
# SHELTER BASED DESIGN METHOD OF A LIGHTWEIGHT AND PORTABLE BY USING OIL PALM FIBER REINFORCED HONEYCOMB PANEL

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2021


## Faculty of Mechanical and Manufacturing Engineering Technology

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**(MUHAMMAD SALMAN BIN NOR AZMI**

**A thesis submitted**
**in fulfillment of the requirements for the degree of**
**Bachelor of Mechanical Engineering Technology Heat Ventilation and Air Conditioning (HVAC) with Honours**

**Faculty of Mechanical and Manufacturing Engineering Technology**

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**2021**

**DECLARATION**

I declare that this Choose an item. entitled “Shelter Based Design Method of a Lightweight and Portable by Using Oil Palm Fiber Reinforced Honeycomb Panel” 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.

| | | |
|---|---|---|
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| Date | : | 18/1/2022 |

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**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 Heat Ventilation and Air Conditioning (HVAC) with Honours.

Signature : .....

Supervisor Name : DR Muhammad Zulkarnain

Date : 26/2/2021

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**DEDICATION**

Alhamdulillah

Praise be to Allah for providing me with the strength, direction, and knowledge necessary to accomplish my research.

&

To my adoring parents and families, I want to express my gratitude for their unwavering support.

&

To my supervisor, Dr Muhammad Zulkarnain for guiding and advising me throughout this project.

&

To everyone who has helped me along the way

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## ABSTRACT

*Conceiving of and selecting concepts with the goal of translating practical users' requirements into a collection of shelter concepts. When faced with extreme weather conditions, the first and most basic requirement is to safeguard the displaced population from external agents. A more efficient alternative honeycomb production method must be pursued in light of the rising costs of electricity and raw materials. The ultimate goal of the cooperative development is to produce sandwich panels that meet technical criteria, are lighter in weight, and are more cost-effective when compared to currently available composite or metal alternatives, among other things. Cold processing is used to adhere the honeycomb preparation to the composite skin, which is made of aluminium alloy. The purpose of this investigation is to establish whether oil palm and epoxy aluminium honeycomb panels are suitable for use in the building of a shelter structure. Furthermore, the goal of this research is to develop a medium for building shelter out of oil palm debris and epoxy aluminium. The next step is to characterise the structure and toughness of a composite made of oil palm and epoxy aluminium alloy.*



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## *ABSTRAK*

*Memahami dan memilih konsep dengan tujuan menterjemahkan keperluan pengguna praktikal ke dalam kumpulan konsep perlindungan. Apabila menghadapi keadaan cuaca yang melampau, syarat pertama dan paling asas adalah melindungi penduduk yang terlantar dari agen luar. Kaedah pengeluaran sarang lebah alternatif yang lebih cekap mesti dilaksanakan memandangkan kenaikan kos elektrik dan bahan mentah. Matlamat utama pengembangan koperasi adalah untuk menghasilkan panel sandwic yang memenuhi kriteria teknikal, lebih ringan, dan lebih menjimatkan kos jika dibandingkan dengan alternatif komposit atau logam yang ada sekarang, antara lain. Pemprosesan sejuk digunakan untuk melekatkan penyediaan sarang lebah pada kulit komposit, yang diperbuat daripada aloi aluminium. Tujuan penyelidikan ini adalah untuk menentukan sama ada panel sarang lebah kelapa sawit dan epoksi sesuai digunakan dalam pembinaan struktur tempat perlindungan. Selanjutnya, tujuan penyelidikan ini adalah untuk mengembangkan media untuk membina tempat perlindungan dari serpihan kelapa sawit dan aluminium epoksi. Langkah seterusnya adalah mencirikan struktur dan ketangguhan komposit yang diperbuat daripada kelapa sawit dan aloi epoksi*



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## LIST OF SYMBOLS AND ABBREVIATIONS

| | | |
|---|---|---|
| D,d | - | Diameter |
| m | - | Metre |
| km | - | Kilometre |

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# CHAPTER 1

# INTRODUCTION

## 1.1 Background

For thousands of years, the use of wave modelling has been in place and continues to find new applications in the modern world. Through a wave design, a low density and high-strength material can be produced for various applications. The honeycomb takes its name from the hexagonal form of the bee's wall, which was used in various constructions over the last century with an increasing frequency

Honeycomb structures are natural or man-made structures with the honeycomb geometry to reduce the amount of material used to a minimum weight and material expenses. The geometry of wave structures can vary widely, but the basic characteristic of all such structures is a range of hole cells between thin vertical walls. Sometimes the cells are columnary and hexagonal. A structure in the honeycomb provides a substance with low density and relatively high out of-plane shear properties, (Li, Lin, et al., 2020)

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The honeycomb style has been used extensively since the 1980s. In large scale, enormous strength is practical with thermoplastic extruded honeycombs at an extremely low density. The honeycomb applications are all but unlimited. Modern buildings often use wall covered aluminum in a wave pattern for esthetics and strength. In certain cases, honeycomb-based isolation is often used for a compact and robust construction process. Structures such as the Honeycomb Bahamas apartment building, the Honey Bee Hive House in Israel and the modular British Hivehaus home design make use of the wave form

to the full. The honeycomb construction process is much better than it used to be with advanced materials, (Kumar & Patel, 2020)

Structural materials made from honeycomb are generally produced by laying a honeycomb material between two thin layers that provide tension resistance. This forms a platform-like mount. Wave materials are commonly used where flat or slightly curved surfaces are necessary and their high specific strength is important. For these reasons, they are commonly used in the aerospace industry and since the 1950s, honeycomb materials in aluminum, fibreglass and state-of-the-art composites have been present in avions and rockets. You can also find them in many other areas, from packaging materials in the shape of a paper carton to sports equipment such as skis and snowboards, (Li, Lu, et al., 2020)

## 1.2 Problem Statement

Many organic and biological materials in nature show excellent performance in various aspects and varied in mechanical performance. 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 Oil Palm 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 oil Palm 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

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## 1.3 Objective

The objectives of this project have been identified and should be achieved to produce a successful Lightweight and Portable by Using Oil Palm Fiber Reinforced Honeycomb. The objectives of this project are as followed:

1. To optimize Oil Palm fibre on polyster resin composite on flexural testing.

2. To fabricate sandwich of thin-walled honeycomb with Oil Palm fibre on resin polyster composite panel.

## 1.4 Scope of Research

In order to produce the best work, the scope is needed to support and guide project progress. These scopes should be properly defined and prepared. The scope of this project are listed as follow:

- Selection of terms to pass the needs of practical users in a range of refuge concepts. In extreme climatic conditions, protecting the displaced people from foreign agents is a first fundamental requirement.

- In view of the rising energy and raw material costs, more sustainable alternative output of wave must be the way forward.

- The Oil Palm fibers are collected from the local product by sun-drying process before apply as reinforcement.

- Material thin-walled honeycomb aluminum produces by commercial manufacturing in the market.

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# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

This chapter presenting the theory and research by previous findings that have been done regarding honeycomb panel and whole parameters relate to the honeycomb sandwich project. This project much concerned with developing a lightweight material and portable friendly by applying oil palm fiber reinforced honeycomb sandwich panel.

## 2.2 Lightweight and portable

### 2.2.1 Development of a shelter unit

Natural catastrophes evict thousands of people in the United States each year. Thousands more are chronically homeless, living on the streets and in parks throughout our cities. When people become homeless, emergency organizations such as the Federal Emergency Management Agency and the American Red Cross are typically responsible with providing emergency housing. Unfortunately, the present shelter-supply system is both complicated and expensive. Emergency shelter is typically provided by the military in the form of huge tents or through the usage of mobile houses. Both approaches are costly and difficult to implement logistically. The goal of this project is to create and test a novel system for providing emergency shelter. The construction of a recyclable shelter unit made of recyclable corrugated board material will be at the heart of this system. These shelter modules will be intended for short-term usage, generally up to three months, and will be completely recycled after that. The units will be light and affordable, and will be made up of a set of corrugated board panels that can be moved and constructed by two people. The setup

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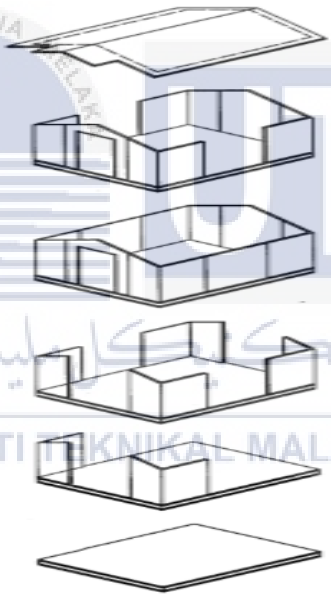
and connectivity will be designed to be easy enough for non-technical people to put together with common equipment. After a crisis, the units may be trucked or airlifted into catastrophe-stricken areas to offer nearly instantaneous refuge. These shelters may be supplied directly to the homeless by truck in winter areas to give protection from the dangerously cold weather as shown in Figure 2.1. The shelter may be readily dismantled and the materials recycled when the primary demand has been met. This project will take into account the economics of both the manufacture and distribution of the shelters, in addition to design issues, (Farmer et al., n.d, 2017)

Figure 2.1Two-person emergency shelter conceptual design, (Farmer et al., n.d,



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2017)

### 2.2.2 Water filled barrier with internal honeycomb cells.

Longitudinal traffic barriers are frequently employed as U.S. road safety elements to keep vehicles on the road and prevent them from colliding with harmful obstructions. Portable water-filled barriers (PWFBs) are one type of temporary longitudinal traffic barriers often employed in speed-limit zones and on the roadside. Current market PWFBs are cost-

effective, showing great efficiency while enduring low-speed vehicle impact. High-level impact severity, however, leads in structural failure and considerable lateral deflection. Based on evaluation criteria from the Assessment Safety Hardware Manual (MASH), some PWFBs are inefficient to fulfil the standards of recently published evaluation materials. In terms of impact loading, because newly designed PWFB with internal honeycomb cells intends to improve energy absorption behaviour and structural resistance. The PWFB with internal cells is built based on the JB-32 barrier prototype, where quadrangle-shaped honeycomb cells are bounded on the inside surface. In the early stages of this research, small-scale barrier specimens the energy absorption behaviour of water-filled barrier structure. Numerical simulation is accomplished with Finite Element Analysis (FEA) software (ABAQUS). Using the resulting FE, a parametric study is conducted to further validate the test observation. With both testing and numerical data, water absorption and system structural strength may be addressed A design advice and optimal condition is offered for the parametric study conducted, (Zhe Wang et al., 2019)

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Figure 2.2 Surface plot of energy absorption percentage combined with water level and length ratio, (Zhe Wang et al., 2019

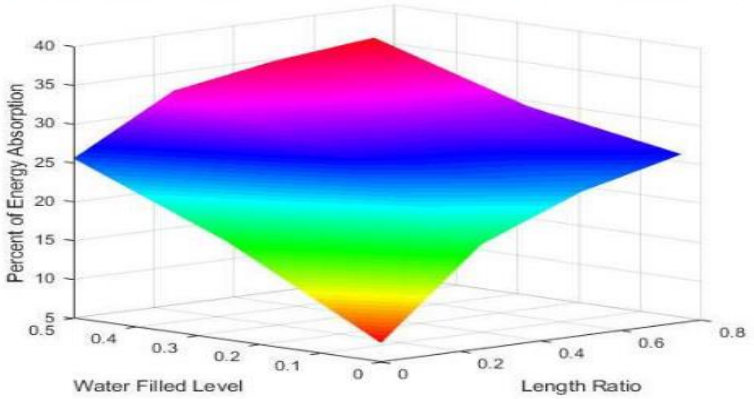


Figure 2.2 provides an overall design of variation in energy absorption in terms of the length and water level of friction BC. The overall energy absorption depends on two

variables: the proportion of length and the volume of water filled. Overall, optimizing the two variables in terms of total energy absorption will find the ideal solution. The global criteria technique successfully addresses the various objective issues that minimize objective functions.

### 2.2.3 Mechanical performances.

Fused Filament Manufacturing (FFF) offers a better geometric flexibility than traditional methods in the manufacture of thermoplastic lightweight sandwich structures. This research employed a 3D printer and biodegradable polylactic acid/polyhydroxyalkanoate (PLA/PHA) material to create lightweight sandwich constructions with honeycomb, diamond-celled, and corrugated core geometries as a single part. Compression, three-point bending, and tensile tests were used to assess the performance of lightweight sandwich constructions with various core topologies in this work. Furthermore, the primary failure mechanisms of the sandwich constructions that were submitted to mechanical testing were assessed. Face yielding, face wrinkling, and core/skin debonding were the most common failure mechanisms detected during mechanical tests of the sandwich construction. The use of elasto-plastic finite element analysis enables researchers to forecast the structure's overall behavior and stress distribution in the components of lightweight sandwich constructions. In terms of failure behavior and force response, the comparison of the results of bending experiments and finite element studies revealed satisfactory comparability. Finally, the three core typologies of honeycomb, diamond-celled, and corrugated cores were impact tested in the leading edge of the wing,

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