UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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PRELIMINARY STUDY OF THE MECHANICAL PROPERTIES FOR DIFFERENT COMPOSITION OF PINEAPPLE LEAF FIBER MIX NATURAL BINDER (RICE) THROUGH TENSILE AND IMPACT TESTS

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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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 Engineering Technology (Maintenance Technology) (Hons.). The member of the supervisory is as follow:

.....

(Mohd Afdhal Bin Shamsudin)

ABSTRAK

Permintaan untuk mempunyai komposit baharu yang boleh terbiodegradasi dan boleh diperbaharui dianggap penting untuk membendung isu-isu alam sekitar. Kajian ini mencadangkan komposit yang boleh diperbaharui, dengan penggunaan nasi dan serat daun nanas sebagai pendahuluan bagi menangani masalah yang telah dinyatakan. Komposit yang baharu dibuat dengan pemuatan serat daun nenas yang berbeza iaitu pada 0wt. %, 30wt. %, 35wt. %, 40wt. %, 45wt. %, 50wt. % dan 55wt. %. Setelah selesai proses fabrikasi, sampel ini telah diuji dan dicirikan dengan menggunakan mesin ujian sejagat mengikut ASTM D3039 (ujian tegangan plastik dan komposit) dan mesin hentaman mengikut ASTM D6110. Daripada ujian yang telah dijalankan, didapati bahawa pemuatan serat daun nanas yang paling dikehendaki dalam komposit nasi adalah 55/45 nasi/serat daun nanas. Hasilnya untuk modulus keanjalan dibaca pada 1.78042 GPa manakala penyerapan tenaga bagi pemuatan yang sama memaparkan hasil yang sederhana sebanyak 4.89 J. Tidak ada peningkatan yang luar biasa dalam modulus keanjalan dan penyerapan tenaga apabila pemuatan serat meningkat. Jumlah beban serat yang berlebihan menyebabkan penurunan modulus keanjalan dan penyerapan tenaga. Serat-serat yang berlebihan ini mempengaruhi gabungan antara matriks dan serat. Kesimpulannya, daripada kajian yang telah dijalankan bahawa komposit ini sangat memerlukan pemuatan pada 55/45 nasi/serat daun nanas.

ABSTRACT

The needs of having a new composite which is biodegradable and renewable is deemed essential as to curb environmental issues. This study proposes a new renewable composite, using rice and pineapple leaf fiber as precursors to address this problem stated. The newly fabricated composite was loaded with different PALF loading at 0wt. %, 30wt. %, 35wt. %, 40wt. %, 45wt. %, 50wt. % and 55wt. %. Upon fabrication, these samples were tested and characterized using universal testing machine in accordance to ASTM D3039 (tensile testing of plastic and composites) and an impact machines in accordance to ASTM D6110. From the tests, it was observed that the most desirable loading of PALF in rice composite is at 55/45 of rice/PALF loading. The result for modulus of elasticity reads at 1.78042 GPa while the absorbed energy at the same loading displayed a modest result of 4.89 J. There is no remarkable improvement in modulus of elasticity and absorb energy when the fiber loading is increased. The excessive amount of fiber loading caused the decrement of modulus of elasticity and absorb energy. These excessive fibers affect the even combination between matrix and fiber. It can be concluded that, from the study conducted that this composite is most desired with a loading at 55/45 of Rice/PALF.

DEDICATION

My baby,

May your future be bright

As bright as daylight.

Love,

Your daddy

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

%	Percentage
±	Plus-Minus Sign
σ	Stress (MPa)
ε	Strain (%)
2D	2-Dimensional
3D	3-Dimensional
A	Cross-Sectional Area
a	Impact Toughness
A	The Work Required For Breaking The Specimen
Ag	Silver
Al	Aluminium
ASTM	American Society For Testing And Materials
Be	Beryllium
$CaCO_3$	Calcium Carbonate
cm^3	Cubic Centimeter
CMCs	Ceramic Matrix Composites
cN	Centi-Newton
Co	Cobalt
Cu	Copper
Cu-W	Copper-Tungsten
E	Modulus Of Elasticity

F	Applied Force
Fe	Iron
g	Gram
g	Gravity
GPa	Gigapascal
GPPS	General Purpose Poly Styrene
H	High Between Surface And End Of The Swing
H_0	High Between Surface And Initial Position Of The Hammer
H_2O	Water
HIPS	High Impact Polystyrene
ISO	International Organization For Standardisation
M	The Pendulum Mass
m^2	Square Meter
MFI	Melt Flow Index
Mg	Magnesium
mm	Millimeter
MMCs	Metal Matrix Composite
MPa	Megapascal
N	Newton
Ni	Nickel
NiAl	Nickel Aluminide
°C	Degree Celcius
PALF	Pineapple Leaf Fiber
PCL	Polycapolactones

PE	Polyethylene
PEA	Polyesteramides
PLA	Poly-Lactic Acid
PMCs	Poly Matrix Composites
PP	Polypropylene
PP	Polypropylene
PVC	Polyvinyl Chlorite
S	Cross-Sectional Area Of The Specimen At The Notch
Tex	Linear Density Of Fibers
THC	Tetra-Hydro-Cannabinol
Ti	Titanium
UV	Ultraviolet
wt	Weight
ε	Strain
μm	Micrometer

CHAPTER 1

INTRODUCTION

1.1 Introduction to Composite

The use of composite has begun for a long time. According to Vinson and Sierakowski (1987) stated that chopped straws in bricks to enhance their structural integrity has been used by ancient Jewish workers during the reign of the pharaohs. Another example is to obtain the most desirable material properties of sword, the Japanase Samurai warriors use laminated metals in the forging of their swords. More than that, the technology of composite in moulding art works has been used by certain artisans from the Far East and Mediterranean whereby the fabrication process is done by layering cut paper in various sizes in order to produce desired shapes and contours.

Composite materials can be defined as the combination of two or more material components (Sharath and Ramachandra, 2018). According to Jose et al., (2012) reported that the combination of these materials gained additional properties that the individual base products does not have. It is also refers to as the matrix and the reinforcement. Nowadays, composite material becomes a high demand material due to the advantages such as excellent strength to weight ratio, resistant to corrosion, water resistant and easy to assemble (Jose et al., 2012). A study by Shaw et al., (2010) stated that the most application of composite as material in an electronic packaging to medical equipment, in making aircraft structures, including aerospace, marine and automotive parts.

A study by Mayer et al., (1998) stated that composite consist of two or more mechanically separable and physically distinct materials. They are made by materials that separate in a way as to achieve uniform dispersion and controlled of the

constituents. They are also known as the uniquely different from the properties of their constituents and have condescending mechanical properties. All these are the characteristic that need to follows for the application of structural in composites.

Avila et al., (2003) stated that the classification of composites was divided into 3 matrix phases which are ceramic matrix composites (CMCs), polymer matrix composite (PMCs) and metal matrix composite (MMCs). All these three are the basis of matrix phase in composite. A study by (Jose et al., 2012) stated that these classifications are according to the types of reinforcement which is particulate composites, laminate composites, and fibrous composites. Among all the 3 basis of matrix, the polymer matrix composite (PMCs) is the most interest to researchers due to its high strength, high stiffness, light weight and ease of process of manufacturing or inventing something (Sharath and Ramachandra, 2018). Moreover, a study by Jasmin et al., (2012) showed that polymer matrix material also known as a resin solution because they are most commercially produced composite. Polymer matrix composites (PMCs) becomes very popular due to their cost and the simplest methods of fabrication.

In the most recent years, the utilization of composites are starting with the raw ingredient which is natural fiber reinforced in polymer matrix composite. Instead of selecting raw materials must be cheap, being ecofriendly becomes the other parameters that need to be considered. (Sreekala et al., 1997). According to Herrera and Valadez (2005) reported that the high degree of flexibility and the absence of health hazard is the other parameters to be considered. The reinforcement materials are usually fiber also known as ground minerals (Mkaddem et al., 2008). Besides, the suitability of natural fibers are directly influenced by the lower plant's age, regional availability and easiest collection (Abdelmouleh et al., 2007 and Tserki et al., 2005). Moreover, a research by Yan et al. (2012) to Satyanarayana et al. (1990) proved that all the natural fibers are not

only the renewable resource, they also provide the best solution of sustainable supply such as low density, low cost no health hazard, least processing and better mechanical and physical properties.

Due to the some factors contributing to the selection of biodegradable polymer which is environmental factors, a new biodegradable fiber shall be chosen to replace the existing non-biodegradable fiber. According to (Sharath and Ramachandra, 2018) stated that the choices of fiber to be reinforced in biodegradable composite includes coir, cotton, jute and manila, new fiber hits the limelight which is Pineapple Leaf Fiber.

1.2 Problem Statement

Basically, polymer can be divided into two classes. One is thermoplastics and the other one is thermosetting. Thermoplastic materials are currently dominate. Poly vinyl chloride (PVC), polypropylene (PP), and polyethylene (PE) becomes the most commonly used thermoplastics for this purpose. While for the thermosetting matrices, epoxy, phenolic, and polyester resins are the most commonly used (Malkapuram et al., 2008). According to Asim et al. (2015) stated that the natural fibers industries collapse its market shares while the synthetic fiber raised up drastically. Synthetic fiber reinforced polymers were high cost and non-environmental friendly (Tseng and Wu, 1998).

Mostly, synthetic fibre-reinforced plastics have high specific strength but the applications are very limited in their fields due to the cost of production is very high (Deepak et al., 2015). To overcome these problem, natural fiber must be used to replace the synthetic fiber that give a lot problem. A study by (Sharath and Ramachandra, 2018) proved that natural fiber is biodegradable and non-carcinogenic which means it cannot

cause cancer for the consumer become the most important property which bring it back into fashion and with an advantage of being cost-effective.

Mostly, the synthetic polymer composites are petroleum based products (Cigasova et al., 2013). A study by Malagavelli and Rao (2010) reported that non-biodegradable waste can create a lot of problems in the environment. Non-biodegradable waste can cause environmental problem and its disposal can last for centuries that will affect more than just the land. Besides, Cristaldi et al., (2014) reported that synthetic polymers is non-biodegradable due to its generation of huge plastic waste and its disposal. The fabrication process required a lot of pressure and heat. Moreover, the methods of recycle for polymer composites become very underdeveloped and it is limited reserves of petroleum.

However, researchers from all around the world are looking into alternative for synthetic fiber and resin system due to the dwindling reserves of petroleum sources and their non-biodegradability (Sanjay et al., 2018). A study by Samuel et al., (2012) reported that the use of natural fibres and matrices for fabrication of polymer composites was increased due to the major problems associated with the use of synthetic polymer. The process in production of natural fibres involve more than half of the energy needed for synthesis of synthetic fibres. The advantages of natural fibres include non-abrasive, non-irritating, non-toxic, combustible, light in weight, good acoustic, durability, cost effectiveness and biodegradable.

According to Gouda et al., (2012) stated that the development of bio-composite material based on polymer which is Epoxy Resin and natural fibers such as Sisal, Jute, and Hemp is discovered at 36wt. % of natural fiber is the most desirable loading. Another study by Verma and Shukla (2018) discovered that the addition of Kenaf Fiber reinforced HDPE green composite at 30wt. % is found to be the most desirable loading.

Taufiq et al., (2018) in their study reported that the desirable loading of Kenaf Fiber reinforced recycled-unused plastic blend is discovered at 30wt. %. A study by Reddy et al., (2018) stated that pineapple leaf fibers (PALFs) exhibit greater mechanical properties among various natural fibers. Besides, rice is the main source of food that contains an organic acid which occurs naturally and can process cellulose. When tested, it showed a result in promising range of traits from rigid and brittle to stretchable and soft. Henceforth, in this study, the loading of Pineapple Leaf Fiber to be reinforced in rice polymer matrix is determined at a range of 30 to 55wt. %.

1.3 Objective of Research

Based on the problem statement discussed above, the objectives of this study are listed below:

1. To fabricate new composite based on polymer and fiber matrix.
2. To test the newly fabricated new composite.
3. To determine the desirable loading of fibers in polymer matrix.

1.4 Scope of Research

In order to achieve the objectives, the scopes are prepared as shown below:

1. Fabricating of new composite using rice as natural binder and pineapple leaf fiber (PALF) as filler.
2. Mechanical properties of newly developed composite using pendulum impact test in accordance to ASTM D6110 and tensile test in accordance to ASTM D3039.

3. Determining the desirable loading of Pineapple Leaf Fiber in rice composite at interval of 30-55wt. % loading.

CHAPTER 2

LITERATURE REVIEW

2.1 Composite

Generally, composite is defined as composition of two or more different chemical and physical phases separated by a distinct interface (Sharath and Ramachandra, 2018). A study by Jose et al., (2012) stated that to make the system more useful structural and more functional properties, the different systems will combine judiciously rather than those of the individual components used alone.

According to Sharath and Ramachandra, (2018) stated that due to the growing awareness of petroleum sources and their non-biodegradability, green composite or bio-composite that made from the natural fibers and bio-polymer shall be replaced the existing synthetic fiber and resin system. Besides, natural fibers have been used as reinforcement material. It can be dated back to nearly decamillenium which is 10,000 years back. For example, to obtain the most desirable material properties of sword, the Japanase Samurai warriors use laminated metals in the forging of their swords. Other example is chopped straws in bricks to enhance their structural integrity has been used by ancient Jewish workers during the reign of the pharaohs. Furthermore, the technology of composite in moulding art works has been used by certain artisans from the Far East and Mediterranean whereby the fabrication process is done by layering cut paper in various sizes in order to produce desired shapes and contours (Vinson and Sierakowski, 1987).