Faculty of Mechanical Engineering

THERMAL INSULATION MATERIAL MADE FROM KENAF COMPOSITE

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SUPERVISOR'S DECLARATION

I hereby declare that I have read this project report and it is sufficient in terms of scope and quality for the award of the Bachelor of Mechanical Engineering.

Signature	**:...**
Name of Supervisor	**:Shamsul Bahari Bin Azraai**
Date	**:...**

DECLARATION

“I hereby declare that the work in this report is my own except for summaries quotations which have been duly acknowledged.”

Signature : ………………….

Author : Chong Yung Oon

Date : …………………..

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ABSTRACT

This project focus on using experimental methods to determine the properties of thermal insulation material made from kenaf composite. The kenaf composite is made of kenaf powder and polypropylene (PP) pellets but divided to four different proportion, which are 20% Kenaf 80% PP, 30% Kenaf 70% PP, 40% Kenaf 60% PP and 50% Kenaf 50% PP. The properties of material to be obtained from the experiment include of thermal conductivity, tensile strength and flexural strength. Experiment stage consists fabrication of specimen, fitting of specimen and testing of specimen. From the results, the thermal insulation properties of composite directly proportional to the natural fiber content. As the kenaf content increase, the thermal insulation properties of composite also increase. Tensile and flexural strength of kenaf composite were improved when compared to the raw material. Overall, the composite with the proportion of 30% Kenaf 70% PP showed the highest average properties compared to other proportions. It had been selected as most suitable proportion of kenaf composite to be used as thermal insulation material.

ABSTRAK

Projek ini menumpukan kepada penggunaan eksperimen untuk mencari sifat bahan penebat haba yang diperbuat daripada komposit kenaf. Komposit kenaf diperbuat daripada serbuk kenaf dan polipropilena (PP) tetapi dibahagikan kepada empat bahagian yang berlainan iaitu 20% Kenaf 80% PP, 30% Kenaf 70% PP, 40% Kenaf 60% PP dan 50% Kenaf 50% PP . Sifat-sifat bahan yang diperolehi daripada eksperimen termasuk kekonduksian terma, kekuatan tegangan dan kekuatan lenturan. Peringkat eksperimen terdiri daripada fabrikasi spesimen, pemotongan spesimen dan pengujian spesimen. Daripada hasilnya, sifat penebat haba komposit yang berkadar langsung dengan kandungan serat semula jadi. Apabila kandungan kenaf meningkat, sifat penebat haba dalam komposit juga meningkat. Kekuatan tegangan dan lenturan komposit kenaf bertambah baik apabila dibandingkan dengan bahan mentah. Keseluruhannya, komposit dengan nisbah 30% Kenaf 70% PP menunjukkan sifat purata tertinggi berbanding dengan bahagian lain. Ia telah dipilih sebagai nisbah yang paling sesuai bagi komposit kenaf untuk digunakan sebagai bahan penebat haba.

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LIST OF ABBREVIATIONS

NF	Natural Fiber
KF	Kenaf Fiber
KBF	Kenaf Bast Fiber
PP	Polypropylene
SEM	Scanning Electron Microscope
CMC	Ceramic Matrix Composite
MMC	Metal Matrix Composite
PMC	Polymer Matrix Composite
rPP	Recycled Polypropylene
KPNC	Kenaf and Polypropylene Nonwoven Composite
KBFB	Kenaf Bast Fiber Bundle
MH	Magnesium Hydroxide
RPM	Revolution Per Minute
TGA	Thermogravimetric Analysis

LIST OF SYMBOLS

k	=	Thermal Conductivity
Q	=	Amount of Heat Transfer
t	=	Time
A	=	Cross-sectional Area
ΔT	=	Temperature Difference
d	=	Length/Thickness
E	=	Young's Modulus
F	=	Force
L_o/ℓ_o	=	Original Length
L_n/ℓ	=	New Length
σ	=	Stress
ε	=	Strain
e	=	Elongation
I	=	Current
V	=	Voltage
ΔX	=	Length Difference
R	=	Rate of crosshead motion, mm/min
L_s	=	Support Span, mm
D_b	=	Depth of Beam, mm
Z	=	Rate of Straining of the Outer Fiber

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Global resources are draining very fast and some of them may facing extinct problem not far in the future. Human traced out this problem and provide a solution to shift to renewable resources. Renewable resources attract the attention from everyone and become preferred choice for public after on. This is because renewable resources can never use up and friendly toward environment. Concept of green enable public to concern more about environment than concern about social fields (German Polish Ukrainian Society, 2017). A lot of green products are made using the renewable resources to reduce the pollution to environment. This is because green products are biodegradable which will not left after certain time.

Natural fibers (NFs) from renewable resources such as kenaf bast fiber (KBF) is very good material option to create green product. Kenaf (Hibiscus cannabinus, L. family Malvaceae) is seen as an herbaceous annual plant that can be grown under a wide range of weather condition. Kenaf is easy to get from market and the price is affordable. It can use to reinforce with binder to create a bicomposite thermal insulation material. Thermal insulation defined as the progress of insulation against transmission of heat (Merriam-webmaster, 2017). This means reinforced kenaf composite is a useful invention under green concept which provide conveniences to human and upgrade the human living quality. This product is then used in construction sector to improve the building energy management.

Polypropylene (PP) is a common use binder for kenaf bast fiber to be reinforced into thermal insulate material. Among binder option, polypropylene is chose because it got very low thermal conductivity. Low thermal conductivity indicate it is very good thermal insulator as it blocks heat energy to penetrate through it.

As kenaf bast fiber reinforced with polypropylene, a green concept product, kenaf composite with better thermal insulation properties is created. However, the thermal insulation properties of this kenaf composite has slightly different for the different portion of the materials. The proportion for the kenaf bast fiber and polypropylene directly affect the thermal conductivity of kenaf composite.

Generally, kenaf composite is a very useful green product. It is biodegradable which mean it might totally compost after some time. Most of the time kenaf composite is produced in the industry in large scale. The materials need to go through some manufacturing process such as hot mixing, grinding and hot pressing before become complete product. This kenaf composite is widely used in construction to block the heat energy from outdoor transmit into indoor. It was use as roof material or wall mounting material.

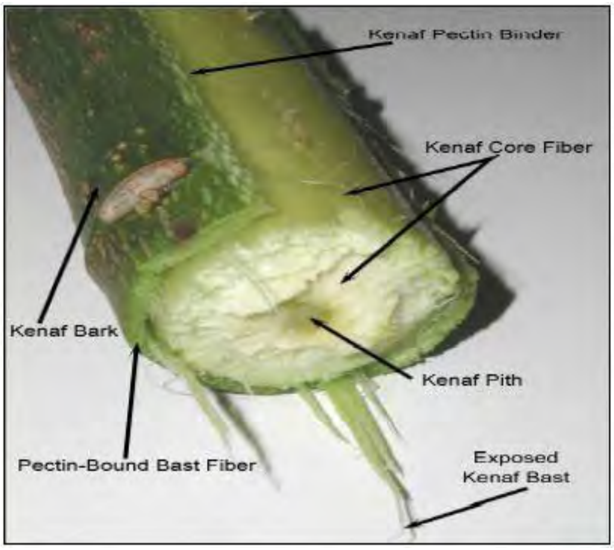

Figure 1.1 Exposed Physical Appearance of Kenaf

1.2 PROBLEM STATEMENT

Global warming issue is not a surprising news. The problem is the global temperature still rising all the time. This situation has caused outdoor temperature to have significant difference when compared to indoor temperature especially for hot season country. Malaysia is a hot season country which located at the equator of the earth. Heat energy from the sun is directly irradiate to building outside. When the outdoor temperature rises due to hot weather, the human stay in indoor would also feel uncomfortable because the heat energy from outside will definitely transmit into indoor in term of conduction, convection and radiation. Rooftop and wall are the most common substances that could transmit heat from outside into inside after exposed to sunlight for a long time. Thermal insulation is needed for building to prevent transmission of heat from outdoor to indoor. By acquiring the thermal insulation material at outer face of building, the heat transmitted to indoor is believe to be reduce. Human who stay in not comfortable surrounding is hard to achieve any productivity. Here come the problem. What is the material that suitable to use for building construction? What is the properties that should behaved by this material in order to achieve requirement of a building construction material?

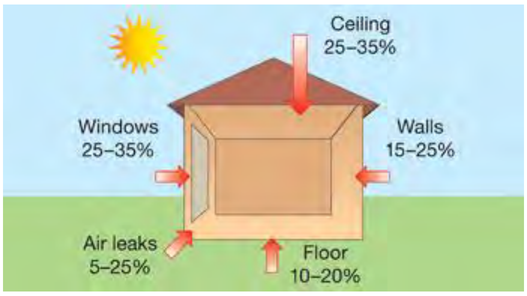

Figure 1.2 The Way House Gain Heat from Sun.

1.3 OBJECTIVE

The objectives of this project are as follow:

1. To determine and compare the Thermal Conductivity Value, k of kenaf composite for different proportion of composite materials.
2. To determine and compare the Tensile Stress of kenaf composite for different proportion of composite materials.
3. To determine and compare the Flexural Stress of kenaf composite for different proportion of composite materials.
4. To compare the experimental results to the previous results stated in journals.

1.4 SCOPE OF PROJECT

The scopes of this project are:

1. Fabricate kenaf composites for different proportion of composite materials.
2. Testing and comparing kenaf composite for different proportion of composite materials on thermal conductivity.
3. Testing and comparing kenaf composite for different proportion of composite materials on tensile strength and flexural strength.
4. Summarise and propose a best kenaf composite to use as thermal insulation material.

CHAPTER 2

LITERATURE REVIEW

2.1 NATURAL FIBER

Natural fibers are string type of substances like thread made by plants and animals. Most of the time, these fiber derived from specifically grown textile plants and fruit trees. Common source of natural fibers can be gained from some plant. For example, coconut, cotton, flax, hemp and kenaf. The benefit of natural fiber is it do not harm environment as it is biodegradable. Natural fibers are use to reinforce or filler material in the fabrication of composites. This is because public interest toward environmental has increased a lot. Human race found out the problem and thinking of use sustainable materials to replace non-renewable source (Bajuri, Mazlan, Ishak, & Imatomi, 2016).

Commonly, natural fiber could be classified based on their source of origin which are animal, plant and mineral. Animal fiber is commonly made from grandular secretion of some insects such as silk. It composed molecular structure material such as keratin. Plant fiber is made of cellulose, which has circular cross section and elongated structure. Plant fiber can be classified to seed fibers, stem fibers, leaf fibers and fruit fibers. Mineral fibers made of fibrous structure which is normally found in mineral such as rock.

When doing comparison among animal, plant and mineral fiber, plant fiber is the most famous and common use. This may due to advantages of plant fiber such as abundance, low cost and low density. It also can absorb carbon dioxide from the environment, renewability and biodegradability which is considered as eco-friendly. However, the disadvantages of this plant fiber still exist. Plant fiber has low thermal stability, lower mechanical properties, low resistance to microorganism and high moisture absorption (Fibrenamics, 2017).

2.2 KENAF

As one of the natural fiber, kenaf is fiber plant native to east-central Africa when it has been grown for thousands year for the purpose food and fiber. Kenaf, is known as Hibiscus cannabinus species, which is a fast growing plant. Kenaf started to be known in late 18th century. After kenaf is known, it was encouraged to be cultivate and produce in large scale during World War II (Encyclopaedia Britannica, 2017).

Kenaf can grow up to 18 feet (5.5 meters) in height and its fiber concentrated mainly at lower part. Kenaf is strong and tough plant. It can grow in very uncomfortable environment, and able to adopt many different types of soil.

Kenaf is new trading material in international. Thus, its demand in market is still not so high. However, high yield rate of kenaf become one of the option of trader.

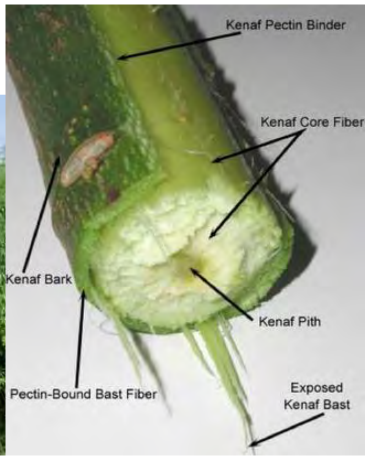

Figure 2.1 Kenaf Plant Field Figure 2.2 Kenaf Structure (kencoind, 2017)

Kenaf is an herbaceous annual plant that can grow in any weather conditions, and it has been dominated to use as rope and other things. Kenaf has been deemed extremely environmentally friendly for two main reasons; (a) it congests carbon dioxide at a significantly high rate and (b) it absorbs nitrogen and phosphorous from the soil. In additional, kenaf, displays the properties same to other natural fibers, includes low density, high specific mechanical properties, and is easily recycled (Zampaloni et al., 2007).

A study was conducted on mechanical properties of kenaf-polyesters composite. According to this study (My, Pt, Ip, & Ar, 2011), they used and tested kenaf fiber as a high potential reinforced material in thermosets and thermoplastics composites. Modification is required and mechanical properties for composites product can be further improved by doing some research. The efficiency of the fiber-reinforced composites also depends on the manufacturing process. In their research, polyester resin, sodium hydroxide (NaOH), and kenaf fiber that needed to go through the retting process were prepared. Kenaf fibers were soaked in five different chemical solution for different chemical treatment.