THERMAL PERFORMANCE OF KENAF COMPOSITE BY IES SIMULATION

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This report is submitted
in fulfillment of the requirement for the degree of
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DECLARATION

I declare that this project report entitled "Thermal performance of kenaf composite by IES simulation" is the result of my own work except as cited in the references

Signature	:	....
Name	:	....
Date	:	....

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Thermo-Fluids).

Signature :. ....

Name of Supervisor : ....

Date : ....

DEDICATION

To my beloved mother and father

ABSTRACT

Increase room temperature on a hot day can cause discomfort to the occupants. Measures to reduce the room temperature include installing thermal insulation. Thus, the project was carried out to study the thermal performance of composite kenaf as thermal insulation for buildings. The project was started by selecting some of the composite kenaf. Kenaf composite 4060, kenaf composite 5050, kenaf composite 6040 and kenaf composite 6040 NaOH selected for this project. Thermal conductivity for each composite was tested. The software used for this porject is Integrated Environmental Solutions. Two insulation which are rock wool and wood strands was added to the project as a comparison for kenaf composite. The simulation results showed kenaf composite 4060 is not effective as heat insulation because the thermal conductivity is more than 1.00 W/m.k. Other thermal insulation managed to reduce building heat and use less energy for air conditioning systems.

ABSTRAK

Peningkatan suhu bilik pada hari yang panas boleh menyebabkan ketidakselesaan kepada penghuninya. Langkah untuk mengurangkan suhu bilik termasuk memasang penebat haba. Justeru, projek ini telah dijalankan untuk mengkaji prestasi therma bagi komposit kenaf sebagai penebat haba untuk bangunan. Projek ini dimulakan dengan memilih beberapa komposisi komposit kenaf. Komposit kenaf 4060, komposit kenaf 5050, komposit kenaf 6040 dan komposit kenaf 6040 NaOH dipilih untuk projek ini. Setiap satu komposit diuji kekonduksian terma. Perisian yang digunakan ialah Integrated Environmental Solutions. *Dua penebat ditambah dalam projek ini sebagai perbandingan iaitu rockwool dan lembar kayu. Hasil simulasi menunjukkan komposit kenaf 4060 tidak efektif sebagai penebat haba kerana kekonduksian terma lebih dari 1.00 W/m.k. Penebat haba yang lain berupaya untuk mengurangkan haba bangunan dan menggunakan tenaga yang sedikit untuk sistem penyaman udara.*

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In addition, I would also like to thank to various people for their contribution to this project in giving me the information and their support.

Finally, I wish to thank to my beloved parents for their support and encouragement throughout the completion of this project.

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LIST OF ABBEREVATIONS

CO_2	Carbon dioxide
IES	Integrated Environmental Solutions
MARDI	Malaysian Agricultural Research and Development Institute
LTN	Tobacco Board of Malaysia
PUR	Polyurethane
PIR	Polyisocyanurate
MDI	Methylene diphenyl diisocyanate
EPS	Expanded polystyrene
XPS	Extruded polystyrene
HVAC	Heating, Ventilating and Air Conditioning
CFD	Computational Fluid Dynamic

LIST OF SYMBOL

λ	=	Thermal conductivity
R	=	Thermal resistance
l	=	Thickness/length
m	=	Mass

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Lately, the promptly increasing consumption of composite components in automotive, construction, and other mass production industries, has been concentrated on sustainable and renewable reinforced composites. This focus encompasses an extensive variety of shapes and materials from synthetic to natural, in order to accomplish the demands of manufacturing composites with preferred properties. The integration of reinforcements, such as fibers and fillers into composites affords a means of spreading and refining the properties of the composites that meets the necessities of most engineering applications. Consequently, these enhancements will be associated with economic gains, such as small production costs and small resin consumption .

Hence, the needs for natural fiber reinforced composites have improved drastically over the past few years, for various marketable applications in the industrial sector. These types of composites present various benefits compared to artificial fibers, for example low tool wear, low cost, low density, availability, and biodegradability (Nishino et al, 2003). The most common plant used in applications are bast fibers, such as jute, flax, kenaf, sisal and hemp (Kozlowski et al, 1999). One of the explanations for this increasing focus is that natural fibers have a greater specific strength than glass fiber but same specific modulus. With these properties and low cost sources, these natural fibers hypothetically proposed required specific strengths and modulus, at a lower cost of manufacturing. Many natural fibers can be used as composites, but regularly in applications that involve low stress. Some of the fibers are obtained by processing agricultural, industrial, or consumer waste.

In this report, the composite of one of natural fiber will be discussed which is kenaf. Kenaf, *Hibiscus Cannabinus L* is an annual herbaceous plant growing up to 1.5-3.5 m tall with a wooded base. The stems are 1–2 cm diameter, often but not branched. The leaves are 10–15 cm long, variety in shape, with leaves near the core of the stems being deeply lobed with 3-7 lobes, while leaves near the upper of the stem are shallowly lobed or unlobed lanceolate. The flowers are 8–15 cm diameter, white, yellow, or purple; when white or yellow, the middle is still dark purple. The fruit is a capsule 2 cm diameter, holding a few of seeds. The fibers in kenaf are found in the bast (bark) and core (wood). The bast make up 40% of the plant. "Rough fiber" separated from the bast is multi-cellular, consisting of numerous individual cells held together (Paridah et al, 2011).

The individual fiber cells are about 2–6 mm long and lean. The cell wall is thick (6.3 µm). The core is about 60% of the plant. It also has thickness of ≈38 µm but short (0.5 mm) and thin-walled (3 µm) fiber cells (Nanko et al, 2005). Paper pulp is formed from the whole stem, and thus contains two types of fibers, from the bast and from the core. The pulp quality is same with hardwood.

1.2 PROBLEM STATEMENT

Building is a climate modifier for humans. Most designers today focus on functions in the buildings and leave the issue of human comfort conditions to engineers who use mechanical systems to modify the interior environment. Energy and CO_2 emissions are influencing factors in the global warming phenomenon. One alternative in the solution of these problems is reducing energy consumption by using insulation materials in the building envelope. Insulation materials provide many benefits to the building, such as reducing energy consumption, increasing comfort, ease of installation, light weight, and low cost. The buildings in cities usually use mechanical air-conditioning systems for thermal comfort in occupied spaces. This requires producing electrical energy to support the demand. This is an important factor contributing to CO_2 in the environment which in turn raises temperatures, example, the Green House Effect and Heat Island. Most buildings in hot, humid climates have been designed without considering for materials and insulation. This is an important reason why heat influencing the temperature inside the building usually includes the heat gained from the outside air and the building's envelope, especially if the roof is directly exposed to sunlight all day.

Inappropriate selection of material can cause the external heat to escape into the building, which, in turn, requires more energy to cool down the building. The proper application of insulation will reduce the heat transmission into the building and the heat gain during the hottest period of the day (Pongsuwan, 2009). This is one alternative to help in solving energy and environment problems. The proposed material for the insulation is kenaf composite.

1.3 OBJECTIVE

The objectives of this project are as follows:

1. To determine the thermal conductivity values of kenaf composite.
2. To perform a simulation of thermal performance of kenaf composite by using IES software.
3. To determine the energy saving with using kenaf composite
4. To obtain the comparison of thermal performance kenaf composite insulator with synthetic insulator.

1.4 SCOPE OF PROJECT

The scopes of this project are:

1. Obtain thermal conductivity of kenaf composite from other researchers.
2. Conduct the simulation of building embed with kenaf composite insulator by using IES software.
3. Do the simulation for synthetic insulator for comparison to kenaf insulator.

CHAPTER 2

LITERATURE REVIEW

2.1 KENAF

2.1.1 Overview about kenaf

In few years back, the enthusiasm of researchers and engineers has converged on utilizing plant fiber as optimal and economically as could be expected under the circumstances to deliver great quality fiber-strengthened polymer composites for many industrial application. It is a result of the accessibility and has prompted to the improvement of auxiliary materials rather than conventional or man-made ones. Natural fiber are originally from animals, plants and mineral sources which can be categorized as appeared in Figure 2.1. The utilization of natural fiber as mechanical components and parts expands the ecological supportability of the parts being built, particularly the automotive market. In the building and construction industry, the enthusiasm in natural fiber is more on insulation properties.

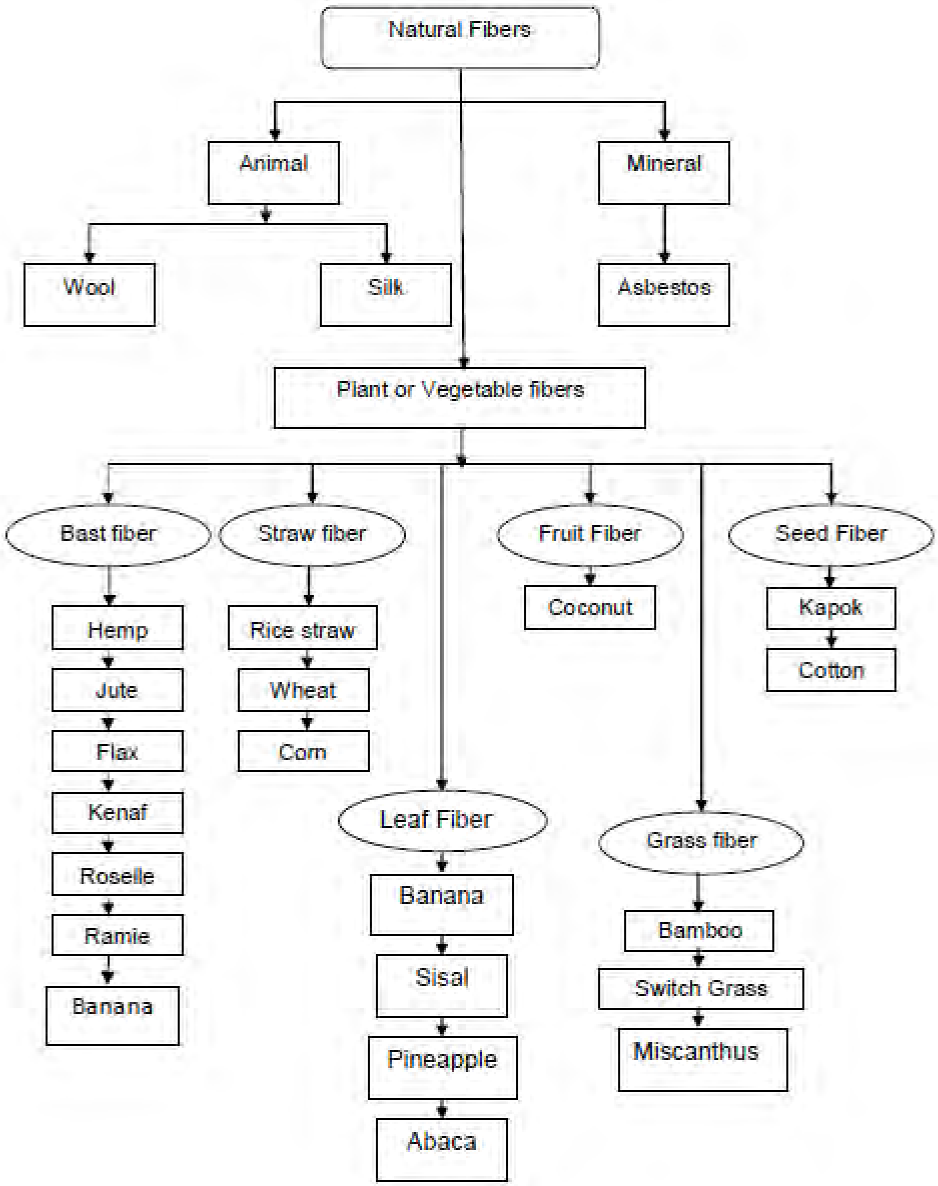

Figure 2.1: Classification of natural fiber

Scientific classification	
Kingdom	Plantae
(unranked)	Angiosperms
(unranked)	Eudicots
(unranked)	Rosids
Order	Malvales
Family	Malvaceae
Genus	Hibiscus
Species	H. cannabinus
Binomial name	
Hibiscus cannabinus L.	
Synonyms	
Abelmoschus congener Walp.	
Abelmoschus verrucosus Walp.	
Furcaria cannabina Ulbr.	
Furcaria cavanillesii Kostel.	
Hibiscus malangensis Baker f.	
Hibiscus vanderystii De Wild.	
Hibiscus vitifolius Mill. No. illeg.	

Figure 2.2 Classification of kenaf plant

Kenaf or Hibiscus cannabinus is a types of hibiscus plant. Kenaf can that can be found in southern Asia. Nonetheless, the origin of kenaf is obscure. The fiber got from kenaf is called as kenaf fiber. Kenaf fiber is comparative with jute fiber. Both fiber practically identical in characteristic. Forenames of kenaf are Bimli, Bimlipatum Jute, Ambary, Deccan Hemp, and Ambari Hemp. There are a few colors of the kenaf blossom, white, bit yellowish, or dark purple.

Kenaf has straight and branchless stalk. Kenaf stalk content an internal wooded center and also an external fibrous bast near the center. The stems of the kenaf produce two types of fiber, bast and center. Bast is a rougher fiber in the external layer. Kenaf center fiber is a finer fiber in the core. Kenaf plants develop in 100 up to 1000 days.

2.1.2 History of kenaf plant in Malaysia

Understanding the potential outcomes of economically usable product coming from kenaf, the National Kenaf Research and Development Program has been made to create kenaf for conceivable new industrial harvest in Malaysia. The administration of Malaysia has distributed around RM12,000,000 for research and further advancement of the kenaf-based industry in the ninth Malaysia Plan (from 2006 to 2010) in acknowledgment of kenaf as a commercial crop.

Kenaf began to be planted by Malaysian Agricultural Research and Development Institute (MARDI). In Kelantan as well in Terengganu, Tobacco Board of Malaysia (LTN) has planted a ton of Kenaf. In Malaysia, kenaf develops rapidly, ascending to statures of 3.66m to 4.27m in duration of below a half year. Different reviews demonstrate that kenaf yields up to 6 to 10 tons of dry fiber per acre section of land every year. Upon reap, the whole kenaf plant is handled in a mechanical fiber separator same like a cotton gin.

2.1.3 Kenaf Bast

The individual bast fiber are up to 0.005 m long averaging 0.0026 m long and 0.02 m in diameter. Bast pulp, bit related to softwood pulp, has exact rigidity, however more noteworthy tear quality and bulk fiber; accordingly it could substitute softwood pulp. Pulping kenaf fiber (center and bast) can enhance environment because the growth require small quantity of fertilizer. Despite the fact that the kenaf bark fiber were once only considered for use as a cordage fiber, now, its have extra uses for industrial usage. These incorporate utilization in car dashboards, as an “additional in man-made fiber”, corrugated medium, injection molded and extruded plastics. Kenaf bark fiber are presently in commercial usage in other ecologically benevolent products like fiber yard mats impregnated with grass seed, and splash on soil mulches for use along highway or construction sites to keep soil disintegration from water and wind. The stalk of the kenaf comprises of two distinctive fiber types. The outer fiber is called bast and comprises about 40 % of the stalk's dry weight. The refined bast fiber length 2.6 mm and the whiter, inner fiber is core and comprises 60% of the stalk's dry weight.

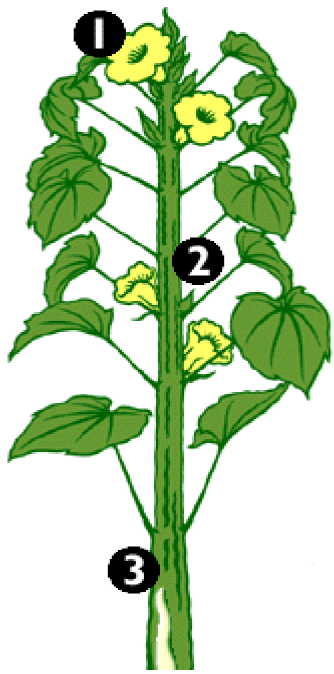

Figure 2.3: Parts of Kenaf Plant (1) kenaf flower, (2) kenaf bast (3) kenaf stack

2.1.4 The usage of kenaf

Kenaf plant grown for almost 40 centuries in Sub-Sahara where its leaves are devoured by human and animal. The bast fiber is utilized for cordage and the woody center of the stalks blazed for fuel. The fundamental usage of kenaf fiber is the fabrication of the product like the product that produced using jute. In Texas, Louisiana, and California, 3,200 acres lands of kenaf were developed at 1992, and utilized for animal bedding and feed. Emerging uses of kenaf fiber incorporate the designed wood, insulation, and clothing.

Kenaf seeds yield a plant oil that is edible and high in cancer prevention agents. The kenaf oil is also used for beauty care products, industrial lubricants/ointments and as additional bio-fuel (Pill et al, 1995).

2.1.5 The Benefits and Drawbacks of Natural Fiber Including Kenaf

Natural fiber, for example, kenaf have driving points of interest contrasted with conventional reinforcement materials, for example, glass fiber as far as expenditure, the ability to recycle, abrasiveness, and biodegradability. The fiber reinforced composites relies on the fiber matrix interface and the capacity to transmit stress from matrix to fiber. The benefits of natural fiber over old-style strengthening materials, for example, glass fiber are low density, minimal cost, globally harmless and incredible physical properties. Natural fiber composites, for example, combination kenaf and polypropylene have been useful in cars parts (Shibata et al, 2005). Other than, natural fiber additionally give the benefits of strength properties, durability, thermal properties, diminished instrument wear, simplicity of detachment, lessened skin and respiratory irritation, enhanced energy recovery furthermore biodegradability. Wood fiber strengthened polypropylene composites have properties exact to conventional glass fiber strengthened polypropylene composites. Many points of interest in utilizing kenaf fiber. Since an innovation of isolating kenaf center and bast has been produced, many plausibility of utilizing the entire kenaf plant or some parts of it. Kenaf production is less cost and less time consuming than other crude yields. Kenaf fiber could be exploited as strengthening material for polymeric composites (substitution of glass fiber). Kenaf bast fiber has unrivaled flexural quality associate with its astounding elasticity that settles on it the material for an extensive variety of extruded, molded and non-woven products. Todays,