Experimental Study on Mechanical Performance of Coconut Fiber/Polyester Panel with Aluminium Honeycomb

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B091810279

BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY WITH HONOURS

2021

Faculty of Mechanical and Manufacturing Engineering Technology

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Bachelor of Mechanical Engineering Technology (Refrigerent and Air Condition System) with Honours

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A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (Refrigerent and Air Condition System) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I declare that this Choose an item. entitled "Experimental Study on Mechanical Performance of Coconut Fiber/Polyester Panel with Aluminum Honeycomb" is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : taufiq

Name : AHMAD TAUFIQ BAIHAQI BIN MOHAMAD

Date : 17/01/2022

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 (Refrigerent and Air Condition System) with Honours.

Signature : .....

Supervisor Name : DR. MUHAMMAD ZULKARNAIN

Date : 17/01/2022

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DEDICATION

This thesis is dedicated to my mother Rusmaizan binti Muda and also my father Mohamad bin Ismail, 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 coconut fiber that is salt-water resistant and as shock absorber went fallen from coconut trees. Thus, coconut 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 coconut fiber polyester panel with aluminum honeycomb sandwich to produces the material is lightweight and durable as industrial requirement.

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 s*andwich*, dan struktur pada *aluminium honeycomb.* Fizikal serat kelapa adalah kalis air masin dan sebagai penyerap gegaran apabila buah jatuh dari ketinggian pokok kelapa. Disebabkan itu, serat kelapa 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 yang dikompos dengan polyester resin sebagai panel untuk di s*andwich* terhadap *aluminum honeycomb* bagi menhasilkan bahan yang ringan dan daya ketahanan yang kuat untuk memenuhi keperluan industri.

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

First and foremost, I would like to thank you and praise Allah the Almighty, my Creator, my Sustainer, for everything I received since the beginning of my life. I would like to extend my appreciation to the Universiti Teknikal Malaysia Melaka (UTeM) for providing the research platform. Thank you also to the Malaysian Ministry of Higher Education (MOHE) for the financial assistance.

My utmost appreciation goes to my main supervisor, Dr. Muhammad Zulkarnain, Institute of Mechanical Engineering Technology in Refrigerant and Air Condition System, Universiti Teknikal Malaysia Melaka (UTeM) for all his support, advice, and inspiration. His constant patience for guiding and providing priceless insights will forever be remembered. Also, to my co-supervisor, Ts. Khairul Amri, Universiti Teknikal Malaysia Melaka (UTeM) who constantly supported my journey. Furthermore, also my gratitude towards Ts. Dr. Kamran Latif, Dr. Ihwan Ghazali and Dr. Mohd Fauzi Bin Mamat. Universiti Teknikal Malaysia Melaka (UTeM) provided video and notes to guide the project research.

Finally, from the bottom of my heart gratitude to my beloved mother, Rusmaizan binti Muda, and my beloved father, Muhamad bin Ismail for their encouragement, endless support, love, and prayers. Finally, thank you to all my classmates and friends who had provided me the assistance, support, and inspiration to embark on my study.

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LIST OF SYMBOLS AND ABBREVIATIONS

E	-	Elastic/Young's modulus
σ	-	Stress
ε	-	Strain
γ	-	Poisson's ratio
ρ	-	Density
σs	-	Yield strength
l	-	Length
b	-	Witdh
h	-	Height
t	-	Thickness
S	-	Width of a unit cell
ρ_{sw}	-	Density of total sandwich panel
ρ_{Ai}	-	The density of aluminum
ρ_c	-	The density of each core respectively for aluminum honeycomb structure.
t_c	-	Thickness of cell membrane
$\tan \delta_C$	-	Damping value of composite
$\tan \delta_m$	-	Damping value for polymer
δ_f	-	Damping value of the fiber
V_f	-	Volume fraction of the fiber
V_m	-	Volume fraction of the matrix

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CHAPTER 1

INTRODUCTION

1.1 Background

The experimental study on mechanical performance of coconut fiber polyester panel with aluminum honeycomb. The production and implementation of these natural fiber in such composites are beginning to increase rapidly uses in automotive, fabric, building construction, and marine industries. There are several types of natural fiber such as kenaf, jute, hemp, flax, oil palm, and bamboo that accepted from industrial to reinforce the fiber in produce the material. Hence, to experimental the mechanical properties of fiber reinforced polyester panel sandwich aluminum honeycomb. There are number of studies must be made to apply them in engineering applications as the replacement to synthetic fiber such as carbon fibers (CF). This is because most natural fibers are required less energy, lower handling costs, possessing excellent strength, stiffness as desirable environment value, renewable, biodegradable, and sustainable compared to synthetic fiber.

There are two types of fibers in a coconut that were green coconuts, harvested after about twelve months on the plant that contain pliable white fiber. Meanwhile, brown fiber is obtained by harvesting fully mature coconut when the nutrition layer surrounding the seed is ready to be processed into copra and desiccated coconut. Coconut trees are tall commonly 25 meters high from the ground and this fibrous layer around the seedpod is a strong shock-absorbing mesh to protects the seed from damage went fallen from the tree. The coconut fiber is suitable as material fiber for composite because the coconut fibrous has durability to withstand high impact forced.

The aluminum honeycomb structure was widely applied in engineering for their excellent energy absorbing capacity and high strength to mass ratio. The aluminum honeycomb is a typical application of the deformable barriers used for some crash tests to assess the crashworthiness of cars required by regulation for the Offset Deformable Barrier (ODB) for car offset impact test. The aluminium honeycomb is characterized as high strain-rate and large compression deformation went impact happen.

1.2 Problem Statement

Many organic and biological materials in nature show excellent performance in various aspects and varied in mechanical performance(Zhao et al., 2012). It has been found that the performance of natural fiber can be reinforced in composite enhanced by content and orientation optimization. The thin-walled honeycomb concept is prevailing in optimizing structural mechanical performance. The combination of thin-walled honeycomb structure has been coupled with the composite panel and introducing their mechanical performance. Nature fiber such as coconut fiber needs to explore as the composite panel to improve thin-walled honeycomb in mechanical performance. Due to the lack of information regarding sandwich material between coconut fibers panel and thin-walled honeycomb structure, further study needs to explain fiber content optimization to honeycomb structure on mechanical performance. Furthermore, it strong enough to reduce composite cost production by using organic for a reinforced composite that proposes to use the wasted local product.

1.3 Research Objective

The main aim of this research is to estimate study on mechanical performance of coconut fiber polyester panel with aluminum honeycomb. Specifically, the objectives are as follows:

i) To fabricate coconut fiber polyester composite panel reinforced with thin-walled of aluminum honeycomb as sandwich specimen.

ii) To obtain mechanical properties of coconut fiber polyester composite panel with aluminum honeycomb sandwich on flexural performance test.

1.4 Scope of Research

The scope of this research are as follows:

The coconut fibers are collected from the local product by sun-drying process before apply as reinforcement. In addition, material thin-walled honeycomb aluminum produces by commercial manufacturing in the market. The mechanical performance is analyzing using drop weight test and three-point bending (TPB) on sandwich thin-walled honeycomb aluminum with coconut fiber polyester composite surface panel. Fabrication process and experiment will conduct in Composite Material Laboratory that provide in Faculty of Mechanical and Manufacturing Engineering, Universiti Teknikal Malaysia Melaka (UTeM).

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In the industrial era today, many manufacturers are dependent on materials that are recyclable or easy to obtain as their main material that is lightweight, durable, and affordable for developing the product. The combination of composite material as the panel to sandwich the aluminum honeycomb at the middle in develop the durable, lightweight, and renewable material as the face sheet panel of the specimen. To develop the specimens, the study must be made on the mechanical performance of coconut fiber polyester composite and aluminum honeycomb core structure from previous study through an article, video, and journal that had been an experiment and tested.

This review is important for an effective methodology to make an experimental study on the mechanical performance of coconut fiber polyester panel reinforced with aluminum honeycomb sandwich before conducting an actual experiment of flexural three-point bending tests on the specimen. This is to classification the standard dimension of specimen needed before conducting actual test of flexural three-point bending tests onto the specimen. With this comprehensive study of coconut fiber polyester composite panel and aluminum honeycomb information, corrective, and preventive solution for producing the composite surface panel and sandwich with aluminum honeycomb can be planned and executed correctly, in a timely and effective manner as Figure 2.1 shown. The purpose of making a literature review is to investigate the previous study and experimental of fiber coconut fiber,

polyester resin and aluminum honeycomb base on the material, method, equipment used, mathematic calculation, advantages, and disadvantages, etc.

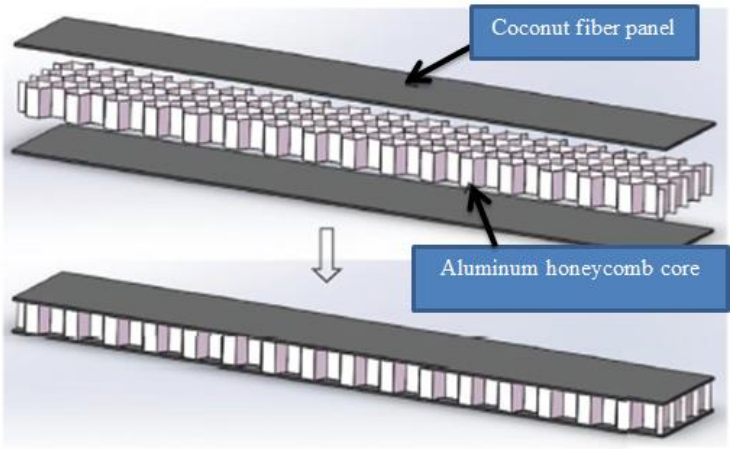

Figure 2.1 Coconut Fiber Sandwich Panel with Aluminum Honeycomb

2.2 Distribution of Composite

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).

Because of these reasons, the FRPs are widely used in the pulp and paper, semiconductor, metal refining, power, waste treatment, petrochemical, pharmaceutical, and other industries that needed high-performance advanced composite. For examples, of

products made of FRPs are pressure vessels, ducts, fans, stacks, pipes, elevator buckets, and heat exchangers. Furthermore, composite is mixture of two or more chemically distinct constituents having a district interface that separates them as reinforcing particles and matrix. Hence, it has a unique combination of properties that are noticeably different from the constituent properties. Based on, two broad classifications are fibrous composites and particulate composites as Figure 2.2 shown, the reinforcement may be in the form of the fibers reinforced.

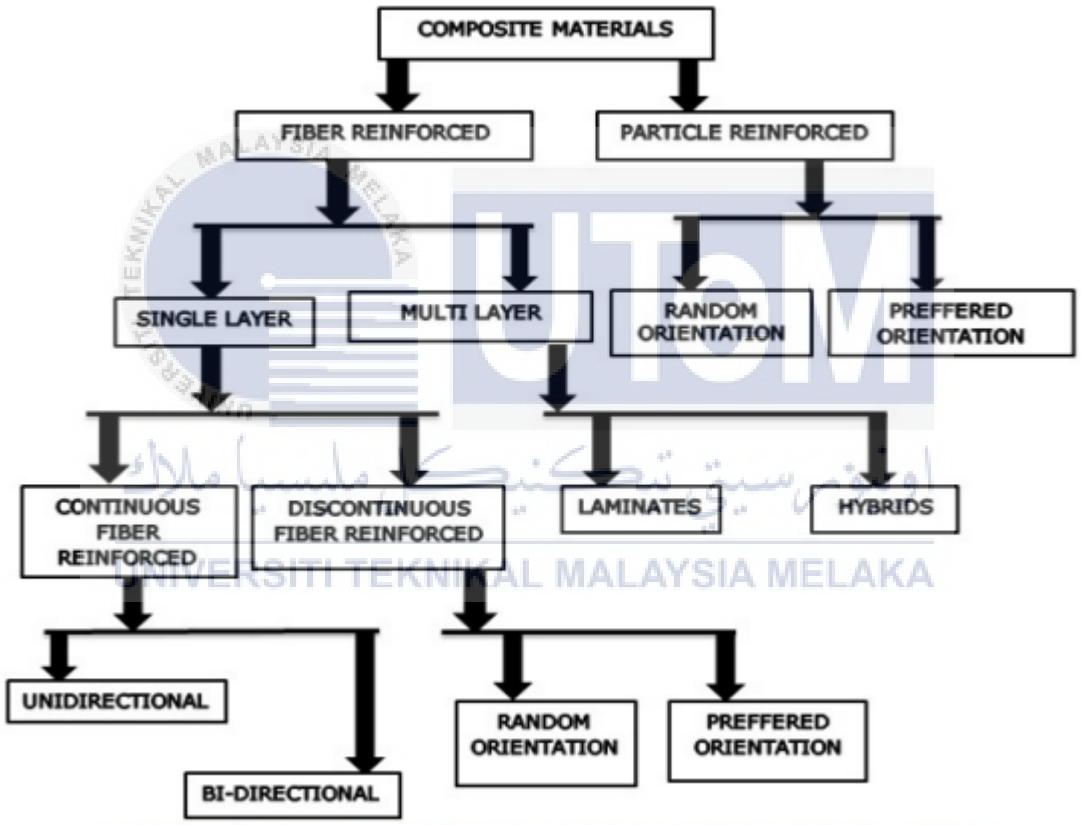

Figure 2.2 Classification of composites materials (Luo et al., 2012)

2.2.1 Molding method of composite

The molding process about hand lay-up fiber reinforced plastics (FRPs) as Figure 2.3 shown is a process of preparing thermoset polymer matrix composites 100 percent with hand

and doesn't use any machine. Mixing the fiber with polyester resin and hardener, then stirred well the material together and then let the material curing for 24 hours in room temperature to forming the reaction process of polyester resin and hardener in forming the composite material products . The process of molding composite material is very different from molding process of metallic materials. This is because to molding for composite process need to mould step by step the preparation moulding process of composite Figure 2.3 shown below.

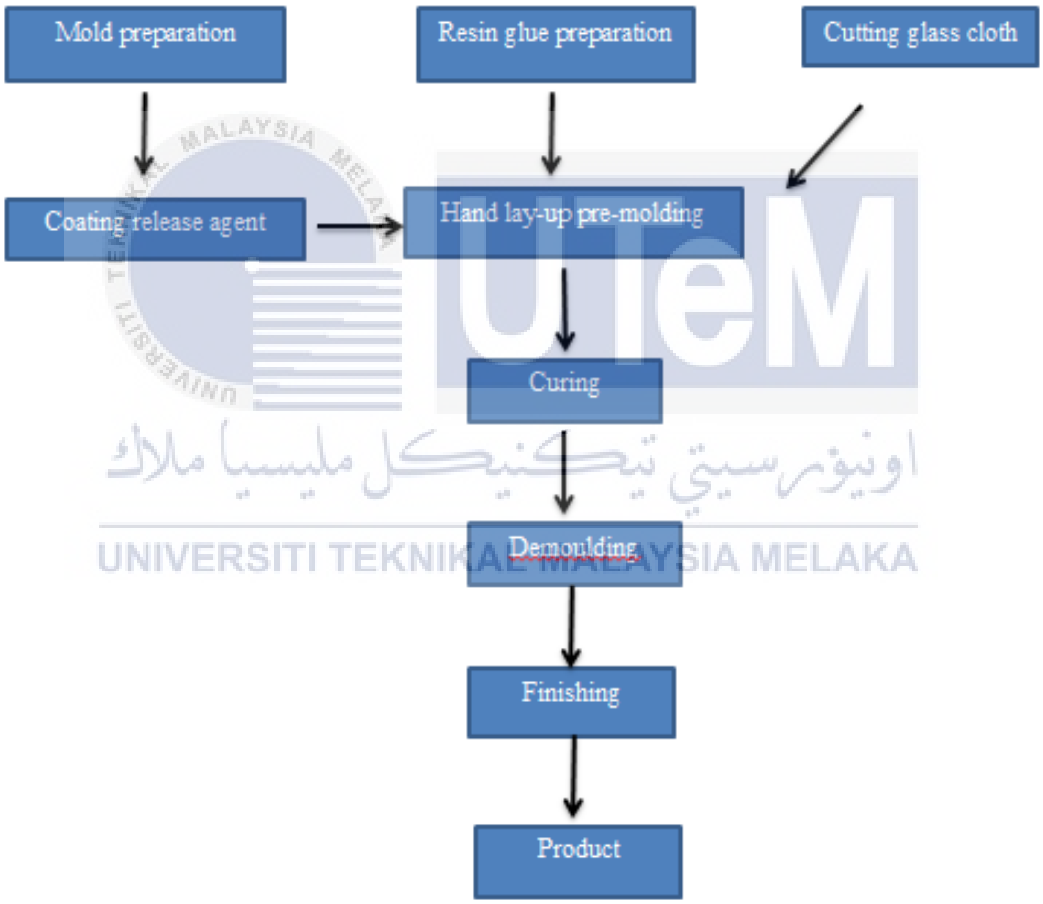

Figure 2.3 The process flow chart of preparing molding process FRP composite by hand lay-up (Achutha Kini et al., 2018)