



Faculty of Engineering

**EVALUATION OF NATURAL FIBER COMPOSITE
MATERIALS CHARACTERISTIC BY USING FINITE
ELEMENT ANALYSIS**

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Bachelor of Engineering with Honours
(Mechanical and Manufacturing System Engineering)
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**EVALUATION OF NATURAL FIBER COMPOSITE
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ELEMENT ANALYSIS**

THIAN CHEE LIP

**This project is submitted in partial fulfilment of
the requirements for the degree of Bachelor of Engineering with Honours
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This Final Year Project report entitled "EVALUATION OF NATURAL FIBER COMPOSITE MATERIALS CHARACTERISTIC BY USING FINITE ELEMENT ANALYSIS" was prepared by THIAN CHEE LIP as a partial fulfillment of the requirement for the Bachelor of Engineering (Hons.) Mechanical Engineering and Manufacturing System is here by read and approved by:

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Dedicated to my beloved family and friends for their endless support.

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ABSTRACT

Natural fiber composites properties were evaluated in this study. The influences of the fiber content and fiber treatment were improving the mechanical properties of the natural fiber composite. The material properties were simulated in cooling pad and ceiling panel lining application to find out the potential of natural fiber composite replacing the materials available in the market now. The heat transfer and deflection were simulated by using finite element analysis method.

The heat transfer simulation for the cooling pad application show that, Polyester - banana fibers treated with Polystyrene Malaic Anhydride (PSMA) had a potential to replace the Perspex Cooling pad due to better heat conduction.. The PSMA treatment composite shows that 1% heat conduction improvement in cooling pad compare to Perspex.

The deflection simulation for the ceiling panel lining application shows that, the natural fiber composite is unable to replace the aluminum as the ceiling panel lining's material.

ABSTRAK

Sifat-sifat komposit serat semulajadi telah dinilai dalam projek ini. Pengaruh kuantiti serat dan serat yang dirawat daripada bahan kimia telah memperkuat sifat-sifat komposit serat semulajadi. Sifat-sifat bahan komposit telah disimulasi dalam aplikasi papan penyejukan laptop dan rangka langit untuk mencari potensi mengganti bahan yang sedia ada di pasaran.

Polyester-serat pisang dirawat oleh Polystyrene Malaic Anhydride (PSMA) mempunyai potensi menggantikan bahan Perspex papan penyejukan laptop kerana bahan tersebut mempunyai konduksi haba yang baik. Komposit yang dirawat oleh PSMA menunjukkan peningkatan 1% konduksi haba dalam aplikasi papan penyejukan laptop berbanding dengan Perspex.

Selain itu, simulasi aplikasi serat semulajadi untuk aplikasi rangkai langit menunjukkan bahan-bahan komposit semulajadi ini tiada yang sesuai untuk menggantikan aluminium.

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LIST OF ABBREVIATIONS

FEA	- Finite Element Analysis
HDPE	- High-density polyethylene
NaOH	- Sodium hydroxide
PSMA	- Polystyrene Malaic Anhydride
V_f	- Volume fraction of fibers
$^{\circ}\text{C}$	- Degree Celsius
K	- Kelvin
VARTM	- Vacuum Assisted Resin Transfer Molding
RTM	- Resin Transfer Molding
ASTM	- American Society for Testing and Materials
CAE	- Computer-Aided Engineering
CAD	- Computer-Aided Design
k	- Thermal Conductivity
C_p	- Specific Heat Capacity
ρ	- Density

CHAPTER 1

INTRODUCTION

1.0 Introduction

In the past, the plant fiber or natural fiber had been made into basket, clothing, rope and other products. However, increasing global energy crisis and ecological risks causing the plant fibers reinforced composites or natural fiber composite have gain more attention. A lot of researches have been carried out to determine and improve its properties. Natural fiber composite had been used in 1990s for replacing the glass fiber composite in automotive application because of its reduction weight property [1]. Beside that, natural fibers composite had been used in construction industry and packaging companies.

The natural fibers of bast and leaf qualities with fibers such as hemp, jute, flax, kenaf or sisal are most common material used in composite application. These natural fibers had embraced by European carmakers and reached North America and the Natural Fiber Composite Industry has registered a 40-50% growth in 2000 [2].

Compared with the carbon fiber or glass fiber, the utilization of natural fiber have many advantages such as renewable raw material or less unlimited, lightweight,

and high specific mechanical performance. Beside that, the low cost of the natural fiber causing the market to expand rapidly. The low environment impact of the natural fiber reduced the dependency of nonrenewable material such as petroleum. The natural fiber processing with the recyclability thermoplastic polymers, such as high density polyethylene and polypropylene will provide an attractive eco-friendly quality.

The mechanical behaviors of a natural fiber composite material are depending to the great extent on the adhesion between the reinforcing fiber and the surrounding matrix [3]. For improving the adhesion between the natural fiber and the matrix in composite, the fibers have been treated with various choice of surface treatment such as, NaOH aqueous solution, saline coupling agent, Surface pre-impregnation with a polyethylene dilute solution and Polystyrene Malaic Anhydride (PSMA) treatment.

In recent year, a studies of the finite element analysis has become commonplace for the industry company. Numerical solutions to complicated mechanical problems can be obtained by using the finite element analysis. Finite element codes are comparatively complicated than many of the word processing. In practice, a finite element analysis usually consists of three principal steps such as processing, analysis, and post-processing.

The mechanical behavior of a new design product with the known material's properties can be analyzed by finite element method. However, the solution of this method is not 100% accurate. The finite element method is powerful and faster than traditional method or hand calculation in predicting the mechanical behavior. The

finite element analysis method will be used in this project to analyze cooling pad and ceiling panel lining application performance.

1.1 Problem statement:

Natural fiber reinforced polymer are found to have good mechanical and thermophysical properties. It is a renewable materials that can be thermally recycled and has lower environmental impact. Beside that, the inexpensive material has been used in automotive industry such car roof and catamaran hull [4]. The thermal conductivity of the composite is found to have improved when reinforced by natural fiber, thus can be applied in cooling pad where the heat transfer is important to reduce the heat at the bottom of notebook. The composite reinforced by natural fiber increased the stiffness and bending strength properties of the material. So it is suitable for ceiling panel application. In this project the mechanical and thermal properties of various natural fibers composite was gathered to perform finite element simulation. Consequently, from the simulation we were comparing and determine the suitability of these materials for the above mentioned application (cooling pad and ceiling panel).

1.2 Objective

The objective of this work is to evaluate the possibility of using natural fiber composite in cooling pad and ceiling panel lining application. The transfer of heat and the deflection of the specimen are estimated using finite element simulation. From the simulation results, the comparison between various types of materials can be achieved and the suitability of the materials for above application can be determined.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter reviews the mechanical properties and thermophysical of natural fiber composite and the effect of different surface treatment on the natural fiber composite's material. This study also includes the finite element method case study.

2.1 Ceiling Panel lining

Ceiling is the inside lining of a room overhead. Ceiling panel board is concealing the underside of the roof structure. Commonly, tile, wood and aluminum are the material used for the ceiling panel board. The function of ceiling panel board that have soundproof can block the sound out of the house to the inside. The ceiling panel board is supported by the ceiling panel lining. So, the material of the lining should be hard that can support the weight of the panel board without deformation or deflection. The material uses in ceiling panel lining are woods, aluminum, and steel. There is several type of ceiling panel available in market as shown in Figure 2.1 to 2.6.



Figure 2.1: Tin Ceiling



Figure 2.2: Drop ceiling or suspended ceiling



Figure 2.3: Coffered ceiling



Figure 2.4: Beam ceiling



Figure 2.5: Luminous ceiling



Figure 2.6: Stretch ceiling

2.2 Cooling Pad

Cooling pad is an electronic device that helps to reduce operating temperature of the notebook in order to improve performance of notebook. The cooling pad fan is dissipating the damaging heat from the notebook. There is no special installation required between the notebook and cooling pad. It can fit directly under any notebook. It is connect through a USB cable. The Figure 2.7 and 2.8 show the example of cooling pad available in the market.



Figure 2.7: Notebook with cooling pad

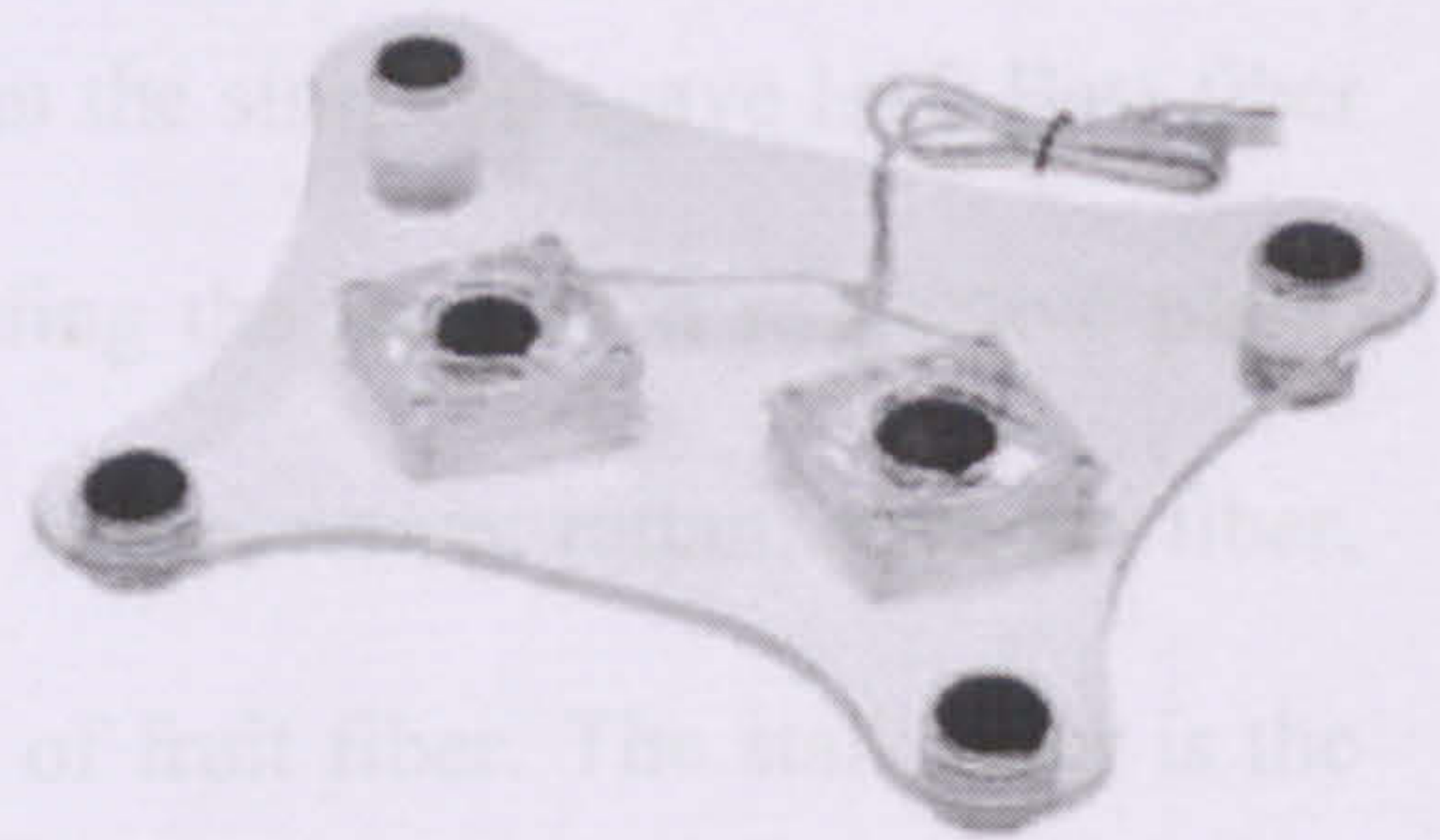


Figure 2.8: Two fan cooling pad