UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PRELIMINARY STUDY OF MECHANICAL PROPERTIES FOR COMPOSITE REINFORCE PINEAPPLE LEAF FIBER THROUGH IMPACT, TENSILE AND TORSION TESTING

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

by

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TAJUK: **PRELIMINARY STUDY OF MECHANICAL PROPERTIES FOR COMPOSITE REINFORCE PINEAPPLE LEAF FIBER THROUGH IMPACT, TENSILE AND TORSION TESTING**

SESI PENGAJIAN: **2017/2018 Semester 2**

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honors. The member of the supervisory is as follow:

……

(Project Supervisor)

ABSTRAK

Fokus kajian mengenai kajian mengenai sifat-sifat awal mekanikal bagi komposit untuk menguatkan serat daun nenas melalui kesan, tegangan dan ujian kilasan. Dalam usaha mengurangkan sisa pertanian, serat daun nanas digunakan untuk menggantikan bahan lain dalam bidang pengeluaran perindustrian. Ini adalah disebabkan oleh kesan alam sekitar apabila menggunakan gentian sintetik yang boleh memudaratkan alam sekitar dan serat semula jadi sebagai pengganti. Tujuan kajian ini adalah untuk mereka-reka komposisi yang berbeza daripada resin epoksi diperkukuh dengan gentian daun nanas melalui ujian kesan, tegangan dan ujian kilasan dengan menggunakan mesin bandul ujian kesan, mesin ujian tegangan dan mesin ujian kilasan. Komposit akan bercampur dengan serat daun nenas yang mengandungi perbezaan nisbah resin epoksi. Selain itu, projek ini adalah untuk menganalisis modulus keanjalan dan ketegaran. Acuan ujian kesan adalah rekaan berdasarkan ASTM D6110. mesin ujian universal (INSTRON) digunakan untuk mendapatkan keanjalan modulus yang tertinggi di kalangan sampel berdasarkan ASTM D3039. Untuk ketegaran modulus, mesin ujian kilasan digunakan untuk eksperimen ini berdasarkan ASTM E143 dan untuk ujian kesan Charpy ujian kesan Mesin digunakan berasaskan. Untuk hasil yang diharapkan, acuan untuk ujian kesan mampu untuk mereka-reka mengikut ASTM D6110 dengan menggunakan kayu. Komposit baru dihasilkan dengan menggunakan nanas serat daun dan resin epoksi. Kemudian, ujian itu dibuat mengikut ASTM E143, ASTM D3039 dan ASTM D6110 dengan menggunakan mesin ujian yang berbeza dan akhir sekali Julat tertinggi keanjalan modulus, ketegaran dan rintangan hentaman dalam setiap komposisi.

ABSTRACT

This study focus on the preliminary study of mechanical properties for composite reinforces pineapple leaf fibre through impact, tensile and torsion testing. In order reduces the agriculture waste, pineapple leaf fibre is used to replace other material in industrial production field. This is due to the environment effect when using synthetic fibre that can harm the environment and natural fibre as substitute. The purpose of this research is to fabricate different composition of epoxy resin reinforced with the pineapple leaf fibre through impact test, tensile and torsion test by using pendulum impact test, tensile testing machine and torsion testing machine. The composite will be mix with different contain ratio of the epoxy resin. Besides that, this project is to analyse the modulus of elasticity and rigidity. The mould of impact test is fabricated based on ASTM D6110. Universal testing machine (INSTRON) is used to get the highest modulus elasticity among the sample based on ASTM D3039. For the modulus rigidity, torsion testing machines used for this experiment based on the ASTM E143 and for the impact test, Charpy impact testing machine is used based. For the expected result, the mould for impact test is able to fabricate according to ASTM D6110 by using wood. The new composite is produce by using pineapple leaf fibre and epoxy resin. Then, the test is made according to ASTM E143, ASTM D3039 and ASTM D6110 by using different testing machine and lastly The highest range of modulus elasticity, rigidity and impact resistance in each of the composition is obtain.

DEDICATION

To my beloved father Hussain B. Hassan and my beloved mother Asmah Binti yusoff. To my sibling and all my friends

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

PALF	-	Pineapple leaf fibre
σ	-	Stress
ϵ	-	Strain
τ	-	Torque
G	-	Modulus rigidity
E	-	Modulus elasticity

CHAPTER 1
INTRODUCTION

1.1 Fibre

Fibre is an indigestible plant food, such as vegetables, fruits, grains, beans and legumes. Fibre has two types that are natural fibre and synthetic fibre. The advantages of natural fibre are usually referred on energy efficiency which is the use of industrial processes that reduce of carbon discharge, renewable materials in polymer products and recyclable materials that reduce waste (Ashik *et al*., 2015). Natural fibre also is eco-friendly, lightweight, strong, renewable, and low cost (Bongarde *et al.*,2014). It gives a combination of dielectric property mechanical property, and environmental advantages for example like renewability and biodegradability (Dhal *et al.*, 2013).

The biodegradability of the natural fibres is also is important and interesting aspects of their utilization in polymeric materials. The usage of natural are it is competent material which replaces the use synthetic materials and which is related products for the less weight and energy conservation applications and replacing existing synthetic polymer or glass fibre reinforced materials in huge (Sanjay *et al.*, 2016). Besides that, the use of natural fibres is it can improve remarkably of the things due to the fact that the field of application is improved especially in automotive industries.

There are some advantages of natural fibres such as low cost, low density, low energy inputs and comparable mechanical properties and also better elasticity of polymer composites reinforced with natural fibres (Ashik *et al.*, 2015). According to the (Ahmad *et al.,* 2015), natural fibre composites is more shatter resistant, very good

sound-absorbing capabilities and have more efficient energy management characteristics than glass.

1.2 Problem statement

There are many types of natural fibre. Pineapple leaf fibre (PALF) is the one of natural fibre. According to the Al-Oqla *et al.,* (2014) proper utilization of the accessible natural resources and wastes became crucial for developing continuous in industry. Based on the rapid development in agricultural sectors, there are many tons of agricultural wastes being disposed annually in Malaysia. The waste of pineapple fibre will caused environmental problem if it not properly disposed. To reduce the waste of pineapple fibre, some researcher has proved that pineapple fibre is suitable for automotive and other industries. PALF provided the highest improvement in all mechanical properties tested such as flexural, tensile, and impact test. It also can be good of heat distortion temperature. Brief consideration of environmental issues suggests that using pineapple leaf waste can be beneficial in terms of both lower embodied energy and also lower overall emissions (Kengkhetkit *et al.*, 2014).

The used of pineapple is to utilize the unused part of the pineapple. The utilize usage of pineapple sustainable in productions practicing the process that will reduce the environment pollution, minimize the waste, conserved energy and natural resources. This sustainable manufacturing will maximize the productions of pineapple leaf fibres and develop green environment as well as improve the economy growth (Yusof *et. al*., 2015). Besides that, the application of PALF can be used for various purposes for example in automobile, cabinet, textile, sports item, baggage, mats and so on.

Natural fibre has many advantages compared to the synthetic fibre. This is because synthetic fibre is harmful and can be polluting to the environment compared to natural fibre that are biodegradable and environment-friendly material. Furthermore, natural fibre composite material are one of material that replace the synthetic materials to be apply to other application where it is require less weight and

energy conservation. With natural fibre, it can reduce the material cost and also can offer and opportunity to adjust the price performance ratio and make the utilization of pineapple leaf waste more attractive to be used for industrial applications.

1.3 Project Objective:

From the background and the problem statement that have been stated, the objectives of this research are:

i. To fabricate different composition of epoxy resin reinforce pineapple leaf fibre
ii. To test the pineapple leaf fibre through impact, tensile and torsion test
iii. To analyse different composition of resin reinforced pineapple leaf fibre

1.4 Scope Project

In order to achieve the objectives, several scopes have been determined:

i. Fabricating new composition of epoxy resin reinforced of pineapple leaf fibre
ii. Testing the pineapple fibre through impact test by using pendulum impact machine according to the ASTM D6110
iii. Testing the pineapple leaf fibre through torsion test by using torsion test machine according to the ASTM E143
iv. Testing the pineapple fibre through tensile test using Instron testing machine according to the ASTM D3039
v. Analysing new composition of epoxy resin with reinforced pineapple leaf fibre

CHAPTER 2
LITERATURE RIVIEW

2.1 Introduction

In this literature review explains about composite structure of natural fibre and the types of reinforcement fibre. There is various type of natural fibre and have many reference options are guided from the journals, previous thesis, references book and articles from the internet. It includes overview properties of natural fibre and pineapple leaf fibre as reinforcement with epoxy resin as matrix. In this chapter also include about the composition and characteristic of natural fibre. Besides that, this chapter explain about total finding of this project.

2.2 Comparison between Natural Fibre and Synthetic Fibre

In the last decades, the natural fibre composite have been widely used in the construction, automobile and aerospace industries (A *et al.*, 2016). Fibre is usually found in many form and appearance which long fibre, small fibre and also sometime produces into powder. Fibre also classified as a hair material because similar to the piece of thread. There are two types of fibre which is natural fibre and synthetic fibre. Usually, natural fibres are extracted from animal, plants and synthetic fibres are obtained by artificial or man-made processes (Faruk *et al.*, 2014). Mostly, natural fibres are found on creatures for example likes silk worm, sheep and the synthetic threads that must be produced by using laboratory procedures. Examples of natural fibres are sheep's wool and linen that comes from plants and the examples of the synthetic fibres are acrylic and nylon.

Natural fibre usually is a based on plant and it is can easily to find and available through the world. The advantages of natural fibre compare to the synthetic comprise low density, low cost, availability, recyclability and biodegradability (Sonar *et al.*, 2015). Because of that, the biodegradability of the natural plant fibres may present a healthy ecosystem while the low costs and good performance of these fibres are able to fulfil the economic interest of industry (Begum K *et al.*, 2013). Other than that, natural fibre also is environmentally friendly materials of the production, processing and waste. Besides that, it is good thermal and acoustic insulating properties. Based on table 2.1, it represent about the cost and properties of natural fibres. Natural fibre composites are very cost effective material especially in building and construction, packaging, automobile and others. According to Sathishkumar (2013), natural fibres have been abundantly available in the world.

Table 2.1 : Cost and properties of natural fibre (Dunne *et al.*, 2016)

Fibre type	**Plant origin**	**Density (kg/m3)**	**Tensile strength (MPa)**	**Moisture regain (%)**	**Cost ($/kg)**
Abaca	*Leaf*	*1500*	12-980	14	0.5-1.8
Bagasse	Stem	550-1250	290	38-40	0.01440.1-0.81
Banana	Leaf	750-1350	180-914	9.59-11.25	0.1-0.81
Bamboo	Stem	1500	575	14.5	2.43-5.71
Coir	Fruit	1250	106-175	13	0.5-0.84
Cotton	Seed	1550	300-700	8.5	1.56-2
Flax	*Stem*	*1400-1500*	400-1500	9.24-12	0.6-0.8
Hemp	Stem	1480-1500	310-1100	8-12	0.7-0.8
Jute	Stem	1300-1500	200-540	13.75-17	0.8-0.9
Kapok	Seed	384	93.3	10.90	0.2

Fibre type	Plant origin	Density (kg/m3)	Tensile strength (MPa)	Moisture regain (%)	Cost ($/kg)
Kenaf	Stem	295-1320	260-930	10-12	0.7-0.8
Pineapple	Leaf	1520-1560	413-1627	12	0.05
Ramie	Stem	1550	585-915	8.50-17.5	1.52
Sisal	Leaf	700-1500	80-855	14	0.7-0.8

Synthetic fibre is material produced from man-made instead of natural fibre and synthetic fibre contained chemical mixture to produce and regenerated from cellulose. Synthetic fibre is made of very large unit called polymers. According to the Shen (2014) , synthetic fibre is viscose fibre that has been produced at industrial scale since 1930s. Synthetic fibre is based on a polymeric structure and it being produced or synthetized often oil, and at the time come from coal or natural gas. (Weinberger, 1996). Synthetic fibre is dividing into several types such as carbon fibre Kevlar, spandex, polyester, nylon, acrylics, rayon and nomex. Synthetic fibres are used ranging from many household articles such as ropes, buckets, furniture, and containers and highly specialised uses in aircraft, ships, healthcare and others.

After several researches, it can be conclude that natural fibre is more advantages compared that synthetic fibre. This is because, natural fibre is more bio-degradable compared to the natural fibre. Synthetic fibre also is not environment friendly. Besides that, on burning of synthetic fibre, it release poisonous gases and it may take years to generate because of non-biodegradable. So that, the use of natural fibre is the way of utilization of biodegradable material and suitable for industry.

2.3 Natural fibre Classification

Based on their origin of the fibre, the fibres may be classified from natural and synthetic fibre or Man-made. Natural fibres also can be further classified based on their origin into the following three groups that is animal fibres, mineral fibres and cellulose fibre. During synthetic fibre, it is classified with organic fibre and inorganic fibre. Figure 2.1 shows the classification of fibre.

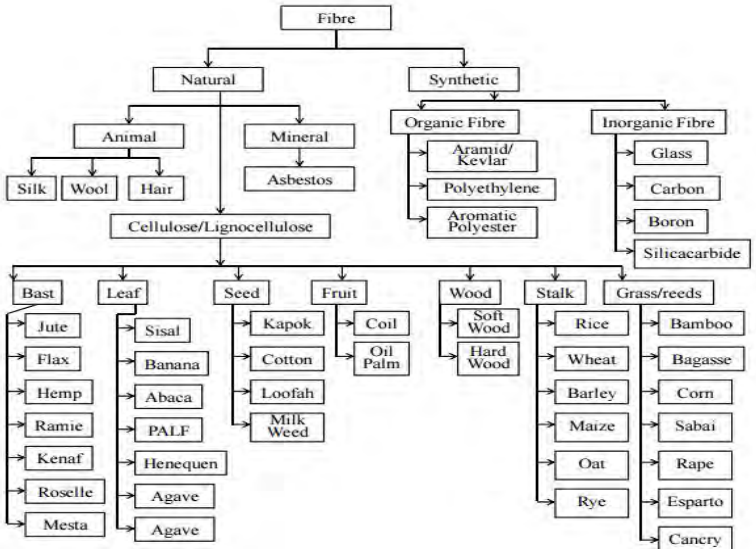

Figure 2.1: Classification of Fibre (Saba, Tahir and Jawaid, 2014)

2.3.1 Animal Fibre

Animal fibres are generally a compromise of protein. Animal fibre also are the mostly protein fibres and include wool and silk (Saba *et al*.,2014). Animal hair contains of wool, human hair and feather. But the most commonly used type of animal fibre is hair. They can be classified as hair fibres, secretion fibres and spider silk. After several years, natural fibre was increase in demand of product and natural resources have profited considerably as one of an alternative to unnatural materials, especially in automotive, structural engineering, and packaging industries (Bharath *et al.*, 2016). Figure 2.2 show the example of the animal fibre.

Figure 2.2: Animal fibre

(Source:http://www.sewcratic.com/learn/sewipedia/fibers/wool-fiber)

Other category of animal fibre is wool fibre. Wool fibre has a low determination because it has excellent elongation and elastic recovery. Besides that, animal fibre is durable with moderate resistance and it is also poor conductor of heat.

2.3.2 Mineral Fibre

Mineral fibre is a general term for different types of inorganic insulation materials such as the rock, glass and ceramic wool. Basalt, dolomite and granite are some of the most common input raw materials in mineral fibre production. The fibres form a homogenous anisotropic structure that has excellent sound and heat insulation properties (Širok *et al.*, 2014). Besides that, mineral fibres are naturally occurring fibre or slightly modified fibre procured from minerals. These can also be categorized as asbestos, Ceramic, Metal fibre (Bongarde and Shinde, 2014).

Figure 2.3: Types of Asbestos

(Source: http://www.asbestosnetwork.com/blog/2015/06/3)

Figure 2.3 show the example of mineral fibre of mineral is that is asbestos. According to Whittaker, (2009) asbestos was once an important commercial fibre but is no longer used for health reasons. Asbestos occurs naturally and based on the environment and usually found on the ceiling, wall and floor. Asbestos is non-flammable even at very high temperatures and is extremely flexible and durable. Asbestos fibre consists of six types that are chrysotile, actinolite, amosite, anthophyllite, crocidolite, and tremolite. The application of asbestos in industrial is useful in commercial application, including wear, electrical insulation, heat stability and ability to be woven.

2.3.3 Cellulose

Cellulose is the mostly is abundant of renewable polymer on earth. Cellulose fibres are a most plant and can be found from various natural plant resources. It is biosynthesized by various living things that move from higher to lowering plants, some ammonia, sea creatures, microorganisms, and organisms. In addition, cellulose is also a low-cost, biodegradable and renewable polymer that is fibrous, tough and insoluble in water and helps in maintaining the structure of plant cell walls, and algae (Gupta *et al.*, 2016). Figure 2.4 show the stucture of the natural fibre that contain cellulose, hemicellulose and lignin.

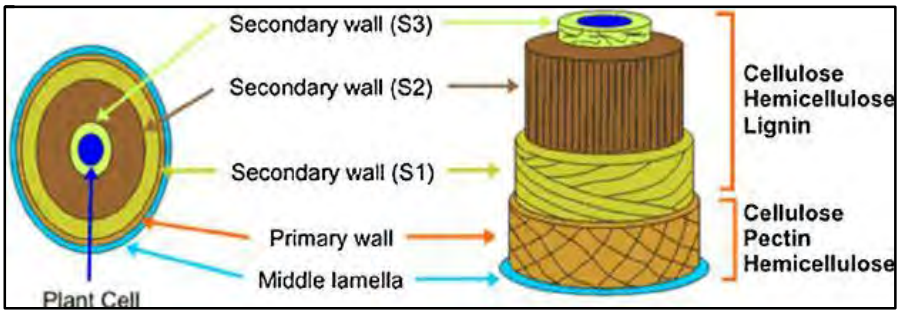

Figure 2.4 : Structure of natural fibre (Mokhothu and John, 2015)