THE EVALUATION SIZE OF KENAF FIBRE REINFORCED WITH PLA COMPOSITES SUBJECTED TO TENSILE AND THERMAL PROPERTIES BY USING ANSYS SOFTWARE.

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This report is submitted
in fulfillment of the requirement for the degree of
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DECLARATION

I declare that this project report entitled "The Evaluation Size of Kenaf Fibre Reinforced with PLA Composites Subjected To Tensile and Thermal Properties By Using Ansys Software." is the result of my own work except as cited in the references.

Signature : ....

Name : ....

Date : ....

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

Signature : ....

Name of Supervisor : ....

Date : ....

DEDICATION

To my beloved mother and father.

Thanks to the non-stop encouragement and guide given by my honourable supervisor, Dr. Nadlene Binti Razali, I am able to complete the task successfully.

ABSTRACT

Through the future, natural fibers are used as an alternative resource especially for environmental issues but then over the past few years, kenaf plants have been widely exploited among the different types of natural resources. The natural fibers have been able to gain both economic and environment-friendly. This research presents the effect of fiber size on mechanical and thermal properties of kenaf fiber reinforced PLA composites by using ANSYS software. The purpose of this project is to evaluate the effect of fiber size on the mechanical and thermal properties of kenaf fiber reinforced PLA composites by using ANSYS software. In order to evaluate the effect size of fibre, 4 parameters have been set. An updated three-dimensional finite element model was developed in the Solidwork 2020 to determine the characterization of the composites under functionally suitable loading conditions. Past researcher has conducted different fibre length and different fibre loading orientations, including different materials widely used in developing countries. The meshing process is important and it indicates a good result between fibre and matrix which improved the mechanical and thermal properties of the composites in the simulation analysis. The best size of fibre was determined in this research for the performance of mechanical and thermal properties of the composites.

ABSTRAK

Menghampiri kemasa depan, serat semula jadi digunakan sebagai sumber alternatif terutama untuk masalah alam sekitar tetapi kemudian sejak beberapa tahun kebelakangan ini, tanaman kenaf telah dieksploitasi secara meluas di antara pelbagai jenis sumber semula jadi. Serat semula jadi dapat meningkatkan ekonomi dan mesra alam. Penyelidikan ini menunjukkan pengaruh saiz serat terhadap sifat mekanikal dan termal komposit PLA bertetulang gentian kenaf dengan menggunakan perisian ANSYS. Tujuan projek ini adalah untuk menilai kesan ukuran gentian terhadap sifat mekanik dan terma komposit PLA bertetulang gentian kenaf dengan menggunakan perisian ANSYS. Untuk menilai ukuran kesan serat, 4 parameter telah ditetapkan. Model elemen hingga tiga dimensi yang dikemas kini dikembangkan dalam Solidwork 2020 untuk menentukan pencirian komposit dalam keadaan pemuatan yang sesuai. Penyelidik yang lalu telah melakukan panjang gentian yang berbeza dan orientasi pemuatan serat yang berbeza, termasuk bahan yang berbeza yang banyak digunakan di negara-negara membangun. Proses pemasangan adalah penting dan ia menunjukkan hasil yang baik antara serat dan matriks yang meningkatkan sifat mekanikal dan termal komposit dalam analisis simulasi. Ukuran serat terbaik ditentukan dalam penyelidikan ini untuk prestasi sifat mekanikal dan haba komposit.

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I would like to thank Dr. Nadlene binti Razali, she was act as my Projek Sarjana Muda supervisor. Without her guidance and assistance, I would not have a clear path on how to engage this project successfully.

Additionally, I would also like to thank all lecturers, staffs and coursemates that were involve in accomplishing this Projek Sarjana Muda. Finally, warm appreciation to our parents with their moral supports and encouragement throughout the Projek Sarjana Muda timeline.

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LIST OF ABBEREVATIONS

PLA	Polylactic Acid
PMCs	Polymer Matrix Composites
NaOH	Sodium Hydroxide
ASTM	American Society for Testing and Materials
TGA	Themogravimetric Analysis
PCL	Polycaprolactone
PHB	Polyhydroxy Butrate
ANSYS	Analysis System
FDM	Finite Different Method
FEM	Finite Element Method
FVM	Finite Volume Method

LIST OF SYMBOLS

σ	=	Stress
ε	=	Strain
M	=	Mass
ρ	=	Density
V	=	Volume
W	=	Weight
F	=	Force
A	=	Area
t	=	Time
°C	=	Degree Celcius
mm	=	Milimetre
GPa	=	Giga Pascal
MPa	=	Mega Pascal
kPa	=	Kilo Pascal
g	=	Gravity
ℓ	=	Length
w	=	Width
h	=	Height
E	=	Young's Modulus
%	=	Percentage
L	=	Length

CHAPTER 1

INTRODUCTION

1.1 Background

In the recent study, the researcher have considerable interest on biopolymers as a replacement for petrol synthetic polymers. Poly (lactic) acid (PLA) is biodegradable aliphatic polyester, which can be fabricated by fermentation of renewable resources such as corn, cassava, potato and sugarcane. Compare to other polyesters, PLA has perfect attributes such as in mechanical properties it have a high strength, high modulus, biodegradability, biocompatibility, bio absorb ability, transparency, energy savings, low toxicity and easy process ability. In addition, PLA has a wide variety of uses such as agricultural films, biomedical instruments, packaging and the automobile industry. Furthermore, PLA also has given significant attention of films or coatings in food packaging applications.

However, because polymer composites are usually comprised of two or more components, it is cost-intensive to separate the components for recycling purposes (Pickering *et al.* 2016). The most common approach for disposing of polymer composites is currently by landfill and incineration, and both approaches have a major effect on the environment. So that, the main issue is the traditional polymers are used as a matrix in composites, such as polyethylene and polypropylene that substances are not biodegradable. In addition, the production of these polymers are dependent on non-renewable resource as we known such as petroleum.

In addition for a better life quality, there an alternative way to produce composite by substituting the components in the composites with materials that have lower environmental impact. These components are also referred to as green composites and are typically constructed from natural fibres as reinforcements and bioplastics as matrixes. PLA as known as Polylatic Acid is a kind of biocompatible and biodegradable polymer with a wide range of applications. However, its applications are limited by its slow crystallization speed and brittleness to some extent. In order to overcome disadvantages of these PLA, a number of studies have shown that the addition of natural fibres such as flax, hemp, jute (kenaf fibre) and sisal is an effective and useful method of reinforcement.

Natural fibres, whether derived from plants, animals or rocks, are subdivided according to their source. According to group researcher, plant fibers are the most popular of the natural fibers, used as reinforcement in fiber reinforced composites. Plant fibers include bast (or stem, soft, or sclerenchyma) fibers, leaf or hard fibers, seed, fruit, wood, cereal straw, and other grass fibers. Kenaf is one of the natural (plant) fibers used as reinforcement in Polymer Matrix Composites (PMCs). Kenaf (Hibiscus cannabinus, L. family Malvacea) has been found to be an important source of fiber for composites, and other industrial applications. Natural fibers were introduced with the intention of yielding lighter composites, coupled with lower costs compared to existing fiber glass reinforced polymer composites.

Lastly, the overall characteristics of kenaf fibre reinforced composites, in terms of mechanical properties, thermal properties and water absorption properties, will be reviewed in this technical review paper. Moreover, the manufacturing processes will be discussed and the key technical issues that need to be solved in the future. So that, in order to publish review articles and even books on the overall properties of natural fibre reinforced composites, the authors concluded that a particular review paper on the overall properties of composites reinforced with kenaf fibre was not yet written, it is assumed that such an article should be of great importance to the composite research community.

1.2 Problem Statement

In the past ten years, Industrialization has been one of the key contributors to emissions throughout history, disregarding environmental concerns, resulting in an unsustainable model of development. The imminent modern business paradigm called the Fourth Industrial Revolution or Industry 4.0, a transition from this context, strives for a supply structure that is simultaneously viable and sustainable. Scientific work illustrates the benefits of a modern business paradigm, such as enhanced product life cycles, automated manufacturing with the use of cyber-physical structures linked to the concepts of this industry, which contribute to greater adaptability to the availability of natural resources and environmental costs. Smaller lots will contribute to a more precise response to the demand curves and ultimately will minimise waste of product.

On this days, the increasing numbers of researchers are more focusing on natural fibres as reinforcing agent of polymers. Compared to other fibre such as fibre glass and carbon fibres that are relatively more costly and non-biodegradable, natural fibres are more environmentally safe. Glass and carbon fibres, in other words, lead to harmful environmental effects. In addition, the relatively low cost, low density, environmentally sustainable, biodegradable material, reasonable basic strength properties and ease of seperation also have fascinating natural fibre characteristics.

Kenaf is the cheapest natural fibre and the most commercially available. Several researchers have discovered that kenaf bast fibres in polymer composites have great potential as a reinforcing component. However, untreated kenaf fibres have low matrix interfacial adhesion, creating composites with subpar mechanical properties and a wetting problem with higher fibre material (El-Shekeil et al. 2012; Park et al. 2015; Wang et al. 2016). In another paper, it is reported that composites fabricated using alkali treated fibres exhibit better durability in terms of flexural properties after the composite is subjected to 12 months of a natural weathering environment (Ariawan et al. 2017b). Orue et al. (2016) reported that the mechanical properties of sisal fibre and polylactic acid (PLA) composites are improved by alkaline and silane fibre surface treatment.

Furthermore, the properties in the natural fibres consist of Crystalline and amorphous regions in distinguish the cellulose structure of the fibres. In the large numbers of strong intra-molecular hydrogen bonds are formed in the crystallite region. This creates a block of cellulose and makes other chemical difficult to penetration. The present of water molecules from the atmosphere, the hydrophilic hydroxyl groups present in this region are combined together. Causes of that it makes the fibre hydrophilic and polar in character which lowers the compatibility with the non-polar/hydrophobic matrix. So, distension of the crystalline region causes from the elimination of the hydrophilic hydroxyl groups and the removal of surface impurities (waxy substances), natural fibre requires to be chemically modified. So that, the treatment on this natural fibres are used by sodium hydroxide (NaOH) and it widely being used to modify the cellulosic molecular structure. It modifies the orientation and the formation of an amorphous region of the highly packed crystalline cellulose order. This provides more access to penetrate chemicals. In the amorphous region, cellulose micromolecules are separated at large distances and the spaces are filled by water molecules.

The Alkali substances are sensitive on hydroxyl (OH) groups present among the molecules are broken down, which then react with water molecules (HAOH) and move out from the fibre structure. As a result, the fibre surface becomes clean. In addition to this, it reduces fibre diameter and thereby increases the aspect ratio (length/diameter) and it increases the effectiveness of fibre surface area for good adhesion with the matrix. If the alkali concentration is higher than the optimum condition it good for the Mechanical and thermal behaviors of the composite are improved significantly by this treatment.

In addition, there other chemical treatment are by using silane treatment. Silane is a multifunctional molecule are used to modify fibre surfaces as a coupling agent. Through a siloxane bridge, the composition of silane forms a chemical link between the fibre surface and the matrix. There are several stages of hydrolysis, condensation and bond formation during the treatment process. Silanols form in the presence of moisture and hydrolysable alkoxy groups (hydrolysis, see Scheme 2a Sever K, Sarikanat M, Seki Y, Erkan G, Erdogan UH et al. 2010). During condensation process, one end of silanol reacts with the cellulose hydroxyl group (Si–O–cellulose, see Scheme 2b Sever K, Sarikanat M, Seki Y, Erkan G, Erdogan UH et al. 2010) and other end reacts (bond formation) with the matrix (Si-Matrix) functional group. As a result, fibre matrix adhesion improves and stabilizes the composite properties of the natural fibres exhibit micro-pores on their surface and silane coupling agents act as a surface coating. This penetrates into the pores and develops mechanically interlocked coatings on fibre surface.

This research aims to know how 3D design fibre-matrix interaction between PLA was responsible for the increases in tensile strength and the thermal properties. Qualitative methods will be used to evaluate the effect of size kenaf on the tensile properties of kenaf reinforced PLA composites. This data will be contextualized with a review of recent literature on effect of size kenaf on the tensile and thermal properties of kenaf reinforced PLA composites.

1.3 Objective

The objectives of this project are as follows:

1. To evaluate the effect of fiber size on tensile properties of kenaf fiber reinforced PLA composites by using ANSYS simulation software.

2. To investigate the effect of fiber size on thermal properties of kenaf fiber reinforced PLA composites by using ANSYS simulation software.

1.4 Scope of project

The scopes of this project are:

1. Materials by using kenaf fibre and PLA-plastic materials
2. The sample will be designing on Solidwork 2020 by following ASTM D638.
3. Testing process by using tensile test and thermal analysis. The 4 Sample will going run on simulation test software.

1.5 General Methodology

The actions that need to be carried out to achieve the objectives in this project are listed below.

1. Literature review
   Journals, articles, or any materials regarding the project will be reviewed.

2. Measurement
   i. The measurement to evaluate the mechanical properties of the bio-degradable composite, tensile test is applied. Some of the properties that can be obtain after endure the tensile test such as Young Modulus, tensile stress, maximum elongation, tensile strain and yield stress. The tensile strength of single fibre can be calculated using equation. Where σ is tensile strength of the fibre (Pa), F is maximum force at break (N) and A is area of the cross section (m^2)

$$\sigma = \frac{F}{A}$$

ii. The measurement to evaluate of thermal properties by using (Themogravimetric Analysis) TGA that studies the changes in the weight of a sample while the sample is being heated or cooled at a controlled temperature, T(t), and the changes are continuously monitored. The program that controls the temperature can be isothermal (T (t) is constant) or nonisothermal. Isothermal is a condition when T (t) is constant, and nonisothermal is a condition when the heating rate is constant (caused by the linear change in temperature with time). The heating rate (β) can be expressed as where dT is the change in temperature and dt is the change in time.

$$\beta = \frac{dT}{dt}$$

3. Testing

For this research, the testing was carried out by following to ASTM D3039. Tensile properties of composite were determined using the Static structural on ANSYS workbench 2019 R3.

4. Analysis and discussion

Analysis will be presented on how and result testing process by using tensile test and thermal analysis.

5. Report writing

A report on this study will be written at the end of the project.

The methodology of this study is summarized in the flow chart as shown in Figure 1.1.

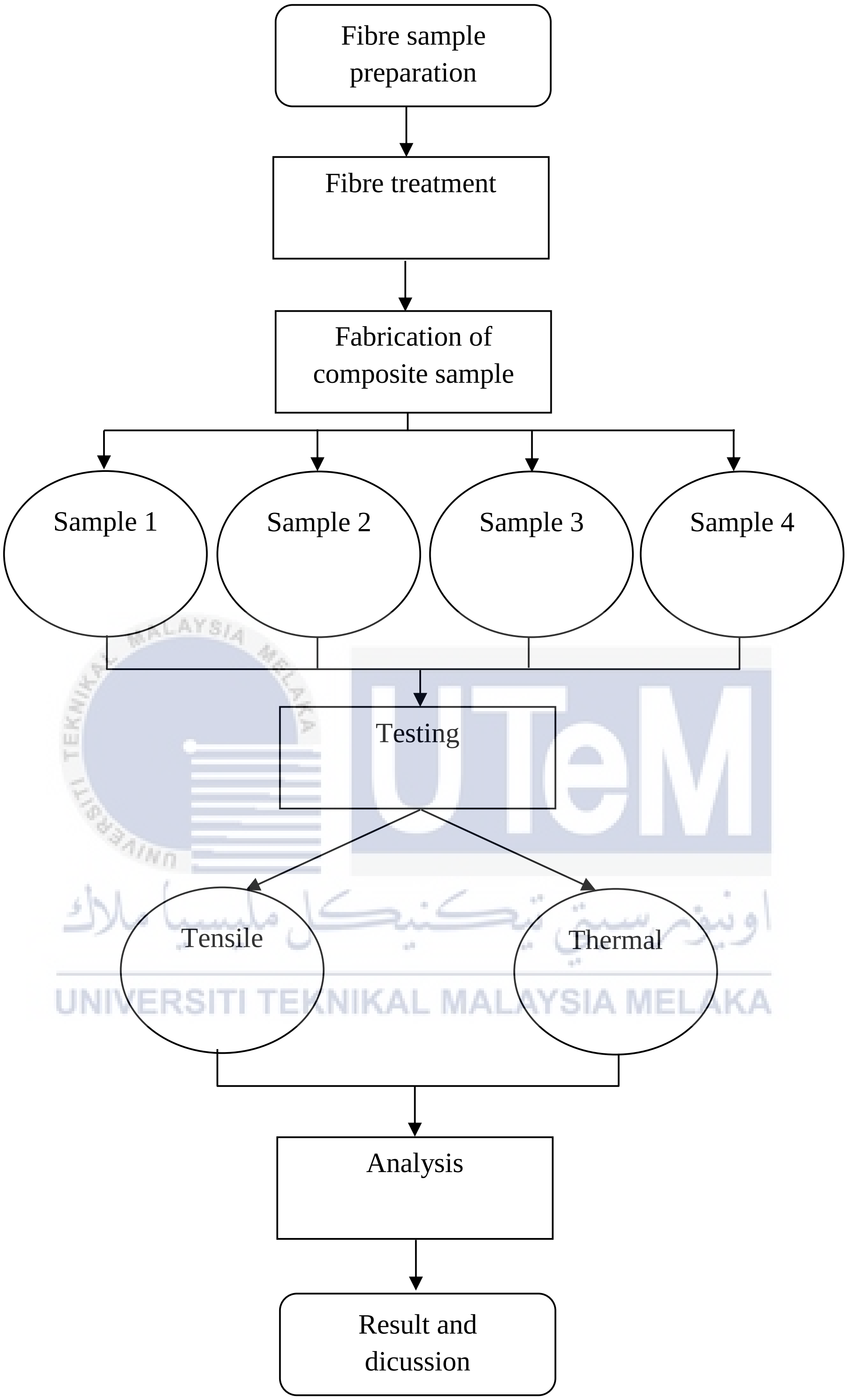

Figure 1.1: Flow chart of the methodology.

CHAPTER 2

LITERATURE REVIEW

1.1 Introduction

The world is growing economically and rapidly through the global, especially in the food technology industry, there are many composite materials that have been invented and become a product in our daily lives. Especially in the food industry technology is the number one end user of packaging materials, thus becoming the number one end user. Then, even a small reduction in the quantity of materials used for each package would lead to a substantial reduction in cost and could improve the problem of solid waste. In an effort to minimise resources and costs, packaging technology has dealt with reducing the volume and/or weight of materials. Several trends have been identified in the evolution of food packaging, including the reduction of sources, improvement of design for convenience and handling, and environmental concerns regarding packaging materials and processes. Although the different functions of food packaging have evolved, each package still has to meet the basic requirements. In other words, good packaging systems are still required to reduce food waste and spoilage during distribution, to reduce preservation costs, to extend the shelf life of food, to provide safe and convenient food.

Moreover, if the material used is not biodegradable, the problem that has been worrying in this food industry means that it can be harmful to the environment and human. Then, this problem lead to increasing and giving the researcher and the scientist the consciousness to discover a way to save humanity's environment in the future. The researcher will find the replacement of a new composite material must be similar on the basis of its mechanical properties, such as strength, bending or material thermolability. In ways, the natural fibres are a good replacement for the composite material as it was considered to be one of the environmentally friendly materials chosen as a good replacement because of its mechanical properties for another reason.

Recently, the researchers and scientists are exploring the properties and ability of kenaf fibre to replace synthetic fibre in the application of engineering. On this review, we