kemudiannya dijalankan ujian tegangan dan ujian lentur untuk mendapatkan nilai kekuatan lentur dan modulus Young. Keputusan yang diperolehi adalah dibandingkan dengan fakta yang diberikan oleh penyelidik sebelum ini supaya penemuan projek boleh digunakan untuk pelaksanaan produk komposit dalam kehidupan harian seperti tangki air.

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σ	-	Stress
ϵ	-	Strain
E	-	Young Modulus

CHAPTER 1

INTRODUCTION

1.1 Project Background

Malaysia is a tropical country that produces a lot of fruits every year. Examples of the fruits are durian, banana, mango, duku and rambutan. Banana is the second most fruit that undergoes into production in Malaysia as shown in Figure 1.1. Those planted banana trees are cut down every year to produce enough banana to meet the demand in Malaysia. These banana trees are left to rot in the banana plantation. The rotting process release methane which is one of the greenhouse gases known as a pollutant.

It is worth to utilize fiber from banana trees since it is considered as one of the renewable resources in Malaysia and in the future the demand for banana stem fiber based will increase as green materials. Utilization of the banana stem fiber not only benefit the environment, but it will also reduce the overall resource and introduction of green technology to the rural areas. Each and every parts of the banana plant stem provides fibers with various strength.

In this investigation different composition of the polyester resin and banana plant stem fibers to form a composite material. Each composition of mixture can result in

different strength for the reinforced polymer composite. The composite polymer is then performed with physical test and mechanical test. At the end of the test, by reviewing the obtained result, a conclusion will be made whether this polymer composite reinforced with banana plant stem fiber is suitable to replace the usage of synthetic fibers as the reinforced composite.

Fruit name	Planted area (Ha)	Production (metric tonne)	Value (RM'Million)
Star fruit	1,276	11,820	31.6
Papaya	3,403	49,760	68.4
Cempedak	11,158	56,631	130.2
Ciku	1,115	6,050	18.1
Dokong	16,130	32,420	97.3
Duku	5,775	27,680	65.0
Durian	104,655	300,470	1392
Guava	1,525	19,650	50.6
Langsat	6,925	25,660	69.3
Mango	9,760	25,510	83.5
Mangosteen	7,685	29,520	79.7
Jackfruit	3,962	27,459	63.2
Banana	29,790	294,530	476
Rambutan	25,460	82,740	171
Salak	1,190	4,530	15.8
Watermelon	11,750	238,050	309

Figure 1.1: Production of Banana in Malaysia

Source: (https://scialert.net/abstract/?doi=jas.2011.3815.3820)

1.2 Problem Statement

Polymers composite materials are one of the most advanced engineering materials. It has a high advantage against few mechanical properties such as corrosion resistance, low thermal expansion, higher stiffness and low weight which makes it suitable for various applications and the materials manufacturing in the field of automotive, aerospace, and

construction industries. Since that the demand on the composite materials starts to rise which brought to the insufficient supply of the raw materials.

The raw materials of the polymers were obtained from the natural gases combustions. Those combustions of the natural gases not only bring benefits in the production of the polymers but it also rises up the global warming issue by releasing the greenhouse gasses such as methane and carbon dioxide during the degradation of the polymers.

Aside from the environmental impact, the cost of the composite material is also an important factor, as glass and carbon fibers are relatively expensive to produce, and fluctuating oil prices mean unstable costs for the composite material as a whole. Fiber glass is an irritant. Skin irritation is generally associated with thick fibers which can be found in insulation wools and filamentous glass. Fiber glass may also cause irritation of the eyes and throat. If the exposure is sufficient, fiberglass may produce irritation dermatitis and difficulty in breathing which will further bring problem with the human respiratory system.

Besides the producing of polymers such as plastic were not easily to decompose in the soil. Therefore, this issues triggers the idea for developing a sustainable resource which is environmental friendly and recyclable. With the increasing in the capabilities of the engineering fields researchers starts to research on the polymer composites reinforced with the natural fibers.

Besides, the fiber reinforcement improves mechanical properties by increasing hardness, flexural ability, better tensile, and higher tensile modulus and impact strength,

and higher tensile modulus. Fibers in between the polymer composites hold the material together to resist deformation and breaking under stresses. Density of the fibers, length and width of the fibers, and adhesion strength between fiber and polymers as well as defects and variation within the fibers themselves are the several factors to be considered in the fiber reinforcement with the polymer composites.

1.3 Objective

- To fabricate new composition of polyester resin reinforced with banana fiber in the fiber orientation of 0°/90°.
- To test and analyse the new composition produced through tensile test and flexural test based on the ASTM standards.

1.4 Work Scope

To fabricate a laminated polyester resin composite reinforced with banana plant fiber as a possible replacement for synthetic fibers in Malaysia such as glass fiber and carbon fiber. Next, is to test the specimens for determine the mechanical properties based on the ASTM standard.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter some previous research are being reviewed to relate to this investigation. The polymers and natural fibers that are the main raw material being discussed in this chapter. Previous researches will be very helpful to know the material specifications, characteristics, advantages and disadvantages of selecting and using it.

2.2 Polymer

Polymers usage start to grow in the twentieth century at where on that time World War II was ongoing. The most commonly used polymers on that period of time are plastics. The needs of in the products of paints, fibers, elastomers, coatings, film and structural plastics enhance the growth of chemical industry to produce large amount of synthetic polymers (McKeen, 2009). Even though in today term most of the material can be manufactured by plastic which able to be moulded and formed into solid or semi solid objects except the fibers.

Polymers formed by covalent chemical bonding. The chemical bonding happens by joining between the large molecule known as macro-molecule and small repeating units known as monomers. The molecules of polymers consist of thousands or millions of atoms in the form of regular, irregular, crystalline regions or amorphous structures. Polymers are normally containing with the repetitive units of carbon atoms.

The arrangement of the polymers atom is normally in one-dimensional, two-dimensional or three dimensional molecules. The important group of polymers can be found in the last type of the atoms arrangements which normally can be detected in the natural fibers and in the manufacturing of man-made fibers (Grishnov, 2011).

Crude oil, natural gas, nitrogen and chlorine are the raw materials that used in the production of polymers. Ethylene, propylene, styrene and butadiene are formed from the basic petrochemicals is later processed into various kind of polymer materials. Polymers can be divided into three categories which are thermoplastic, thermoset and elastomers. Examples of the polymers with their categories has been shown in Table 2.1.

Thermoplastics are a polymer that can formed or deformed easily depends on the temperature changes because the molecular chain in the thermoplastic were connected apart from each other. Meanwhile thermosets are covently bonded makes it is hard to formed or deformed into other shape (Gerdeen, et.al, 2005).