



**SHELTER BASED DESIGN METHOD OF A LIGHTWEIGHT AND
PORTABLE BY USING COCONUT FIBER REINFORCED
POLYPROPYLENE (PP) HONEYCOMB PANEL FOR TYPICAL
MALAYSIAN CLIMATE**



MOHAMAD IZMUL FAREEZ BIN AZMAN

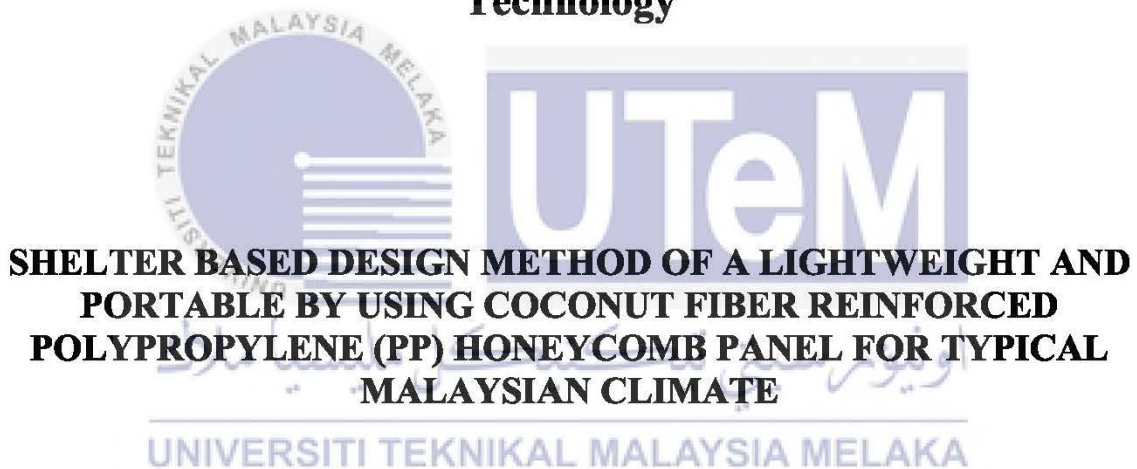
B091910290

**BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY
(REFRIGERATION AND AIR-CONDITIONING SYSTEMS) WITH
HONOURS**

2023



**Faculty of Mechanical and Manufacturing Engineering
Technology**



**SHELTER BASED DESIGN METHOD OF A LIGHTWEIGHT AND
PORTABLE BY USING COCONUT FIBER REINFORCED
POLYPROPYLENE (PP) HONEYCOMB PANEL FOR TYPICAL
MALAYSIAN CLIMATE**

Mohamad Izmul Fareez Bin Azman

**Bachelor of Mechanical Engineering Technology (Refrigeration and Air-
Conditioning Systems) with Honours**

2023

**SHELTER BASED DESIGN METHOD OF A LIGHTWEIGHT AND PORTABLE
BY USING COCONUT FIBER REINFORCED POLYPROPYLENE (PP)
HONEYCOMB PANEL FOR TYPICAL MALAYSIAN CLIMATE**

MOHAMAD IZMUL FAREEZ BIN AZMAN



Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I declare that this Choose an item. entitled “Shelter Based Design Method of a Lightweight and Portable by Using Coconut Fiber Reinforced polypropylene (pp) Honeycomb Panel For Typical Malaysian Climate” is the result of my research except as cited in the references. Choose an item. has not been accepted for any degree and is not concurrently submitted in the nature of any other degree.

Signature

:



Name

:

Mohamad Izmul Fareez Bin Azman

Date

:


20 JANUARY 2023

اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

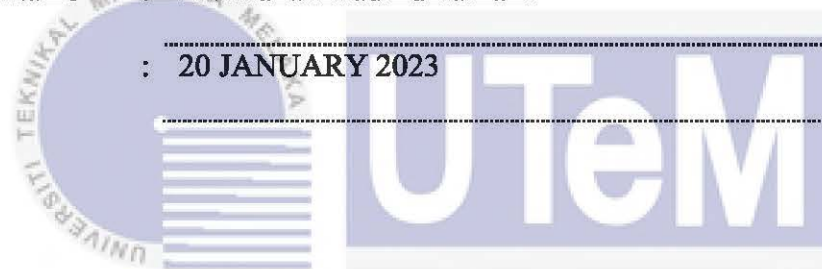
APPROVAL

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 (Refrigeration and Air-Conditioning Systems) with Honours.

Signature : 

Supervisor Name : Dr. Muhammad Zulkarnain

Date : 20 JANUARY 2023



اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEDICATION

This research is the fruit of countless and arduous sacrifices. Through the effort, this research is heartily and proudly dedicated to the people who serve as an inspiration. From parents and guardians to classmates and circle of friends, everyone offered assistance when challenges arose at work. To the faculty and staff of University Teknikal Malaysia Melaka, and, most importantly, to our Almighty God, who has blessed us with time and direction in carrying out this research.



ABSTRACT

The honeycomb sandwich-based shelter became the choice because it was based on current events making it an inspiration to do this study. Things that happen as the situation of flood victims who live in hardship and face difficulties when their homes collapse and are destroyed when the flood season arrives. Through this problem, an idea was born to build a dwelling that is easy to move, light, and durable to facilitate its users during a disaster or in trouble. In addition, as we all know, Malaysia is a tropical country rich in treasures and natural resources. Malaysia is also a high producer of coconut among Asian countries in the world. Inspired by this, coconut fiber is the choice as a natural fiber to be used as the main material for the experiment. Coconut fiber obtained from coconuts will be mixed with polypropylene to produce a composite of honeycomb-shaped aluminum that acts as a sandwich to the composite. The objective of this study is to fabricate a coconut fiber sandwich and investigate the thermal conductivity of honeycomb sandwich coconut fiber reinforcement. Next, the scope of this project is an analytical study that focuses on coconut fiber with polyester resin as a composite that attaches to an aluminum honeycomb as a sandwich material. In addition, coconut fiber is treated with carbonate to eliminate unwanted particles before being prepared as reinforcement, and standard thermal testing used to analyze the thermal distribution of honeycomb. Everything that was told was told in detail in chapter one, then entered chapter two told the literature review about the materials used following previous studies. Through it, we are told about natural fibers and examples of natural fibers that are found around us, composites and how to produce composites, honeycomb type of composites and the types of composites that exist, and material preparation found in past studies which are about guidelines for treatment on natural fiber materials that have been selected and testing that has been done through previous studies. this is done to help to choose the best way that we will do during the experiment to get good results for the study. This chapter is told in detail about the things that are stated for understanding and appropriate reports can be done to continue this experiment. Then, the third chapter told about the method and method of research used during the experiment. Therefore, all the processes and methods are told in more detail about what is carried out. This aims to provide an understanding of how the work is done in order to help get accurate information about the title and the study that made it. In addition, the next chapter tells about the results and discussions made as a result of experiments conducted in the previous chapter. It aims to detail the findings of the study and the important evidence for each question that arises in the future. Finally, conclusions and recommendations are presented in the last chapter to give emphasis to reemphasized and recommendations to those who want to do research on natural fiber in the future.

ABSTRAK

Rumah perlindungan berasaskan sandwich sarang lebah menjadi pilihan kerana berdasarkan peristiwa semasa menjadikannya inspirasi untuk melakukan kajian ini. Perkara yang berlaku seperti keadaan mangsa banjir yang hidup dalam kesusahan dan menghadapi kesusahan apabila rumah mereka runtuh dan musnah apabila tiba musim banjir. Melalui masalah ini lahirlah idea untuk membina sebuah kediaman yang mudah dialihkan, ringan dan tahan lasak bagi memudahkan penggunaanya ketika ditimpa musibah atau kesusahan. Selain itu, seperti yang kita sedia maklum, Malaysia merupakan sebuah negara tropika yang kaya dengan khazanah dan sumber asli. Malaysia juga merupakan pengeluar kelapa yang tinggi di kalangan negara Asia di dunia. Diilhamkan daripada ini, sabut kelapa menjadi pilihan sebagai serat asli untuk digunakan sebagai bahan utama untuk eksperimen. Sabut kelapa yang diperolehi daripada kelapa akan dicampur dengan polipropilena untuk menghasilkan komposit kepada aluminium berbentuk sarang lebah yang bertindak sebagai sandwich kepada komposit. Objektif kajian ini adalah untuk menghasilkan sandwich sabut kelapa dan menyiasat kekonduksian terma tetulang sabut sarang lebah sarang lebah. Seterusnya, skop projek ini adalah kajian analitikal yang memfokuskan kepada sabut kelapa dengan resin poliester sebagai komposit yang melekat pada sarang lebah aluminium sebagai bahan sandwich. Selain itu, sabut kelapa dirawat dengan karbinat untuk menghilangkan zarah yang tidak diinginkan sebelum disediakan sebagai tetulang. dan ujian haba piawai yang digunakan untuk menganalisis taburan haba sarang lebah. Segala yang diceritakan diceritakan secara terperinci dalam bab satu, kemudian masuk bab dua untuk menceritakan tentang kajian literatur tentang bahan yang digunakan berikutan melalui kajian lepas. Melaluinya, kita diberitahu tentang gentian asli dan contoh gentian asli yang terdapat di sekeliling kita, komposit dan cara menghasilkan komposit, jenis komposit sarang lebah dan jenis komposit yang wujud, penyediaan bahan yang terdapat dalam kajian lepas iaitu tentang panduan untuk rawatan ke atas bahan gentian asli yang telah dipilih dan ujian yang telah dilakukan melalui kajian lepas. ini dilakukan untuk membantu memilih cara terbaik yang akan kami lakukan semasa eksperimen untuk mendapatkan keputusan yang baik untuk kajian. Melalui bab ini diceritakan secara terperinci tentang perkara-perkara yang dinyatakan bagi tujuan pemahaman dan laporan yang sewajarnya boleh dilakukan bagi meneruskan eksperimen ini. Kemudian, pada bab ketiga diceritakan tentang kaedah dan kaedah kajian yang digunakan semasa eksperimen dijalankan. Oleh itu, semua proses dan kaedah diberitahu dengan lebih terperinci tentang anda dijalankan. Ini bertujuan untuk memberi kefahaman tentang cara kerja dilakukan agar dapat membantu pembaca mendapatkan maklumat yang tepat tentang tajuk dan kajian yang dibuat. Selain itu, melalui bab seterusnya menceritakan tentang hasil dan perbincangan yang dibuat hasil daripada eksperimen yang dijalankan pada bab yang lepas. Ia bertujuan memperincikan dapatan kajian dan bukti penting bagi setiap persoalan yang timbul pada masa hadapan. Akhir sekali, kesimpulan dan cadangan dibentangkan dalam bab terakhir untuk memberi penekanan kepada projek atau kajian yang dibuat dan cadangan kepada mereka yang ingin membuat kajian tentang gentian asli pada masa hadapan.

ACKNOWLEDGEMENTS

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

First and foremost, I would like to thank 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 lecturer at Universiti Teknikal Malaysia Melaka (UTeM), for all his support, advice, and inspiration. His constant patience in guiding and providing priceless insights will forever be remembered.

Last but not least, from the bottom of my heart gratitude to my beloved mother, Zuraida Binti Ibrahim, for her encouragement who has Behance an amplifier of strength in all my endeavors. My eternal love also to all my siblings, Azia Zuraikha, Alia Amalin, Syamil Haikal, Ayuni Aleesya, and Syakir Izuddin, for their patience and understanding. I would also like to thank my beloved person Amilia Farzana for their endless support, love, and prayers. Finally, thank you to all the individuals were provided the assistance, support, and inspiration to embark on my study.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

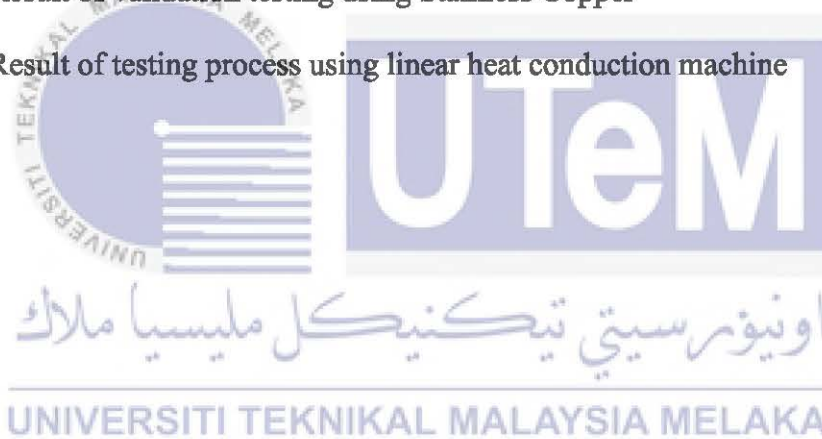
TABLE OF CONTENTS

	PAGE
DECLARATION	
APPROVAL	
DEDICATION	
ABSTRACT	i
ABSTRAK	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	vi
LIST OF FIGURES	vii
LIST OF SYMBOLS AND ABBREVIATIONS	ix
LIST OF APPENDICES	x
CHAPTER 1 INTRODUCTION	11
1.1 Background	11
1.2 Problem Statement	13
1.3 Research Objective	13
1.4 Scope of Research	14
CHAPTER 2 LITERATURE REVIEW	15
2.1 Introduction	15
2.2 Natural fiber	15
2.2.1 Plant fibers	16
2.2.2 Animal fibers	17
2.3 Composite	18
2.3.1 Background of composite	18
2.3.2 Fabrication of composite materials	19
2.3.3 Mechanical performance of natural fiber composite	24
2.3.4 Types of composite materials	25
2.4 Honeycomb	27
2.4.1 Honeycomb structure	27
2.4.2 Manufacturing of honeycomb composite	28
2.4.3 Types of honeycombs composites	29
2.5 Material preparation	32
2.5.1 Chemical treatment of natural fiber with alkaline treatment	32
2.5.2 Chemical treatment of natural fiber with acetylation of natural fiber	32

2.6	Testing	34
2.6.1	Mechanical testing	34
2.6.2	Water absorption	36
2.6.3	Thermal conductivity	38
2.7	Summary	40
CHAPTER 3 METHODOLOGY		41
3.1	Introduction	41
3.2	Flowchart	42
3.3	Experiment setup	43
3.3.1	Fiber extraction process	43
3.3.2	Chemical treatment of coconut fiber	43
3.3.3	Sample preparation	44
3.4	Material testing	49
3.5	Material properties	53
3.6	Summary	54
CHAPTER 4 RESULTS AND DISCUSSION		55
4.1	Introduction	55
4.2	Results and Analysis of testing process	55
4.2.1	Validation	56
4.2.2	Table result of testing process	58
4.2.3	Calculation of Thermal Conductivity	60
4.2.4	Graph of Thermal conductivity vs Amount of fiber	62
4.3	Summary	63
CHAPTER 5 CONCLUSION AND RECOMMENDATIONS		64
5.1	Conclusion	64
5.2	Recommendations	66
REFERENCES		67
APPENDIX A		71
APPENDIX B		72
APPENDIX C		73

LIST OF TABLES

TABLE	TITLE	PAGE
Table 2.1	Example of plant fiber	17
Table 2.2	Thermoplastic vs thermoset	23
Table 2.3	Mechanical test of natural fiber composite.	25
Table 3.1	Material properties of aluminium panel sheets	53
Table 3.2	Material properties of coconut fibers	53
Table 4.1	Result of validation testing using Stainless Copper	56
Table 4.2	Result of testing process using linear heat conduction machine	58



LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 2.1	Coconut fiber from plant fiber.	17
Figure 2.2	Example of animal fiber that is from silkworms	18
Figure 2.3	Composite combination	21
Figure 2.4	The types of composite material	26
Figure 2.5	Honeycomb structure with panels	29
Figure 2.6	Aluminium honeycomb	30
Figure 2.7	Nomex honeycomb	30
Figure 2.8	Thermoplastic honeycomb	31
Figure 2.9	Stainless steel honeycomb	31
Figure 2.10	Tensile strength of the PP-Fiber composites, untreated, CMUV and CCUV samples.	34
Figure 2.11	Water absorption of untreated fiber	36
Figure 2.12	Mechanically treated PP-Fiber (CMUV)	37
Figure 2.13	Chemically treated PP-Fiber composites (CCUV)	37
Figure 2.14	Test device for thermal conductivity, (Heat Flow Meter -HFM 436 Lambda).	38
Figure 2.15	Specimen holder.	39
Figure 2.16	Relationship between thermal conductivity and density of coconut fibers.	39
Figure 3.1	Flow chart diagram	42
Figure 3.2	Preparing process of coconut fiber	43

Figure 3.3	The treatment process with NaOH 2 wt.%	44
Figure 3.4	Process of evaporation coconut fiber	44
Figure 3.5	The method of randomly cutting coconut fiber using a grinder	45
Figure 3.6	Ratio of hardener uses for mixture composite	45
Figure 3.7	Mold preparation	46
Figure 3.8	Mixing process of resin and hardener	46
Figure 3.9	Composite making process	47
Figure 3.10	Sample of composite	48
Figure 3.11	Cutting process using bandsaw	49
Figure 3.12	Honeycomb sandwich composite	49
Figure 3.13	Honeycomb sandwich composite with insulation	50
Figure 3.14	Linear heat conduction mechine	51
Figure 3.15	Thermal conductivity formula	52
Figure 3.16	Testing process	52
Figure 4.1	Graph of thermal conductivity vs Amount of fiber.	62

LIST OF SYMBOLS AND ABBREVIATIONS

BC	-	Before Christ
GFRP	-	Glass-Fiber Reinforced Plastic
UV	-	Ultraviolet radiation
NaOH	-	Sodium hydroxide
CH ₃ COO ⁻	-	Acetate
CH ₃ COOH	-	Acetic acid
H ₂ SO ₄	-	Sulfuric acid
PP	-	Polypropylene
K	-	Thermal conductivity



LIST OF APPENDICES

APPENDIX	TITLE	PAGE
APPENDIX A:	Gannt chart	72
APPENDIX B:	Result of testing process using linear heat conduction machine	73
APPENDIX C:	Graph of thermal conductivity vs Amount of fiber	74



CHAPTER 1

INTRODUCTION

1.1 Background

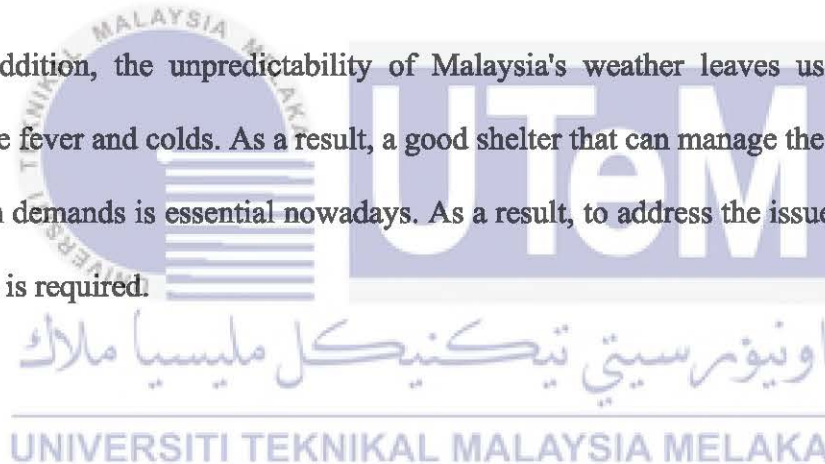
Shelter is the most important thing for every living thing in this world, especially for humans. Shelter is defined as a place that gives temporary protection from the elements of danger. In other words, it is a basic architectural structure or building that shields people from the elements. The man had to rely on the natural environment for shelter until he discovered how to build his own. The first types of shelter were those found in trees, which only provided modest protection from the burning heat of the sun and the chilling cold of the rain. Nowadays, shelters exist in many different sizes and sorts of items, for example, tents. Furthermore, tents are built of a variety of materials, including nylon. Tents, on the other hand, have several flaws that must be addressed because a decent shelter must meet specific criteria such as lightweight, strong durability, ease of movement, and a comfortable temperature when inside. Aside from that, discusses the advantages and disadvantages of tents. In summary, the article reveals that tents have a variety of flaws depending on their nature; for example, a polyester tent is not breathable, hence these shelters require ventilation at high altitudes, and during severe weather, the polyester tent will not provide appropriate protection that is it is unable to withstand the noise produced by wind and other elements(Ullal *et al.*, 2022).

Furthermore, Malaysia's climate is subjected to annual monsoon waves, which can be disastrous in some areas due to the high frequency of rain and storms. Because of that, the tent is an alternative shelter that is easy to put up in an emergency for temporary accommodation for flood victims because the tent is an alternative shelter that is easy to set up to keep flood victims safe and allow them some privacy while at the evacuation center victims of the floods. However, even though tents are provided at flood victims' evacuation centers, they still require a hall to put up tents because the tents' construction is not strong enough to be set up in an open location. As it is pushed according to the capacity of the hall area, this invariably results in a disadvantage. As a result of these issues, this study was created to test the material to see if it met the criteria of being lightweight, easy to move, and sturdy enough to be utilized to build a shelter. Coconut fiber was chosen since it is a natural material that is readily available in Malaysia. The research aim is to study the temperature equilibrium which is adequate for the Malaysian climate. In addition, the research concerning coconut fiber potential regarding thermal insulators to counter Malaysia's climate which synergy to refugee's safety and health advantages. Finally, the research observes a random of lengths of fibers to examine the accuracy about the suitability required in the random distribution technique.

1.2 Problem Statement

Nowadays, shelter is a requirement for humans since it protects them from many risks and provides a private space for them and their families. This research is centered on the issues that develop as a result of the Malaysian floods. As we all know, when a home is flooded, it is compelled to relocate to a safer location. As a result, there were issues with the usage of tents in the hall where the flood victims were evacuated, resulting in a lack of capacity to accommodate more victims. This creates a dilemma because the tent cannot be used outside the venue due to inclement weather. As a result, a solution that requires a better shelter than a tent is required.

In addition, the unpredictability of Malaysia's weather leaves us vulnerable to ailments like fever and colds. As a result, a good shelter that can manage the temperature to meet human demands is essential nowadays. As a result, to address the issues, a new blend of materials is required.



1.3 Research Objective

- 1) To fabricate sandwich coconut fiber/polyester resin and aluminum honeycomb panel.
- 2) To investigate the thermal conductivity of the honeycomb sandwich coconut fiber reinforcement

1.4 Scope of Research

The scope of this research is as follows:

- 1) The research analysis is focused on coconut fiber with polyester resin as a composite sheet that attaches to aluminum honeycomb as sandwich material.
- 2) The coconut fiber is treated with carbonate to eliminate unwanted particles before being prepared as reinforcement fiber.
- 3) The fiber lengths are varied during thermal analysis of randomly distributed technique as a composite sheet.
- 4) The coconut fiber is a waste local product that supplies from varied sources in Malacca state.
- 5) Standard thermal testing is used to analyze the thermal conductivity of honeycomb sandwiches.



CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discussed how to comprehend the study's key subject. Natural fiber has to be discussed first, followed by composites, honeycomb, material preparation, and testing. This chapter covers the entire main information, including the findings of internet reference searches, journal readings, previous studies, and reference books.

2.2 Natural fiber

Natural fibers are fibers formed as a result of geological processes or from plant or animal bodies. Most natural fibers are known for their ability to absorb sweat and other fluids (Mathur, 2021). The discovery of wool and colored flax fibers in an ancient cave in the Republic of Georgia 36,000 years ago is the oldest indication of the use of human fibers (Ganguly *et al.*, 2022). Natural fibers are classified into two parts, namely natural fibers from plants and natural fibers from animals. Different natural fibers can produce different types of textures. The cotton fiber, for example, is a natural fiber derived from the cotton plant used in the creation of cotton garments distinguished by its low weight and delicate taste. Another feature of the cotton fiber is that it can be made into clothing in various sizes and colors. Clothing made from natural fibers, such as cotton, is often chosen over clothing made from synthetic fibers, especially by those living in hot and humid climates (Eng and Koh, 2022). It can be used in composite materials where the orientation of the fibers affects the properties. Natural fibers can also be coated and shaped into pieces to produce paper or fabric. In addition, looking at the history of the discovery of natural fiber, because of its good

nature and ease to obtain, humans chose natural fiber for clothing and equipment of daily use such as farming and hunting animals to be used as food in ancient times. Clothes were made of the skins of animals such as sheep in ancient times. Sheepskin is treated and dried before being worn regularly, especially during the winter. This is because the technology was still not advanced in ancient times, forcing early humans to rely on nature to exist. As a result, natural fibers are the result of earlier human concepts.

2.2.1 Plant fibers

As we are aware, there are many natural fibers from plants, for example, coconut fiber is a natural fiber that is widely used in the construction industry. It is usually used as a mixed composite to strengthen the skeletal structure of the material. The most famous fiber waste from coconut crops is coconut fiber. Coconuts are abundant in the coastal areas of tropical countries and produce at least 30 million tons per year (Bakatovich and Gaspar, 2019). Coconut fiber is very elastic, strong, and rot-resistant due to its high lignin concentration. As a result, coconut fiber is an excellent choice for indoor use. Figure 2.1 shows a picture of coconut fiber made from natural fiber. In Europe, for example, the automobile industry lined cars with coconut fiber as a rope wrapped with a rubber band to show its durability (Li *et al.*, 2022). Coconut fiber consists of 30% fiber and 70% pith, with high levels of lignin and phenolic compounds (Unnikrishnan, 2022). However, in plant fiber, there are still many types and other useful properties. Table 2.1 shows the characteristics and types of plant fibers and their uses by category.



Figure 2.1 Coconut fiber from plant fiber.

Table 2.1 Example of plant fiber

Category	types
Seed fiber	Seed fibers are the fibers extracted from the seeds of various plants. Cotton is the most relevant example.
Leaf fiber	Leaf fibers are fibers obtained from the cells of a leaf, such as banana, pineapple (PALF), and others.
Bast fiber	Bast fibers are isolated from the plant's stem's outer cell layers. Fabric, paper, and packaging, are all made with these fibers. For example is kenaf and rattan
Fruit fiber	Coconut fiber, for example, is obtained from the fruit of the plant (coir).
Stalk fiber	Fibers are derived from plant stalks, such as wheat and bamboo.

2.2.2 Animal fibers

Animal fiber is a type of natural fiber composed of proteins such as fibroin, keratin, and collagen. Silk, for example, is made from animal fibers derived from silkworms, and it produces very high-quality fabrics with high values due to their scarcity. The sinuses are animal fibers that join the muscles and bones of certain animals. Animal fiber was very important to ancient humans because they prepared it for use as hand tools for food hunting and farming purposes (Antico *et al.*, 2021). However, nowadays, many industries commercialize the products of this animal fiber such as the famous brand Chanel which

processes the skin from animals to be made into women's handbags that certain sheep are then used as winter clothing. Finally, Angora goat hair is used to make mohair animal fiber. Because of their silky texture, fibers from these animals are commonly used to make clothing(Saunier *et al.*, 2022). However, there are animal fibers that are used as medicine and have nutrients. Figure 2.2 shows the examples of animal fibers from silkworms.



Figure 2.2 Example of animal fiber that is from silkworms

2.3 Composite

2.3.1 Background of composite

A composite material is sometimes referred to as composition material or composite, which is a general term for a substance made up of two or more basic elements. These constituent elements have vastly diverse natural or substantial properties, and when combined, they produce a substance with characteristics not seen in the separate constituents. Composites differ from mixes and solid solutions in that individual elements in the completed structure stay separate and distinct. (Aruntas, 2022). The composite's various materials work together to give it its distinct features. Composite materials have been developed by humans since ancient times for a range of uses. Around 1500 BC, early Egyptians and Mesopotamian immigrants used a combination of mud and straw to construct