UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATION OF RICE HUSK CONTENT TO THE MECHANICAL PROPERTIES OF NATURAL COMPOSITE USING 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 Technology) with Honours.

by

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……

(EN. MOHD HARRIS FADHILAH BIN ZAINUDIN)

ABSTRAK

Tujuan kajian ini dijalankan adalah untuk mengkaji dan menganalisis satu komposisi baharu yang diperbuat daripada campuran bahan semula jadi seperti hampas padi, kanji dan alcohol polivinil (PVA). Hampas padi ialah bahagian dari bulir biji padi yang merupakan lembaran yang kering, bersisik dan tidak dapat dimakan. Ia berfungsi untuk melindungi bahagian dalam padi. Selain itu, campuran antara hempas padi dan kanji yand dicampur bersamaan dengan PVA dijadikan sebanyak 8 specimen dengan berbagai komposisi. Untuk menjalankan eksperimen ini, ciri-ciri yang terperinci mengenai hampas padi dan kuantiti hampas padi yang akan digunakan perlu diketahui. Spesimen ini disediakan dengan meletakkan campuran antara serbuk hampas padi, 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 yan dipengaruhi dari segi jumlah campuran yang digunakan sepanjang eksperimen ini.

ABSTRACT

The purpose of this study was to study and analyze a new composition made from a mixture of natural ingredients such as rice, starch and alcohol polyvinyl (PVA). Rice paddy is part of the grain of rice that is dry, scaly and inedible. The function of rice husk is to protect the inside of rice. In addition, a mixture of rice 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 paddy seizures and the quantity of rice to be used should be known. This specimen is prepared by placing a mixture of rice husk powder, thermoplastic starch and polyvinyl alcohol into the mold. This experiment that involves in this research is are tensile and impact test. The design of experiment (DOE) method will clarify and verify the properties and characteristics of mechanical that will affect in this experiment. The results of the experimental design will explain and verify the mechanical properties that are influenced by the amount of mixture used throughout the experiment. In the conclusion, the results shows that highest level of thermoplastic starch and followed by rice husk plays an important role in determining the maximum tensile strength.

DEDICATION

A special thanks to my beloved family for being very supportive to me in my research. A part of this success also dedicated to my supervisor Encik Harris Fadhilah Bin Zainuddin for the guide during my research. Last but not least, thank you to all my friend.

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PVA	Polyvinyl Alcohol	4
DOE	- Design Of Experiment	4
TPS	Thermoplastic Cassava Starch	4
FRP	Fibre Reinforced Polymer	6
SEM	Scanning Electron Microscope	53

CHAPTER 1
INTRODUCTION

1.1 Background

In present days, most industries are currently facing problems due to its high energy usage during the processing phase, depletion of raw materials and high raw and semi-finished material costs. In order to overcome these problems, researchers have focused in the direction of providing agricultural residue and plant waste fibers. (Mittal & Chaudhary, 2018). Fibers are a substance from plants, minerals and animals that is naturally found or inorganic. The most important category of fibers is natural and synthetic. According to R. Yahaya, (2016), natural fibers are mainly based on animals, plants and minerals, and synthetic fibers are chemically enriched with fiber structure and composition.

Barely there are hundred million tons of rice paddy are harvested and planted annually. Based on table 1.1 below, an information data which gained from the Food and Agriculture Organization of the United Nations displays that rice production is rising annually.

Table 1.1: Production of Rice Paddy (Worldwide)

Year	Total Amount (million tons)
2010	701 million tons
2011	722 million tons
2012	734 million tons
2013	740 million tons

The paddy's outer shelter is known as rice husk, which covers the paddy's weight by up to 20-25%. The production of rice paddy in Malaysia is 2,4 million tons in 2010, 2,5 million tons in 2011 and 2,6 million tons in 2012, mentioned by United Nations Food and Agriculture Organization. As the demand for rice paddy increases therefore approximately 0.52 tons huge amounts of rice husk, an agro-waste is produced annually. In the meantime, because of its abundance, this causes the environmental problem into disposals such as agro-waste. In general, rice husk will be burned in exposed air or sent to land fill, but both methods will generate additional production of atmospheric carbon dioxide. (Kartini, 2011). One of these is to rescue the spin-off generated from industrial manufacturing events and agricultural which results into rising request for structural material that has become a concern for public and related industries. Examples from agricultural sources for agro-waste are rice husk, jute fiber, coconut husk, and so on. (Maduwar, Ralegaonkar & Mandavgane, 2012) These agro-wastes able to renew into a practicable structure materials. Reprocess of such agro-waste will not only astounded environmental pollution, a shortage of structural materials, yet in the agro-waste disposal problem.

The main advantages of natural fiber composite are its low specific weight, resulting in greater specific strength and rigidity than synthetic fiber (D. Chandra, 2003). It is a source of renewable energy as production which requires little energy and carbon dioxide is used while oxygen is returned back to the environment. Thus, with low investment, it can deliver at low cost, making the material a remarkable invention for low-wage countries.

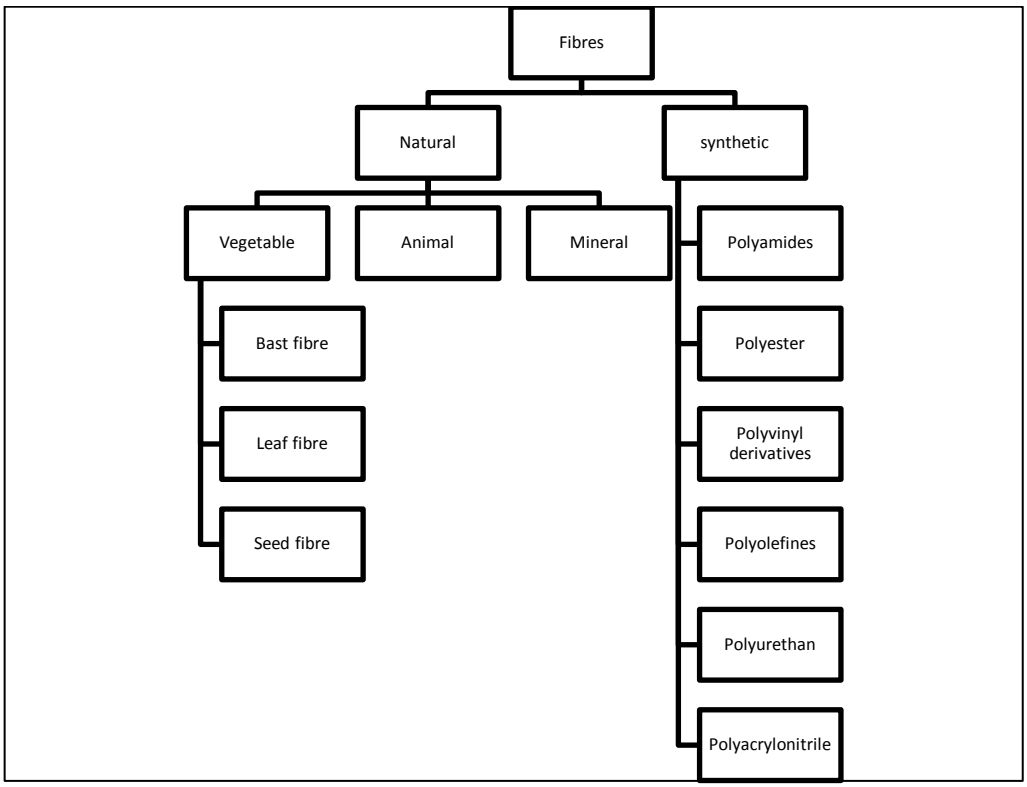

Figure 1.1: Classification of Natural and Synthetic Fibres. (Source: D. Chandra, 2003)

1.2 Problem Statement

A composite is a basic material which contains of two or more combined elements (matrix and reinforcements) at a macroscopic level and insoluble to one another. In order to meet the environmental adaptation, both matrix and reinforcement need to be fully biodegradable as to avoid from further obliteration of the environment. Increasing concern about global warming and depleting reserves of petroleum has been investigating the use of bio-composite materials such as rice husk, coconut fiber, sisal, jute and kenaf to give extra concern. (Mittal & Chaudhary, 2018). Natural fiber reinforcement in composites has recently attracted attention due to environmentally friendly, fully biodegradable, renewable, low cost, easy availability, increased energy recovery, light weight and recyclable in nature. The major applications of natural fibers are in automobile, packaging, building and construction, railway coach interiors, storage devices and partition wall cabinets are due to its wide variations of beneficial properties such as light weight (low density),

cheaper source, good specific strength and modulus, biodegradability, high level of stability, non-carcinogenic and lack of health hazards. (Bharath & Basavarajappa, 2016)

Rice husk is one of the most widely available agricultural waste in many rice-producing countries around the world that consumed rice. Comprehensively, about 600 million tons of rice paddy are produced throughout the world every year. On average, 20 percent of rice paddy consisting of husk, resulting in an annual total production of 120 million tons. (Kumar, Mohanta, Kumar & Prakash,2012). In most rice-producing countries, almost all of the husk produced from rice processing is either burned or dumped as waste. Therefore, by disposing rice husk through burning leaves a residue in the ambient atmosphere, called rice husk ash. Its adsorbent and protective properties are beneficial as a reinforcing agent in structure materials for many industrial applications. (Kumar et al., 2012).

In general, starch is one of the most common natural compounds that can be found in many plants. Bio starch is the most common binder in the tablet formulation which is a non-chemical product such as corn, tapioca, sweet potato and cassava starch.

Steadily, cassava changes from being the staple food for human consumption to becoming an effective industrial crop, mostly evolving Asian economies. Besides that, when being compared to other starchy staple crops, cassava starch owes part of its popularity due to its high rate of converting solar energy to starch per unit area. (Hershey & Howeler, 2018). This study will focus on investigation of natural composite mechanical properties made of rice husk and thermoplastic cassava starch (TPS) and PVA Furthermore, it will use design of experiment (DOE) method in obtaining the weight amount of each method. Therefore, using natural based polymer helps to improve an individual's living standards with the properties of environmentally friendly nature. Thus, this will help to reduce the need for chemicals that harm the environment.

1.3 Objective

According to the background and ı 4 statement that has been stated, the objectives of this experiement are:

i. To develop a new bio composite material using rice husk as a reinforcing agent and thermoplastic cassava starch (TPS) with polyvinyl alcohol (PVA) as a matrix.
ii. To investigate the factor that affect the mechanical properties of natural composite using different material parameter by analyzing through DOE method.

1.4 Scope

From the above-mentioned objectives, the investigation becomes increasingly explicit as to provide a clearer perspective on the fundamental focuses. Scope of the studies includes:

i. Implementing (DOE) method to find the optimum weight of rice husk and matrix which affect the mechanical properties.
ii. Testing the mechanical properties of specimen by using ASTM D256 for impact while ASTM D638 for tensile test.
iii. Evaluate the factor that affect the mechanical properties by using statistical tool.

CHAPTER 2
LITERATURE REVIEW

2.1 Composite

Composite is essentially a material made of two or more different materials that, when combined, are stronger by themselves than those individual materials as stated by (Leong Tuck Lun, 2015). The development of today's engineering materials can be clearly seen in the use of composite materials in different industries. Composite can be found very easily as wood, coconut and more can be collected by nature. Composites are made of a polymer matrix manufactured for reinforcement, synthetic, natural fiber or other material. The matrix protects the fibers from environmental and external damage and passes the weight between the fibers. In turn, the fibers provide strength and rigidity to enhance the matrix and help it endure flaws and ruptures. Polyester resin is used as a matrix in many of the products meanwhile, glass fiber is remarked the reinforcement. However, composites of fiber-reinforced polymer (FRP) that include fillers, additives, core materials or surface finishes designed to improve the process, appearance and quality of the final product.

2.2 Bio Composite

Bio composites are defined as composites that are environmentally friendly as mentioned by (Kazutoshi Haraguchi, 2014). Besides that, bio composites involving a wide range of organic and inorganic components, including natural and synthetic polymers, polysaccharides, proteins, sugars, ceramics, metals, and nano-carbons. Bio composites derived in various forms including films, membranes, mouldings, coatings, particles, fibers

and foams. A large number of studies have been carried out to develop composite that is environmentally friendly.

2.2.1 Properties of Bio Con 6

Bio composite fibers are generally long strands with a high content of cellulose, which transmits a high degree of elasticity and cellulose crystallinity. It is listed as a cheap, renewable source and is entirely recyclable in some cases. One advantage of natural fibers is its low density, which results in higher tensile strength and stiffness compared to glass fibres. Bio composites could therefore be a viable sustainable alternative to composites manufactured from wood, glass and man-made fibres, in addition to their lower production costs. (VP Della, 2002) It is recognized as a class of materials that can be handled easily and therefore suitable for a wide range of applications such as packaging, construction, automotive, aerospace, military applications, electronics, consumer products and medical industries.

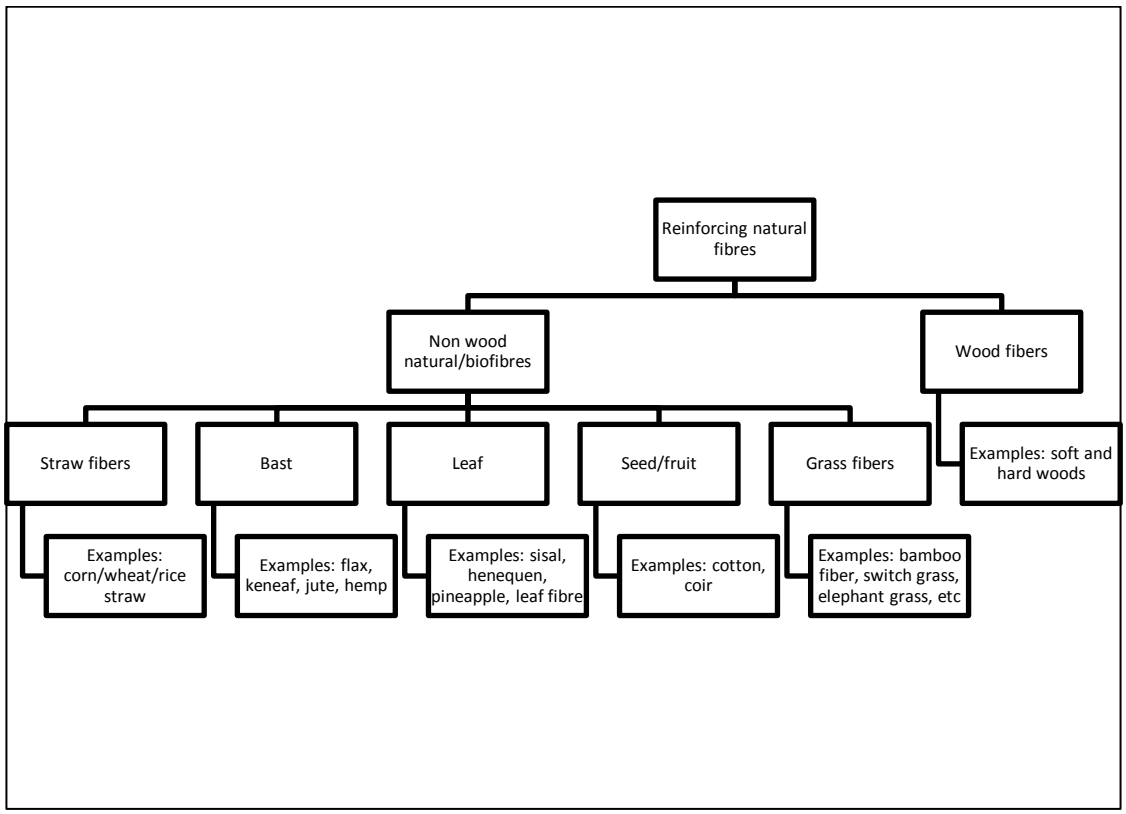

Figure 2. 1: Application of bio composite materials. (Source: Kazutoshi Haraguchi, 2014)

2.2.2 Mechanical Properties Of Bio Composite

Bio based composites are promising materials for future applications of automotive industry. The challenge of making automotive products lighter, safer and cheaper. Besides that, a composite material is a combination of two different materials with distinct properties that are commonly made with the reinforcement of a matrix structure. The most common matrix materials are thermoset or thermoplastic resins such as polyester, epoxy and vinyl ester. The most common reinforcement agents are carbon, aramid and glass fibres. Besides that, composites materials also may contain additives, core materials or fillers, and have different properties than conventional materials that are used to manufacture. The main dissimilarity is that the properties change the path of the load applied. The foremost benefit of the composite materials is the ability to alter the properties as required by design. Composite materials can be produced lighter and safer compared to its traditional counterparts. (M Rubinstein, (2003)

2.3 Natural Fibre Composites

Natural composites derived from both plants and animals. Natural fiber composites are now popular in research and innovation. Building industry is the largest consumer of composite materials. This is due to the natural fiber composites identified as options that may have a lower impact compared to other synthetic composites. Natural fiber composite is considered to have less impact on the environment than glass fiber, and composite material is more environmentally friendly than glass fiber. The use of natural fiber can also reduce environmental pollution, which will cause considerable damage to our earth compared to the base polymer content. Natural fiber composites are composite materials in which, as mentioned by (Loh et.al, 2016) at least the reinforcing fibers are resultant from renewable and carbon dioxide neutral resources like wood or plants. A key advantage of natural fiber composites over traditional materials is often cited as environmental and biological durability. In many industry applications, the uses of natural fiber composites are also unfamiliar and a complete understanding of their durability has yet to be achieved.

2.3.1 Rice Husk

Figure 2.2: Rice husk