UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATION OF COCONUT COIR CONTENT TO THE MECHANICAL PROPERTIES OF NATURAL FIBRE REINFORCED COMPOSITE BASED DOE APPROACH

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.

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Pada masa kini, bio-komposit telah menarik perhatian masyarakat walaupun komposit berasaskan sintetik mempunyai banyak kelebihan. Oleh kerana kos yang tinggi, sifat tidak boleh diperbaharui dan bukan biodegradable komposit sintetik, bahan bio-komposit cenderung mempunyai kemuncak mereka disebabkan oleh kos rendah, sumber yang boleh diperbaharui dan biodegradability.Oleh itu,tujuan kajian ini dijalankan adalah untuk mengkaji dan menganalisis satu komposisi baharu yang diperbuat daripada campuran bahan semula jadi seperti sabut kelapa, kanji dan alcohol polivinil (PVA). Sabut kelapa ialah sebahagian dari biji buah kelapa yang berupa serat yang kering, bersisik dan tidak dapat dimakan. Ia berfungsi untuk melindungi bahagian dalam buah kelapa. Selain itu, campuran antara sabut kelapa dan kanji yand dicampur bersamaan dengan PVA dijadikan sebanyak 8 specimen dengan berbagai komposisi. Untuk menjalankan eksperimen ini, ciri-ciri yang terperinci mengenai sabut kelapa dan kuantiti yang akan digunakan perlu diketahui. Spesimen ini disediakan dengan meletakkan campuran antara serbuk sabut kelapa, kanji dan alkohol polivinil ke dalam acuan yang disediakan. Eksperimen ini kemudian akan diuji dengan menggunakan ujian tegangan dan impak dengan menggunakan reka bentuk ekesperimen. Hasil reka bentuk eksperimen akan menjelaskan dan mengesahkan sifat mekanikal yang dipengaruhi dari segi jumlah campuran parameter yang digunakan melalui analysis Design of Experiment (DOE).

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ABSTRACT

In the present days, bio-composite have caught the attention of the society although synthetic based composite has a lot of advantages. Due to the high cost, non-renewability and non-biodegradability properties of the synthetic composite, the bio-composite material tends to have their highlight due to their low cost, renewable resources and biodegradability. Therefore, the purpose of this study was to study and analyze a new composition made from a mixture of natural ingredients such as coconut coir, starch and polyvinyl alcohol (PVA). Coconut coir is part of the coconut fruit that is dry, scaly and inedible. It works to protect the inside of coconut fruit. In addition, a mixture of coconut husk and starch and mixed together with PVA was used as 8 specimens with various compositions. In order to carry out this experiment, detailed features of coconut coir and the quantity of the coir that need to be used should be known. This specimen is prepared by placing a mixture of coir powder, starch and polyvinyl alcohol into the mold. This experiment will then be tested using tensile stress and impact tests using the experimental design. The results of the experimental design will explain and verify the mechanical properties that are influenced by the amount of parameter used throughout the Design of Experiment (DOE) analysis.

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PVA	-	Polyvinyl Alcohol
OH	-	Hydroxyl
PVC	-	Polyvinyl Chloride
wt %	-	Weight Percentage
ASTM	-	American Society of Testing and Materials
TPS	-	Thermoplastic Starch

CHAPTER 1

INTRODUCTION

1.1 Background

Composites materials are generally a material that signifies when two or more materials are combined in order to form a useful material. Briefly, these materials are made up of fibre reinforced along with a matrix or binder which keeps the fibre hold in a place. In this case, a well-produced composite material can contribute to several advantages of improve properties such as mechanical properties of strength, stiffness and toughness of material. Apart from this the fatigue life, corrosion resistance and thermal insulation can be considered as a well-produced composite material. However these fibre reinforced composites are mainly classified as synthetic fibre reinforced composites and natural fibre reinforced composites.

The synthetic fibre is known as man-made fibre or artificial fibre generally derived from chemical substances. These fibres are basically made up from inorganic materials such as glass, carbon, boron, etc. Besides in order to form a composite material, these fibres are made with from petroleum based chemical product which known as a synthetic polymer. (Composite, Composite, Fiber, Fiber, & Asim, 2017) had stated that , although this synthetic based composite have applications in several due to their advantageous properties such as good strength and durability characteristic. Despite all these advantages, synthetic fibre reinforced composites lack after their life span in various aspects such as reusability, recycling and biodegradability.

On the other hand, the natural fibre is made up from organic substances which consist of plant, animal and mineral based. These fibres are considered the main fundamental in the natural fibre reinforced composites. Moreover, (Beloor et al., 2014) had stated that due to several advantages of low-cost, environmentally friendly and low-density natural fibre composites have dramatically increased their value for sustainable green products. There are several applications of natural fibres in composite materials. It has attractive options such as construction industry, automotive industry and furniture industry (Vairakkumar, August 2011). In terms of their industrial applications and fundamental research, interest the need of natural fibre-composite materials is growing rapidly. Natural fibers can be renewed, cheap, recycled and biodegraded as stated by Mishra S, Tripathy SS, Misra M, Mohanty AK, Nayak SK, 2002.

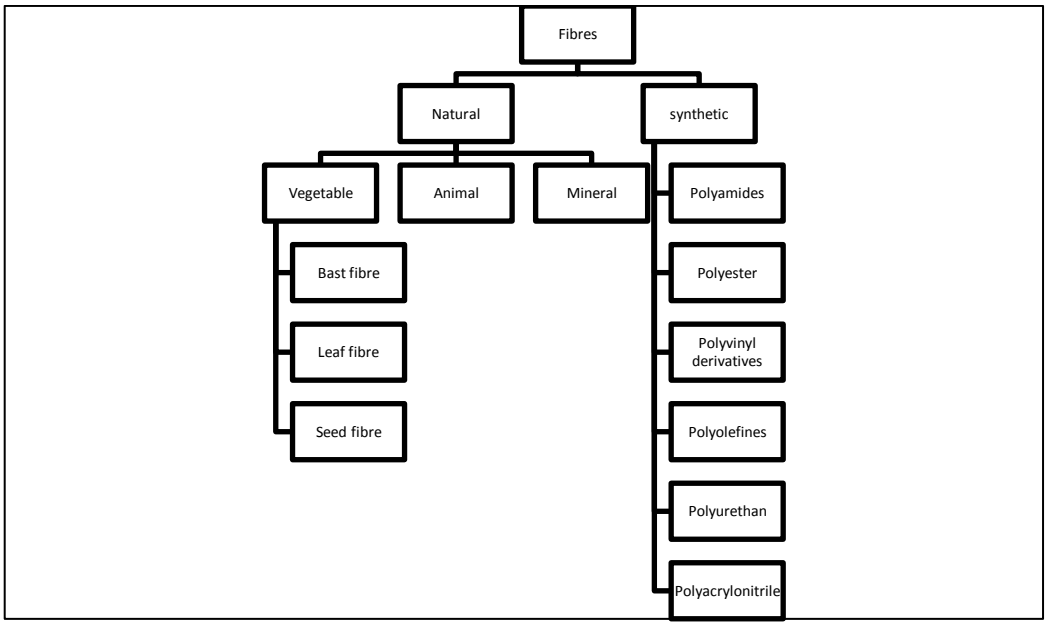

Figure 1.1: Classification of Natural and Synthetic Fibres

As a result bio composite material fibre is known as the next generation of sustainable material in which made up from the agriculture waste fibre product such as, coconut coir, rice husk, hemp and etc. Bio composite is made up of combination of eco-friendly materials such as, plant fibre mixed with natural resins or starch binders. A bio composite helps to remove non-renewable waste and reduce of raw material usage.

The use of bio-composite material as a substitute for synthetic material is vital for the future generation in order to preserve the environment and reduce the need for non-renewable resources. The natural fibres can be considered as naturally occurring composites consisting mainly of cellulose fibers embedded in lignin matrix also known as resin. According to (K.G.Satyanarayana, August 2011) coconut coir has more life compared to other natural fiber due to its high lignin content .The development of composite materials by using natural fiber as coconut coir with low thermal conductivity is an interesting alternative which would solve environment and energy concern. Hence, an investigation of coconut coir has been finding in order to utilize the coir fibre as reinforcement in a bio composite material.

1.2 Problem Statement

Malaysia is a nation that has huge productions of agricultural plantations for example, coconut fibre, rice husk and oil palm fibre. According to (Agamuthu, 2009) the global production of agricultural waste amounts to 998 million tons per year.

However particularly in Malaysia, the wastes disposed of these organic fibres are 1.2 million tons. As indicated by a study that has Ministry of Agricultural Malaysia the coconut fibre is one of the waste fibre due to the numbers of production. (Sivapragasam, 2014) had stated that Malaysia, faces the challenging of exporting the supply of the coconut processing sector inclusive of the husk ,shell ,wood and etc. Recycling the waste fibre is one of the best ways to treat agricultural waste.

This natural fibre expansion in the advancement of bio composite had been conducted by many researchers. It demonstrates that the majority of them highlighted the physical and mechanical properties of the bio composite as referenced by (Marimuthu, 2011). There are many researchers who conducted research using coconut coir. Besides that, the investigation of the mechanical properties on coconut coir reinforced polymer by conducting a test of tensile strength (Kattimani, Raikar, Nayakappa Patil, & Nandi, 2017). This proposed plan composition is mainly to decrease the utilization of mineral based fibres.

Along with this due to the increase of degradation of petroleum based polymer had gain the concern of the environment preservation therefore researchers have found a greater alternatives for these polymer that is a plant based starch. In general, starch is one of the most common natural compounds that can be found in many plants and pocket friendly that are used along with the formation of a bio-composite In this work cassava starch is added in the mixture of the composite to substitute the synthetic based polymer. Hence, with the properties of environmental friendly nature the use of natural based polymer helps to improve the living standard of an individual. Besides nowadays

the polyvinyl alcohol (PVA) is a modify polymer that is reinforced with the natural fiber. The PVA is added with the natural starch polymer to improve the properties of the matrix where the it will help to increase the mechanical properties, biodegradability and etc. (Yusof et al., 2018). Therefore in this investigation, the PVA is added with cassava starch is used as the biopolymer for the matrix and coir fiber as the reinforcement in bio composite to create a composite by identifying the mechanical properties of these materials.

1.3 Objectives

i. To investigate the mechanical properties of bio composite in different composition of natural fibre, starch and polyvinyl alcohol (PVA).
ii. To investigate the factors that affects the mechanical properties of bio composite in different composition of material substance.

1.4 Scope

Based from the objectives, the study stated more specific to observe the critical point in this investigation. Therefore the scopes that includes are:

a) To investigate the mechanical properties using tensile and impact test.

b) To investigate the factors that affects the material by using the full factorial design of experiment.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction of composite

A composite is a type of material when two or more material are combined to form a well-produced material with a better characteristic in order to achieve with a greater influence of physical and mechanical properties of a material (Tornabene, 2017).There are two types of composite can be categorized such as man-made or synthetic composite and bio composite. Generally, improvement of a composite material will provide to the improvement of durability properties such as stiffness, strength, fatigue life, corrosion resistance and etc. The formation of synthetic composites has developed to ordinarily join a basic fiber and a plastic, this is known as fiber Reinforced Plastics. The straw like fiber, gives the structure and quality of the composite. However, while a plastic polymer holds the fiber together. Apart from that the application of this composite material most widely recognized at construction area. For example in these needs of basic steel rebar or know as steel reinforcement gives the quality and solidness to the solid, while the restored bond holds the rebar stationary. The steel reinforcement also known as “Rebar” has the potential to flex excessively and concrete alone would break effectively. On the other hand, the bio-composite material can be reinforced with natural fibers which are more economical and ecological friendly in comparison with a fiber reinforced with plastic. Therefore, it shows that with the potential properties of a composite material where it is suitable for all sort applications

of building construction, fabrics automotive, transportation, aerospace and many other more.

2.2 Introduction of Bio - Composite

Bio composites reinforced fibres are divided into non-wood fibres and wood strands as shown in Figure 2.1 below which generally consisting of cellulose and lignin. (Faruk, Bledzki, Fink, & Sain, 2012) had stated that due to their wide availability, the reinforced natural fibre of bio-composite increased demand and increased awareness of renewable resources as environmental sustainability.

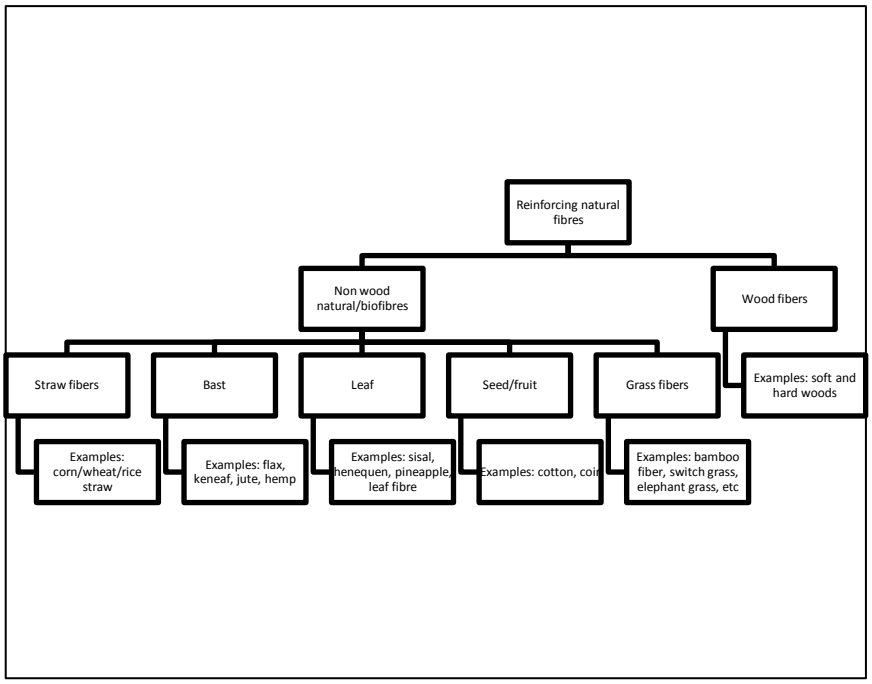

Figure 2.1: Classification of bio composite reinforced fibre materials

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