FLEXURAL PROPERTIES OF KENAF FIBRE REINFORCED PLA COMPOSITES SUBJECTED TO SIZE OF KENAF FIBRE BY USING FINITE ELEMENT ANALYSIS

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A report submitted in fulfillment of the requirement for the degree Bachelor of Mechanical Engineering (Structure & Materials)

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DECLARATION

I declare that this project report entitled “Flexural Properties of Kenaf Fibre Reinforced PLA Composites Subjected to Size of Kenaf Fibre by Using Finite Element Analysis” 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

Nowadays, natural fibres are used as a reinforcing material in polymer composites, owing to severe environmental concerns. Among many different types of natural resources, kenaf plants have been extensively exploited over the past few years. In this experimental study, partially eco-friendly composites were studied by using kenaf fibre and PLA with four different sizes of fibre 0.5 mm, 1.0mm, 1.5 mm and 2.0 mm. The mechanical properties such as flexural of these composites have been evaluated. During the experiment, the finite element analysis was carried out to analyse the flexural properties, beside the elastic behaviour of the composites. An updated three-dimensional finite element model was developed in the Solidwork 2018 to determine the characterization of the composites under functionally suitable loading conditions. Different fibre length and different fibre loading orientations, including different materials have been conducted by the past researcher and have been widely used in developing countries. In Finite Element Analysis, the meshing process is important to indicates a good result between fibre and matrix which improved the flexural properties of the composites in the simulation analysis. The best size of fibre was determined in this research for the performance of flexural properties of the composites.

ABSTRAK

Pada masa kini, serat semula jadi digunakan sebagai bahan penguat dalam komposit polimer, kerana masalah persekitaran yang teruk. Di antara pelbagai jenis sumber semula jadi, tanaman kenaf telah dieksploitasi secara meluas sejak beberapa tahun kebelakangan ini. Dalam kajian eksperimen ini, sebahagian komposit mesra alam dikaji dengan menggunakan serat kenaf dan PLA dengan empat saiz serat yang berbeza 0.5mm, 1.0mm, 1.5mm dan 2.0mm. Sifat mekanikal seperti lenturan komposit ini telah dinilai. Semasa eksperimen, analisis elemen hingga dilakukan untuk menganalisis sifat lenturan, di samping tingkah laku elastik komposit. Model elemen hingga tiga dimensi yang dikemas kini dibangunkan dalam Solidwork 2018 untuk menentukan pencirian komposit dalam keadaan pemuatan yang sesuai. Panjang serat yang berbeza dan orientasi pemuatan serat yang berbeza, termasuk bahan yang berbeza telah dilakukan oleh penyelidik masa lalu dan telah digunakan secara meluas di negara-negara membangun. Dalam Analisis Elemen Terhingga, proses jalinan penting untuk menunjukkan hasil yang baik antara serat dan matriks yang meningkatkan sifat lenturan komposit dalam analisis simulasi. Ukuran serat terbaik ditentukan dalam penyelidikan ini untuk prestasi sifat lenturan komposit

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I would like to express my deep and sincere gratitude to my supervisor, Dr. Nadlene Binti Razali, for giving me a golden opportunity to doing this Projek Sarjana Muda under her supervision and for guide me during Projek Sarjana Muda. Her dynamism, vision, and sincerity with motivation have help me to go throughout this PSM with successfully.

I am extremely grateful to my beloved parents for their love, prayers, caring and sacrifices for educating and preparing for my future. I am very much thankful to my brother and my sister-in-law for their kindness and love for let me staying in their house during Movement Restricted Order (MCO) period. My special thanks go to all my partner for showing valuable knowledge that I will not forget and will be useful for my future.

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LIST OF ABBEREVATIONS

NEAC	National Economic Action Council
KOH	Potassium Hydroxide
LiOH	Lithium Hydroxide
UPR	Unsaturated Polyester Resin
MCR	Magneto-Rheological Device
DFS	Depth First Search
NaOH	Sodium Hydroxide
APS	γ-aminopropyltriethoxysilane
PLA	Polyactic Acid
LRTM	Light Resin Transfer Moulding
PP	PolyPropylene
UKF	Unidirectional Kenaf Fibre
FRC	Fibre Reinforced Concrete
KFRC	Kenaf Fibre Reinforced Concrete
TPU	Thermoplastic polyurethane
HDPE	High-Density Polyethylene
LPT	Low Processing Temperature
HPT	High Processing Temperature
FEA	Finite Element Analysis

LIST OF SYMBOLS

m_0	=	Initial mass
m_1	=	Final mass
m	=	Mass
V	=	Volume
ρ	=	Specific gravity
L	=	Support span
P	=	Maximum load
b	=	Width
d	=	Thickness
σ_f	=	Flexural strength
E_f	=	Flexural modulus

CHAPTER 1

INTRODUCION

1.1 Overview

For the past few years, there are many issues that highlighted about environmental issue, especially global warming, deforestation and disposal of plastic products that have no limitation in this world." Ecological problems have led to an increased interest in natural fibers and, as a good replacement candidate for synthetic fibres, concerns like environmental safety has become crucially essential for the implementation of natural fibres", (Khalina, Zainuddin and Aji, 2011). Natural fibers are highly favoring for the industry rather than synthetic fibre as they have a good strength, renewability, sustainability, and ecoefficiency. Recent studies show that nowadays industrial company are more preferable producing green material product that helping to safe the environmental become more worse, as we know that natural fibres is a biodegradable product, thus is not bring bad side effect to the community health. Biodegradable material is those which can be degraded by natural processes into some usable forms.

Natural fibre in simple definition are fibers that are not synthetic and manmade. The natural fibre type that will be used for this analysis is kenaf fibre. "Kenaf fibre is one of the most popular natural fibres used as a composite polymer matrix reinforcement (PMC)", (Suhairil *et al.,* 2012). The performance benefits of PMC

natural fibers are their chemical properties, high rigidity, high strength and sound absorption. “Kenaf is mostly easy to find across the globe, such as India, Bangladesh, Thailand, Malaysia, countries in Africa and Southeast Europe”, (Mahir *et al.*, 2019). Moreover, the industry has implemented the usage of kenaf fiber widely especially have been established in automotive industry (interior parts).

Apart from that, the other material that will be composite in this study is PLA composites. “PLA is a polymer with a high variety of applications that is biocompatible and biodegradable”, (Mohammed *et al.*, 2015). However, by its slow crystallization speed and brittleness have made the application of the PLA become limited (Kargarzadeh and Ahmad, 2012). To overcome these disadvantages, a research that have been made found that by adding the natural fibre such as kenaf will be useful technique to reinforce with the PLA.

1.2 Problem Statement

Nowadays, most of the researchers are interest to develop research on natural fibres as a reenforcing agent in polymers. Because of environmentally friendly that advantages have on natural fibres compared glass and carbon fibres, which attracted many researchers to explore natural fiber in replacing glass and carbon, that currently have been using as reinforced material (Sapuan, Leman and Zainudin, 2016). There are many interesting features that draw the researcher, such as reasonable cost, low density, environmentally sustainable, bio-degradable content, acceptable precise strength characteristics and simplicity of separation of natural fibers (Kabir *et al.*, 2007).

The problem in previous researchers mostly about the weakness of interfacial adhesion between polymer and fibre. By introducing alkaline treatment of the fibres,

it can enhance the performance of mechanical properties due to an improved adhesion thus affecting rough surface at the fibre matrix. The performance and quality of the composite product depends greatly on the adhesion of the fibre matrix, as it influences the transfer of stress from the matrix to the fibre (Kabir *et al.*, 2007). The harder the bonding of the kenaf fibre with the PLA composites, the harder the composites will fail due to the load and applied stress. For this project, the kenaf fibre will be reinforced with PLA composites subjected to the size of kenaf fibre.

1.3 Objectives

The objectives of this research are stated as below:

1. To evaluate the effect fibre size on the flexural properties of kenaf fibre reinforced PLA composites by using Finite Element Analysis.

1.4 Scope of Project

To achieve the main goal of this project, the scope of this study was set according to the time given. The scopes of this project are:

a) The characterization of the composites was done by using ANSYS software.

b) Three parameters have been set subjected to different kenaf fibre size to analyse the effect on the mechanical and thermal properties.

c) The different results will be compared and discussed.

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

   Journal, articles, or any material regarding the project will be reviewed.

2. Inspection

   The kenaf fibre hat have been undergo alkaline treatment and surface treatment, will be layered by different thickness of PLA and being simulate using ANSYS

3. Measurement

   For this project, the kenaf fibre hat have been undergo alkaline treatment and surface treatment, will be layered by different thickness of PLA. ANSYS software will be used to get the result of the mechanical properties for the composites material.

4. Simulation

   Simulation and testing of the composite's material will be going through ANSYS simulation using T-Dog bone shaped.

5. Analysis and proposed solution

   Analysis will be presented by using ANSYS software to get the simulation of the specimen that have being tested for its flexural and rheological properties.

6. 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

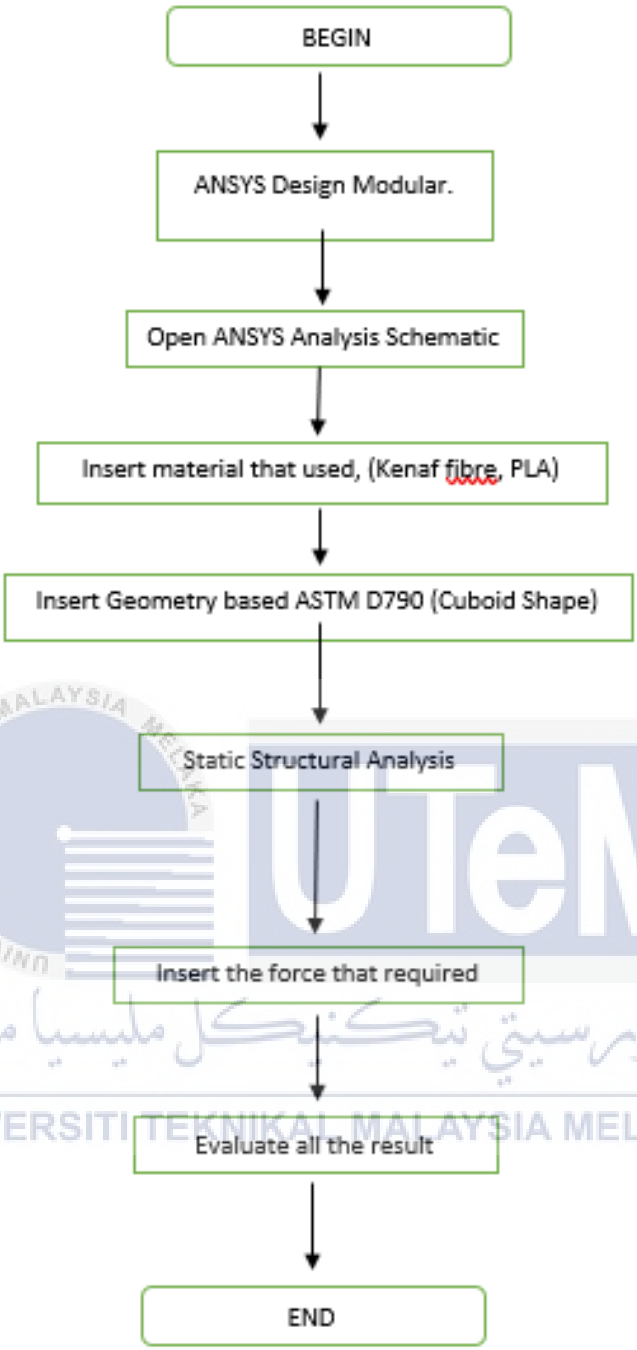

Figure 1.1 General Methodology for this project

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

As the world are economically and growing rapidly, especially in the technology industry, there are many of composite's material that have been invented and become a product in our daily lives. But the issue that have been worrying about in this industry when the material that have been used is not biodegradable, means that can be harmful in the environmental. Then, this issue being growing and giving the consciousness to the researcher and the scientist to discover a way that can save the environment for the mankind in the future. The replacement of the new material that will be composites must have similarity based on its mechanical properties such as strength, flexural nor ductility of the material. Natural fibres is the good substitution for the composites material as it considered one of the environmentally friendly material which with another reason being choose as a good substitution because of its mechanical properties.

Other than having a good mechanicals property, there is several reasons that why natural fibre chosen as a good material to composites rather than synthetic fibre. Lightweight design, relatively high modulus, non-toxicity, convenient manufacturing and CO2 absorption during their growing are the attractive features that can be discovered from the fiber (Mohammed *et al.*, 2015). These special

characteristics that have on fibre will be suitable material to be processed into composite or other form of product, plus it can preserve the environment to become greener. Although natural fibre has many special characteristics but these green sources are really not free from problems. Because of its complex internal fiber structure (such as cellulose, hemicellulose, lignin, pectin and waxy substances), it becomes a factor that contributes to weak bond with the material of the matrix, as this composition enables the environment to absorb water (Materials and Vol, 2014). But each issue comes with a good solution. The characteristic that fibre have which is have a high affinity to water can be treated by undergo chemical treatment. It will influence the composition of the fibre to stop the affinity to water and better bonding with the matrix material. Several industrial and academic projects are underway to improve strong fibre-matrix adhesion characteristics of fibre composites through the use of various chemical treatments, fibre orientation and production methods (Essabir *et al.*, 2016).

Until now, researches and scientist are still explored on the kenaf fibre characteristics and potential of the engineering application to replace inorganic fibre. From this study, we found that the feasibility studies conducted on this high-grade plant will cover the flexural properties of composites, the rheological properties of composites, and the impact of surface treatment. From this review, kenaf fibre already established in automotive industry and many well-known companies have use this natural fibre as their 'green' material that will be composites. In addition to the automotive industry, natural fiber composite applications, such as frames, glass panels, decking, and bicycle frames, have also been used in the civil industry, sports, aviation, and others (Mohammed *et al.*, 2015) , (Mahir *et al.*, 2019), (Gentian, Satu and Polimer, 2019).