UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EXPERIMENTAL STUDY ON THERMAL CONDUCTIVITY PERFORMANCE OF OIL PALM FIBER/POLYESTER PANEL WITH ALUMINUM HONEYCOMB SANDWICH

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A thesis submitted
in fulfillment of the requirements for the degree of
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DECLARATION

I declare that this thesis entitled "Experimental Study On Thermal Conductivity Performance Of Oil Palm Fiber/Polyester Panel With Aluminium " is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date : 20 / 01 / 2023

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology with Honours.

Signature : 

Supervisor Name : DR. MUHAMMAD ZULKARNAIN

Date : 23/1/2023

DEDICATION

This thesis is dedicated to my mother Norazilah Binti Md.Ali and also my father Azmi Bin Ibrahim, who have raised and support me to be the person I am today. You have been with me from a little child every step by step until now, through good times and bad. Thank you for your love, pray, guidance, and support that you have given to me, helping me to succeed and encouraged me to be confident that I am capable of doing anything I put my mind and effort into it. Thank you for everything.

ABSTRACT

Many industrial sectors nowaday's demands for recyclable materials, lightweight structures, and easy to obtain in nature. Many research efforts have been studied by various researchers previous experiments in terms of knowledge about natural fiber, sandwich panels, and honeycomb structure. The physical oil palm fiber that is salt-water resistant and as shock absorber. Thus, oil palm fiber is an excellent material to reinforced with polyester. The characteristics of sandwich aluminum honeycomb are known as lightweight structures widely used in industrial automotive, naval, and aircraft. This study is about the combination of composite material as sandwich panels with aluminum honeycomb to make experiment on mechanical properties of the specimen. This experiment of oil palm fiber/polyester panel with aluminum honeycomb sandwich to produces the material is lightweight and durable as industrial requirement.The scope of this project is an analytical study that focuses on oil palm fiber with polyester resin as a composite that attaches to aluminum honeycomb as sandwich material. In addition, oil palm fiber is treated with sodium hydroxide to eliminate unwanted particles before being prepared as reinforcement. and standard thermal testing used to analyze the thermal distribution of honeycomb.

ABSTRAK

Kebanyakan industri sekarang membuat permintaan keatas bahan yang dapat di perbaharui, struktur yang ringan, dan mudah diperolehi dalam alam semula jadi. Banyak penyelidikan telah dikaji dengan kajian-kajian terhadap eksperimen dari segi pengetahuan tentang serat semula jadi, komposit panel sandwich, dan struktur pada aluminium honeycomb. Fizikal serat kelapa sawit adalah kalis air masin dan sebagai penyerap gegaran. Disebabkan itu, serat kelapa sawit merupakan bahan yang sesuai untuk di komposkan dengan polyester. Ciri-ciri sandwich aluminium honeycomb terkenal dengan struktur yang ringan yang digunakan dalam industri automotif, perkapalan, dan kapal terbang. Kajian ini adalah tentang kombinasi antara bahan komposit sebagai panel sandwich kepada struktur aluminum honeycomb untuk menbuat penyelidikan keatas mekanikal properti terhadap spesimen tersebut. Dalam penyelidikan ini sarat kelapa sawit yang dikompos dengan polyester resin sebagai panel untuk di sandwich terhadap aluminum honeycomb bagi menhasilkan bahan yang ringan dan daya ketahanan yang kuat untuk memenuhi keperluan industri. Skop projek ini adalah kajian analitikal yang memfokuskan kepada gentian kelapa sawit dengan resin poliester sebagai komposit yang melekat pada sarang lebah aluminium sebagai bahan sandwic. Selain itu, gentian kelapa sawit dirawat dengan natrium hidroksida untuk menghilangkan zarah yang tidak diingini sebelum disediakan sebagai tetulang. dan ujian haba piawai yang digunakan untuk menganalisis taburan haba sarang lebah.

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LIST OF SYMBOLS AND ABBREVIATIONS

FRP	-	Fiber-reinforced polymer
k_0	-	Thermal conductivity
L	-	Thickness of the test
L_0	-	Thickness of material
T_3	-	Temperatures of copper plates
T_2	-	Temperatures of copper plates
T_1	-	Temperatures of copper plates
ASTM	-	American Society for Testing and Materials
ISO	-	The International Organization for Standardization
DI NEN	-	Thermal performance of building materials and products
m	-	Meter
K	-	Kelvin
Mm	-	Millimetres
kg	-	Kilograms
Q	-	Heat trasnfer
A	-	Cross-sectional area
dT	-	Temperature difference
dx	-	Sample thickness
W	-	Heat flux
L	-	Distance
ρc	-	Density honeycomb sandwich
ts	-	Thickness of the bee wall
C	-	Side length honeycomb

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CHAPTER 1

INTRODUCTION

1.1 Background

Bio-composites are materials created by mixing natural fibre with either a petroleum-derived non-biodegradable polymer or a biodegradable polymer. Bio-composites created from natural fibre and crop/bioderived plastic (biopolymer/bioplastic) are more likely to be environmentally benign, and these composites are referred to as green composites. Natural fibre fillers provide various benefits over typical inorganic fillers, including lower energy costs, a positive contribution to the global carbon budget, higher deformability, biodegradability, combustibility, ease of recyclability, and superior thermal and insulating qualities.

Bio-composites have received significant attention in recent decades as environmental responsiveness and ecological concern have grown. Since composites have several advantages such as low cost, light weight, nontoxicity, biodegradability, and so on. Various natural fillers, such as pineapple, sisal and bamboo, coconut coir, jute, and so on, have previously been described as reinforcements in composites. Aside from that, natural fibres have a far lower thermal conductivity than synthetic fibres and may be employed as a filler in a variety of insulating applications.

There is a growing interest on natural fiber composites in various fields due to these advantages. By example, the palm oil business is by far the greatest contributor to Malaysia's

biomass industry. Huge volumes of lignocellulosic materials are found in oil palm trees in the form of empty fruit bunches, mesocarp fibres, palm kernel shells, fronds, and trunks.

Depending on the local environment, energy efficiency may be accomplished by developing adequate roof insulation material. Thermal characteristics vary depending on the substance. In a hot and humid climatic country like Malaysia, the best roofing material is one that reduces or reflects solar radiation. This is done to maintain the building's internal temperature as low as possible. Roof insulation is critical for lowering solar radiation, and most roof insulations on the market are built of inorganic materials with low thermal conductivity that could not be formed naturally.

1.2 Problem Statement

Cooling system and lighting consume the most energy compared to others house appliance. The design of the building envelopes and the materials used have a vital impact in lowering the building's energy usage. When compared to the walls, the roof is more exposed to solar radiation. According to Malaysian climate conditions, the duration of roof exposure to solar radiation is greater than that of walls.

The use of passive design may considerably boost the cooling impact of a structure, hence increasing occupant comfort. However, the use of thermal insulation and specialty construction materials has expanded dramatically in recent years, regardless of whether the region is hot or cold.

As a result, by using Aluminium honeycomb sandwich along with oil palm fiber / polyester panel to produce a low cost, biodegradability, and better thermal insulation capabilities for Malaysia climate.

1.3 Research Objective

The main aim of this project is to study on thermal conductivity performance of oil palm fibre / polyester panel with aluminium honeycomb for equator climate. Specifically, the objective are as follows:

1) To study the thermal and absorption characteristic aluminium honeycomb oil palm fibre/Polyester panels under thermal conductivity prediction.

2) To evaluate the thermal conductivity performances by varied fiber volume content on honeycomb sandwich

1.4 Scope of Research

The scope of this project are as follows:

- The research focus on chop fiber size with random distribution of natural Oil Palm.
- The varied amount of fiber content will be addressed to thermal analysis
- The characteristic of oil palm will be random distribution.
- Standard thermal testing is used to analyze thermal distribution

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

Energy efficiency has been acknowledged as a significant strategy for addressing developing difficulties in today's modern society in the use of thermal insulation and specialty construction materials has expanded dramatically in recent years, regardless of whether the region is hot or cold. As technology improves, more and more effective man-made materials for building thermal insulation are being produced. Many of these synthetic items do not degrade naturally when disposed of in landfills because water, air, and soil have little effect on the materials, degradation can take hundreds of years in some cases. The growing environmental impact demands the quest for feasible biodegradable renewable materials for use as building thermal insulation. The combination of composite material as the panel to sandwich the aluminium honeycomb in the centre in order to build the specimen's face sheet panel that is robust, lightweight, and renewable. To create the specimens, previous research on the thermal conductivity performance of oil palm fibre polyester composite and aluminium honeycomb core structure must be conducted via an article, video, and journal that was an experiment and evaluated.

This review is essential for developing an appropriate approach for conducting an experimental investigation on the thermal conductivity performance of oil palm fibre polyester panel reinforced with an aluminium honeycomb sandwich. This is to classification the standard dimension of specimen needed before conducting actual test. With this comprehensive study of oil palm fibre polyester composite panel and aluminium honeycomb

information, corrective, and preventive solutions for producing the composite surface panel and sandwich with aluminium honeycomb can be properly planned and executed in a timely and effective manner. The goal of doing a literature review is to look at past studies and experiments on fibre oil palm fibre, polyester resin, and aluminium honeycomb based on the material, technique, equipment utilised, mathematical calculation, benefits, and drawbacks, and so on.

2.2 Natural Fibers

2.2.1 Oil Palm Fibers

The female bunch has around increasingly growing fruits on 100–120 spikelets connected to a peduncle from the axil of a frond. The two primary products of the fruits are palm oil from the outer mesocarp and palm kernel oil from the kernel within the nut. Many studies have been undertaken to investigate the potential of natural fibres as composite reinforcement, and the findings in some cases have revealed that natural fibre composites have high stiffness but not the same degree of strength as glass fibre composites to a peduncle from a frond's axil. The cultivation of the oil palm, Elaeis guineensis, has risen dramatically in recent years due to rising demand for vegetable oils. Short fibres were initially used to reduce the cost of the rubber compound or to increase its processability. Later, it was discovered that reinforcing rubber with short fibres provided good strength and stiffness to both soft and strong rubber matrices. The adhesion between oil palm fibre and rubber matrix was found to be poor, but it may be increased by treating the material at high temperatures and with different bonding agents. The thermal insulation was investigated at conductivity for possible use as a building thermal insulation.

2.2.2 Resins

Resins is any natural or synthetic organic compound consisting of a non-crystalline or viscous liquid substance natural resins are organic compounds that are fusible and combustible, are transparent or translucent, and range in colour from yellowish to brown. They originate in plant secretions and are soluble in a variety of organic liquids but not in water. Synthetic resins are a broad category of synthetic compounds that have certain physical features with natural resins but differ chemically. Plastics and synthetic resins are not readily distinguished. Matrix materials are of different types like metal matrix, ceramic matrix, and polymer matrix. When compared to metal and ceramic matrices, polymer matrices are most typically utilised due to their cost effectiveness, ease of producing complicated components with reduced tooling expense, and excellent room temperature characteristics. Polymer matrices can be either thermoplastic or thermoset. Thermoplastic materials are formed by addition polymerization. Thermoplastics soften or fuse when heated, harden, and become rigid after cooling. Unlike thermosets, thermoplastics can be modified or reused upon the need. Thermoplastics have longer shelf life and higher fracture toughness than thermoset resins. Thermoplastic resins have high viscosity and less creep resistance when compared to thermosets (Barbero, 1998).

Thermosets are formed when two or more components chemically react with each other under ambient conditions or when induced by radiation or heat to form a highly cross-linked network. The process of thermoset production is irreversible. Thermosets are often stiff and unyielding. When compared to thermoplastics, they have superior temperature resistance when exposed to heat and will not creep or deform at higher degrees. Thermoset matrices are created when a resin undergoes an irreversible chemical change into an amorphous cross-linked polymer matrix. Because of their massive molecular structures,

thermoset resins provide excellent electrical and thermal insulation. Low viscosity allows for optimal fibre wet out, improved thermal stability, and greater creep resistance in thermosets. Epoxy, polyester, vinyl ester, and phenolics are the most regularly used thermoset resins. Generally, thermoset resins may be designed to provide a wide range of qualities depending on the application.

Epoxy resin has superior adhesive qualities as compared to other resins. It also has low shrinkage after curing, strong chemical resistance, and excellent thermal properties. Epoxies have been employed in advanced composites due to their adherence to a wide range of fibres, outstanding mechanical and electrical capabilities, and high temperature performance. Epoxies are more costly than polyester and have a lower moisture resistance. Polyester has the advantages of being inexpensive, easy to handle, chemically resistant, and having reasonable mechanical characteristics. Polyester and epoxy account for around 85 percent of fibre reinforced polymer composites.

2.3 Distribution Composites

A composite material is made up of two components that have distinct physical and chemical characteristics. When they are mixed, they form a material that is specialised to perform a certain function, such as becoming stronger, lighter, or electrically resistant. They can also help to increase strength and stiffness. They are preferred over traditional materials because they increase the qualities of their basic materials and are useful in a variety of scenarios. Composites are employed in many industries, including aircraft, architectural, automotive, energy, infrastructure, marine, military, and sports & recreation. Read about intriguing composites uses in certain sectors below and come back frequently as we continue to add more applications to this site. Composite materials have significant class of structural elements because the materials are lightweight, flexible, highly corrosion resistance,

excellent impact strength, and good fatigue strength. Because of this property, composite materials are being considered as a replacement for traditional materials used in aerospace, automotive, and other industries. With careful selection of matrix and reinforcement can achieve the specialty of composites by engineering the material properties, which are required in the product

The outstanding features of fiber-reinforced polymer composites (FRPs) are their high specific stiffness, high specific strength, and controlled anisotropy (Abbood et al., 2021). FRPs are widely employed in the pulp and paper, semiconductor, metal refining, electricity, waste treatment, petrochemical, pharmaceutical, and other sectors that require high-performance advanced composites for these reasons. Pressure vessels, ducts, fans, stacks, pipelines, elevator buckets, and heat exchangers are examples of FRP goods. Furthermore, a composite is a blend of two or more chemically unique ingredients separated by a district interface as reinforcing particles and matrix. As a result, it possesses a distinct set of qualities that differ considerably from the constituent attributes. As seen in Figure 2.1, two major classes are fibrous composites and particulate composites, with reinforcement in the form of fibres reinforced.