UNIVERSITI TEKNIKAL MALAYSIA MELAKA

A study on material of book rack fabricated from biocomposite Kenaf fiber-based

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

by

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DECLARATION

I hereby, declared this report entitled “A study on material of book rack fabricated from biocomposite Kenaf fiber-based” is the results of my own research except as cited in references.

Signature :
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Date :

APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology (FTKMP) of UTeM as a partial fulfillment of the requirement for the degree of Bachelor of Mechanical Engineering Technology (maintenance Technology) with Honours. The member of the supervisory is as follow:

…….

(MOHD AFDHAL BIN SHAMSUDIN)

ABSTRACT

The purpose of this research is to fabricate the material of biocomposite Kenaf fiber based and determine the mechanical properties of the material. The waste product based on synthetic material is negative contribution for environment and humankind future. The effect for the excessive synthetic material consumption may lead to the global warming that cause by the way of the waste material disposed. Kenaf or its scientific name Hibiscus cannabinus L. is natural fiber that has good mechanical properties and can grow quickly in its season. It is the plant fiber that have a potential to replace the synthetic fiber for production of biocomposite. Composite material composed a matrix as the binder to the fiber reinforcement. The matrix material of the biocomposite used is mixture of epoxy resin and clay and embedding the reinforcement of Kenaf fiber. There were 42 sample of biocomposite material with different composition prepared. The sample prepared by hand layup method. The sample of three layers were prepared by combining the mixture of epoxy resin and clay with the Kenaf fiber. The fiber was located in the middle of the sample layers. The samples have tested by two mechanical test to obtained mechanical properties of the biocomposite which were Tensile test and Flexural test. All the tests carried out were according to the standard of ASTM D3039 and ASTM A790. The result of mechanical properties were used for analyzing to decide the best composition which was the sample reinforced by 30% Kenaf fiber have the optimum value after static analysis from Solidwork by certain loaded. The last step was the fabrication for scale model of book rack. Therefore, both objective of this project have been achieve which the composite for fabricate book rack by tested and analysed.

ABSTRAK

Tujuan penyelidikan ini adalah untuk mencipta bahan biokomposit Kenaf berasaskan serat dan menentukan sifat mekanik bahan. Produk sisa berasaskan bahan sintetik adalah sumbangan negatif terhadap alam sekitar dan masa depan manusia. Kesan penggunaan bahan sintetik yang berlebihan boleh membawa kepada pemanasan global yang disebabkan oleh cara bahan buangan dilupuskan. Kenaf atau nama saintifiknya Hibiscus cannabinus L. adalah serat semulajadi yang mempunyai ciri-ciri mekanik yang baik dan boleh tumbuh dengan cepat pada musimnya. Kenaf adalah tumbuhan yang mempunyai potensi untuk menggantikan serat sintetik untuk pengeluaran biokomposit. Bahan komposit terdiri daripada matriks sebagai pengikat kepada penguat gentian. Bahan matriks biokomposit yang digunakan adalah campuran epoxy resin dan tanah liat serta penanaman pengukuhan serat Kenaf. Terdapat 42 sampel bahan biokomposit dengan komposisi yang berbeza disediakan. Sampel disediakan melalui kaedah “hand layup”. Sampel yang dihasilkan mempunyai tiga lapisan disediakan dengan menggabungkan campuran resin epoksi dan tanah liat dengan serat Kenaf. Serat terletak di tengah-tengah lapisan sampel. Sampel telah diuji oleh dua ujian mekanikal untuk memperoleh sifat mekanik biokomposit iaitu ujian tegangan dan ujian pembengkokkan. Semua ujian yang dijalankan adalah mengikut piawaian ASTM D3039 dan ASTM A790. Hasil sifat mekanik digunakan untuk menganalisis untuk menentukan komposisi terbaik. Sampel yang diperkuat dengan 30% Kenaf serat mempunyai nilai optimum setelah analisis statik dari Solidwork. Langkah terakhir adalah fabrikasi untuk rak buku. Konklusinya, kedua-dua objektif projek ini telah dicapai yang komposit untuk rak buku fabrikasi dengan diuji dan dianalisis.

DEDICATION

To my beloved parent Mr. Jamil bin Abdullah and Mrs. Rosmawati binti Iram. The people that always help and give me advices Mr. Mohd Afdhal bin Shamsudin, my supervisor and all stuff of UTeM that invole either direct or indirect in my project. Lastly, my amazing friends that support me for accomplish my project in the date that have been decided.

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TABLE OF CONTENT

LIST OF TABLE

LIST OF FIGURE

LIST OF APPENDICES

LIST OF SYMBOLS

ASTM	-	America Society for Testing and Material
C	-	Celsius
GPa	-	Giga Pascal
Mm	-	Milimeter
MPa	-	Mega Pascal
N	-	Newton
wt	-	Weight

Chapter 1
INTRODUCTION

1.1 Background of study

The first modern composite was introduced by Owens Corning in 1935 which was fiberglass when the combination of a plastic polymer creates an incredibly strong structure that is also lightweight (Nagavally, 2016). However, due to environmental issue created an idea for the researchers to produce biocomposite which uses the natural fiber as reinforcement. There are several researches that related to the production and development of biocomposite such as pineapple peel fiber based biocomposite for green packaging (R. R. Ali et. al., 2015),biocomposite from oil palm resources (Khairiah badriI and Khairul Anuar Mat amin, 2006), and bagasse fiber reinforced biocomposite (A. Balaji et. al., 2015). The biocomposite act as a replacement material for certain material that apply in the manufacturing produce of furniture, decking, partition wall, flooring, car component and sport equipment (A. Balaji et. al., 2015).

The Egyptians and Mesopotamian settler for the first time used a mixture of mud and straw as a material to create a composite for strong and durable building in 1500 B.C. In 1200 B.C, Genghis Khan, a King of Mongol Empire was invented a great military weapon which is the first composite bow using the combination of wood, bone, and animal glue (Nagavally, 2016).

As an alternative to synthetic materials, the increase in population of natural resources are being exploited substantially. As the result, more attention has been paid to the use of natural fibers to strengthen the composite. Natural fiber composite is not a new concept, it has been in existence since the early 1900 but has received little attention until late in the 1980. Based on Babatunde et al. (2015), Kenaf fiber is a natural fiber that have the future possibility to replace the synthetic fiber as reinforcement in composite. In term of strength properties, natural fiber is not as great as glass. However, the use of natural fiber widely in composites because of the relatively low production costs, low weight, correct strength, good mechanical structures and resistance to fatigue (J. Praveenkumara et. al., 2017).

The manufacturing of biocomposite happen when social concern of global environment, high percentage of exhaustion of petroleum resources, and the research carry out due to environment regulation (K. N. Bharath and S Basavarajappa, 2016). Biocomposite is a material that consist of matrix polymer and natural fiber as reinforcement. V. Ojijo and S. S. Ray (2014) identifying that the development and application of biopolymer in manufacturing industry is one of the important solution to the pollution of environment caused by use of non-biodegradable polymer. Possibility to overcome brittleness, stiffness and hardness of a polymer material made a biocomposites were important in the evolution of engineering materials. By having a light weight, high strength-to-weight ratio and stiffness properties, composite material was an option of replacing the conventional materials like metal and wood (V.S. Shinvankar and Bhangwat Joshi, 2015).

1.2 Problem statement

Plastic is made up of wide range of synthetic or semi- synthetic organic substances which usually synthetic derived from petrochemical based (Rinku Verma et. al., 2016). The production of product by synthetic material arise in few decades. The advantages of the synthetic material provide a lot of contribution in industry. Based on Comanița et. al. (2016), the production of plastic in the world attained about 311 million tons since 1950 until 2014. However, the production of the synthetic material give some negative effects to environment and health effects for the people. It is happening when the waste or any product made from synthetic material need to dispose. The plastic waste disposal is a major worldwide problem for the developed country like in Europe, United State of America and Japan. They produced about 50 million tons of post-consumer plastic waste annually (H.I. Abdel-Shafy and M.S.M. Mansour, 2018). Incineration of plastic waste is one of the disposal method which can be applied for energy recovery, but plastics combustion can generate emissions which contribute to global warming even might produce toxic or hazardous gases (Comanița et. al., 2016). Those gases can threat the environment and also people health.

The manufacturing of furniture from synthetic material is not categorize as ecological products. The manufacturing of furniture that use chemical materials like finishes, paint and glue can contribute to the air pollution that caused by gases which are emitted by the wooden furniture saturated with chemicals. The production of furniture also include the usage of synthetic material that issues the highly toxic gases as well (I. Valentiniene and G. Pilkis, 2017). This problem is a threat for human being and environment. By using the natural fiber composite, the problem of the pollution would be reduced due to the ecological characteristics of the natural fiber. Kenaf fiber composite is the composite that compose the natural fiber that not just reduced the dependency of the synthetics material for manufacturing process, it also can improve the mechanical properties of the material which are high heat resistance, acceptable strength properties, lower cost (M.R. Ishak et. al., 2009).

1.3 Objective

Based on the background and problem statement, there are two objectives for this research.

1. To fabricate the material of biocomposite Kenaf fiber based
2. To determine the mechanical properties of the material

1.4 Scope of study

The objective of the study have been elaborated to the several scopes.

1. Fabricating the material of natural fiber reinforced biocomposite from Kenaf fiber with epoxy resin and clay
2. Determining the mechanical properties of the material by using tensile test, Flexural test according to ASTM D3039 and ASTM D790.

Chapter 2

LITERATURE REVIEW

2.1 Composite Material

Composite material is a material that contain two or more constituent materials with various physical and mechanical properties also distinct on macroscopic level within the finished structure. There are two categories of constituent material which main component that consist in the composite material or known in phase of reinforcement or filler and matrix or binder as shown in Figure 2.1. The matrix is continuous phase that hold the reinforcement and transfer a stress to it while the reinforcement is discontinuous phase where the improvement of mechanical properties of a composite based on this reinforcement Asit Sahoo (2011).

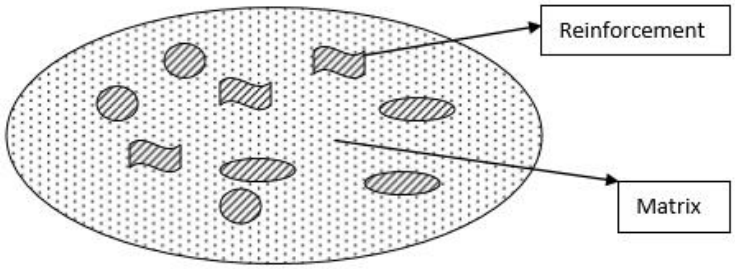

Figure 2.1: Structure of composite (A. Sahoo, 2011)

There are classifications of composite materials based on reinforcement form which consists three type; particle-reinforced, fiber-reinforced, and structural composite in Figure 2.2.

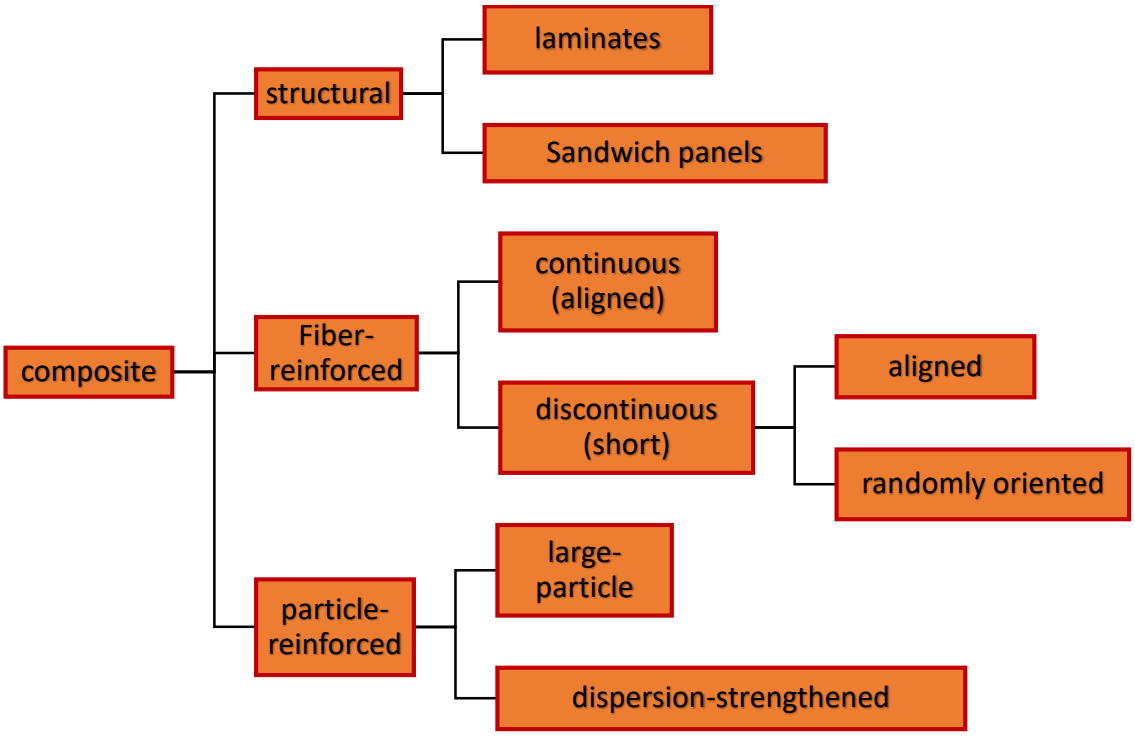

Figure 2.2: A classification of composite (William D. Callister, Jr., 2007)

Fiber reinforced composite are divided to two category that related to the fiber length which are continuous (aligned) and discontinuous (short). The orientation of the fiber reinforced composite influenced the mechanical properties of the composite (R. R. Nagavally, 2016). The discontinuous fiber reinforced divided to discontinuous with aligned fiber composite and the other one is discontinuous with randomly oriented fiber composite. According to William D. Callister (2007), the comparison of reinforcement efficiency for discontinuous composite is lower than the continuous fibers. However, the value commercial of discontinuous with aligned fiber composites increasing in market for example the chopped glass fibers are used most extensively and aramid discontinuous

fibers are also employed. It about 90% of moduli of elasticity and 50% of tensile strength of short fiber composites can be produced of their continuous fiber counterparts.

Based on the Figure 2.2, large-particle and dispersion-strengthened composites are fall in the particle-reinforced composites classification. The reinforcement or strengthening mechanism are the different of the particle-reinforced composites classification. The reinforcement of particle used in composite have varies function and impact on the matrix material. The highest toughness strength will achieved if the matrix is ductile and the particle reinforcement is brittle while the high strength and stiffness material obtained if the situation in vise versa (Islam,et. al., 2018). For most of these composites, the particulate phase is harder and stiffer than the matrix. The mechanical properties improvement is depends on the strength of bonding at the matrix–particle interface. While for dispersion-strengthened composites, the size of particle is smaller with diameters between 10 nm and 100 nm. So, the strength of degree of the atomic or molecule will increase when the particle and the matrix interaction happen (William D. Callister, 2007). For the laminar composites, it is composed of layers of materials held together by matrix. Sandwich structures fall under this category.

The characteristic of composite material show the wide application of this material in industry. According to A. Sahoo (2011), the most important feature of composite that contribute to the industry are light weight, high strength, high resistance of corrosion and chemical, and high elasticity. Fiber reinforced polymer (FRP) is one the composite material that compose the fiber reinforcement and matrix. In the research of D. U. Shah (2013), fiber is providing strength and stiffness to the composite while the matrix act as protection and transmit external load of shear stresses at the interface to fiber reinforcement. The application of composite very significant nowadays. The high stiffness, high strength, improved fatigue life, high resistance to corrosion and light weight are the feature that very needed and high demand for the industry of aerospace,

manufacturing, telecommunication application, offshore application, armor system, and smart memory hybrid composite Islam et. al. (2018).

2.1.1 Biocomposite

Biocomposite also known as natural fiber composite is a composite material made up from two component which are matrix and natural fiber as reinforcement. N. Navaranjan and T. Neitzert (2017) stated in their research stated that the material of matrix phase of natural fiber composite or biocomposite are polymer reinforced by cellulose-based plant fiber. The dependable of the biocomposite properties is not just focusing to its properties of constituent component, distribution, and the interaction between two phase but it also affected by other factors. There are fiber geometry, fiber orientation, packing arrangement volume of fiber fraction (D. Saravana and G. C. Mohan Kumar, 2010).

The fabrication of biocomposite for the application in industry show a lot of good impact. It is assisted by the advantages of the biocomposite which are high specific strength and high modulus, reduced density of products, lower cost, corrosion resistance, high creep resistance, high toughness, biodegradable and some of the biocomposites can have much higher wear resistance than metals. They are also eco-friendly materials at the stage of production, processing and waste with annual renewability and lower energy inputs in production per unit. (A. Balaji et. al., 2015). It is also claimed to offer environmental benefits such as reduced dependence on non-renewable energy or material sources, lower pollutant emissions, lower greenhouse gas emissions, increased energy recovery and biodegradability of components end of life (S. V. Joshi et. al., 2003).