Faculty of Mechanical and Manufacturing Engineering Technology

PARAMETER OPTIMIZATION OF KENAF CORE FOR HEAT INSULATION APPLICATION

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PARAMETER OPTIMIZATION OF KENAF CORE FOR HEAT INSULATION APPLICATION

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DEDICATION

Dedicated to

My beloved father, Ragu A/L Veeramuthu

My appreciated mother, Subah A/P Barland

My sibling, Tilan Raj A/L Ragu and all my teammates

Thank you for all the moral support and encouragement that you all gave me

Thank You So Much & Love You All

ABSTRACT

Natural fibers have their own properties that have high strength, environmentally friendly and lower cost compared to synthetic fibers. Therefore, many manufacturing areas such as aircraft and automobiles use natural fibers as reinforcement to produce high strength composite materials. In addition, there are many research focusing on natural fibre- based composites in the form of lamina, but there is no specific study on the kenaf core in the use of the thermal insulation. Therefore, the purpose of this study is to investigate the different size of the kenaf core using intraply concept. The purpose of the study was to develop intraply composite by combining kenaf core as reinforcement with different kenaf core parameters of size by using polyurethane and natural rubber as matrix. Furthermore, the sample surface morphology tested was analyzed using scanning electron microscope (SEM). Ultimately, this research is expected to have the best thermal insulation from kenaf core which will contribute to high performance in the mechanical and physical properties of the intraply composite system.in this research also helped to make the best design to meet the demand of today's manufactures by reducing the weight and transportation cost. The best layup from the research is CCC (40 mesh) which is 31.2 % better than the original PU and tend to become the good thermal insulation compare to other sample. This sample is light in weight and also the price is reasonable. Lastly, usage of natural fibre reduced weight and more recyclable.

ABSTRAK

Serat semulajadi mempunyai sifatnya yang tersendiri iaitu mempunyai sifat kekuatan yang tinggi, mesra alam dan kos yang lebih rendah berbanding dengan serat sintetik. Oleh sebab itu, banyak bidang pengilang seperti pesawat dan automotif menggunakan serat semulajadi sebagai pengukuhan untuk menghasilkan kekuatan tinggi bahan komposit. Di samping itu, terdapat banyak penyelidik yang menumpukan komposit berasaskan gentian semulajadi dalam bentuk lamina, tetapi tiada kajian khusus tentang teras kenaf dalam penggunaan penebat haba. Oleh itu, matlamat kajian ini adalah untuk mengkaji perbezzan saiz teras kenaf menggunakan konsep intrply. Tujuan kajian adalah untuk membangun komposit intraply dengan menggabungkan serat kenaf sebagai pengukuhan dengan parameter teras kenaf yang berbeza saiz dengan menggunakan polyurethane dan getah asli sebagai matriks. Seterusnya, morfologi permukaan patah sampel yang diuji dianalisis dengan menggunakan mikroskop elektron imbasan (SEM). Pada akhirnya, penyelidikan ini dijangka mempunyai penebat haba yang terbaik daripada teras kenaf yang akan menyumbang kepada prestasi tinggi dalam sifat mekanikal dan fizikal sistem konposit intraply. Dalam pemyelidikan ini juga telah membantu untuk membuat reka bentuk yang terbaik untuk memenuhi permintaan pengeluar pada masa kini dengan mengurangkan berat dan kos pengangkutan. Dalam kajian tentang kenaf core bergabung dengan polyurethane dan latex didapati yang paling bagus dalam kajian ini adalah CCC (40 mesh) dan 31.2% lebih baik berbanding dengan PU yang kini ada dalam pasaran. Sampel ini mempunyai keliangan yang kurang dan bagus untuk dijadikan bahan kedap haba. Kesimpulanya, sampel ini mempunyai berat yang ringan malah harga yang berpatutan untuk dijadikan produk.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURE

LIST OF ABBREVIATIONS

ABBREVIATION		TITLE
ASTM	-	American standard testing method
SEM	-	Scanning electron microscopy
PU	-	Polyurethane
NRL	-	Natural rubber latex
UTM	-	Universal testing machine

LIST OF SYMBOLS

SYMBOLS		TITLE
°	-	Degree
%	-	Percent
Mpa	-	Mega pascal
Gpa	-	Giga pascal
° C	-	Degree Celcius
mm	-	Milimetre
kg/m^2		Kilogram per square metre
J	-	Joule
RM	-	Ringgit Malaysia
W		Watt

CHAPTER 1

INTRODUCTION

This chapter mostly explained and clarified about the historical background of kenaf core, parameter of kenaf core, and heat insulation. The idea generation for this research problem occurred based on fundamental theories taken from books, journal, magazines, product catalogue and online resources. Hence, various issue are mentioned and listed so that improvements can be done in this research.

1.1 Background

Meanwhile, in our country natural fibre are widely used because it has the same equal amount of usage as other material. This natural fibre are mostly used in many application, used in many scientific research and all product development research. Moreover, this natural fibre has its own benefits which are corrosive resistance, economically friendly, chemical resistance, high mechanical performance, and thermal properties. This natural fibre has many types which are sisal, oil palm, banana, pineapple, coir fibre and also kenaf (Geethamma *et al.*, 1998). Other than that, polymer also can be categorized in to three types which are elastomer, thermoplastic, and thermosetting. Besides, these polymer used as matrix to bind together with natural fibre into form natural fibre reinforced composite. The tensile properties of the natural fibre reinforced polymer will be affected by the interfacial adhesion between matrix and fibre. Therefore, better interaction between the matrix and fibre must be takes in the consideration to produce reinforced composite (Ku *et al.*, 2011). Properties of kenaf is about how skilled are the kenaf to make composite materials.

According to. Atanu Kumar Das *et al.*, (2015), says about physical and mechanical properties of kenaf and about the thickness of the kenaf. Kenaf have mechanical properties which are can become quicker and it takes just 150 days to collect kenaf. Kenaf have 35 to 40 % bast fiber and 60 to 65 % core. This implies that center is more than the fibre. Moreover, kenaf contains 65.7 % cellulose, 21.6 % lignin and gelatin and other creation. Kenaf additionally can develop under range with high climate condition. The stature that kenaf can develop is more than 3m and a base width of 3 to 5cm. Other than that, kenaf has single, straight, unbraced stem comprising of two sections.

Kenaf core is used as source of pulp and cellulose derivatives, especially for papermaking absorption material, cosmetics, medicine, industrial chemicals and other bio-polymer (Juhaida, 2008). Moreover, the kenaf core has high demonstrated high tensile and burst strength compare to hardwood pulp (Sabharwal, 1994). Not only that, kenaf core is good water absorbent, which the soft pitch (Lips *et al.*, 2009). Misha *et al.*, (2013) expressed in their study about that kenaf core have constant drying rate, which the temperature give more effect compared to air humidity.

Iyer *et al.*, (2016) had performed a review by referring from previous paper abstracted from other researcher that preparation fibre-reinforcement composite by using maleate polyurethane , rubber latex, polyester resin are categories from thermosetting as matrix system which will result an enhancement in mechanical properties. Thermosetting binds are typically used to impact shape and strength to nonwoven materials. Akil *et al.*, (2011) had concluded that enhancement of composites with both fibres either with thermosets or thermoplastics did show a varied influence for the mechanical properties to composite materials. Percentage of the fibre did show a strong relationship to the mechanical behaviour of the composite no matter it embedded with which polymer categories. Romayne and Ahmad (2016) has performed by using epoxy resins as binder system by fabricating the

specimen using hand lay-up technique. Thermosetting polyurethane have excellent properties and solvent resistance, but they cannot be reshaped like thermoplastic polymers after molding (Cao *et al.*, 2017).

Furthermore, Gulay Baysal and Esra Kasapbasi (2017), explained that polyurethane has very special properties such as temperatures, hardness, excellent tear and abrasion resistance ,good resistance to nonpolar solvent, flexibility, high compressive and tensile strength. Mazundar (2002) identifies that, epoxy is a common resin that usually used in many application such as sporting goods, automotive and aerospace. The correct temperature for the epoxy to function when temperature is above 127 °C and when the temperature is 73 °C to 23 °C the operation is well used. The cost is very high, but still it is a good chemical, corrosion resistance and also can well performed in high temperature. Liquid state epoxy go through fabrication process with reinforced fibre by using Resin Transfer Molding (RTM), filament winding, pultrusion, hand lay-up and other process. Vacuum bagging and autoclave process are used in semi-solid epoxy. Bunsell and Renard (2005) explains that epoxy resin has many good properties which are low shrinkage, high adhesive, and better mechanical strength compared to polyester resin. This can produce a well high performances composite material.

1.2 Problem Statement

Nowadays, there are two categories in composite which are natural fibre composite and synthetic fibre composite. The best mechanical properties are the most recent arguments made by researchers about seeking advanced engineering application. As a view, good performances of composite are came from environment friendly, production with low cost, good fatigue resistance ad tensile behaviour (Sanjay *et al.* 2018). Types of heat insulation and selection of matrix also crucial in creating a good and strong combination of fibre

reinforcement polymers in one composite material as this similar goes to synthetic fibre. However, there still lack of researches about applying the best heat insulation by using kenaf core that embedded together with a strong matrix.

Fibre reinforced composites are mostly applied in the field of automotive, aerospace, furniture or gardening. Various reinforcement of using fibres will dominate the different application such as jute, hemp, coconut fibre, kenaf, rice husk and saw dust. Is increase the percentage of natural fibre, the better of the mechanical behaviour of that specific composite material mentioned by Rajesh *et al.*, (2018). However, there are still lack proves in effects of kenaf core in thermal insulation itself nowadays. Hashim (1983), he mentioned that by analysis of material properties like thermal expansion, moisture humidity, elasticity, static strength and fatigue failure can assist to categories the best composite material when it is created with specific reinforcement and matrix system.

Meanwhile, polyurethane also used are also used as matrix. Polyurethane has low density, excellent thermal conductivity combined with their mechanical properties make them excellent thermal and good insulators, as well as structural and comfort materials (Nuno *et al* ., 2018).

Another reason this kenaf core is not been widely used in marketing industry. This is because kenaf is more used for its kenaf fibre which is the hard part in the stem. Polyurethanes are regarded as an affordable, durable and safe way of reducing carbon emissions that lead to global warming. Polyurethanes can dramatically reduce heat loss in homes and offices in cold weather by Jelle *et al.*, (2011). A study from Salman *et al.* (2015). Other polymer are much more ineffective than epoxy. This is because it bonds better with kenaf fibre and produce good adhesive between the fibre and matrix which causes the reduction in impact energy with the increase of adhesion in fibre matrix. Mazundar (2002) identifies that, epoxy is a common resin that usually used in many application such as

sporting goods, automotive and aerospace. The correct temperature for the epoxy to function when temperature is above 127 °C and when the temperature is 73 °C to 23 °C the operation is well used. The cost is very high, but still it is a good chemical, corrosion resistance and also can well performed in high temperature. Liquid state epoxy go through fabrication process with reinforced fibre by using Resin Transfer Molding (RTM), filament winding, pultrusion, hand lay-up and other process. Vacuum bagging and autoclave process are used in semi-solid epoxy. Bunsell and Renard (2005) explains that epoxy resin has many good properties which are low shrinkage, high adhesive, and better mechanical strength compared to polyester resin. This can produce a well high performances composite material. By considering all these matters, it is very attractive reason and aims for seeking and performing this research as this scan reveal the final decision for the best combination.

1.3 Objective

The objectives of this research are as follows:

(a) To fabricate the heat insulation panel made from different size of kenaf core reinforced polyurethane and natural rubber latex.

(b) To investigate the mechanical properties of different size of kenaf core reinforced polyurethane and natural rubber latex as heat insulation panel.

(c) To purpose the best layup sequence of kenaf core reinforced polyurethane and natural rubber latex with optimum proportion.

1.4 Scope

The scope of this research as follows:

(a) To study the most potential thermoset to be used by considering the temperature and the parameter of kenaf core.

(b) To study the different type of matrix used in the kenaf core for heat insulation.

(c) To study the properties of kenaf core when different type of matrix is embedded together as reinforcement with thermoset materials.

(d) Effect of mechanical and physical behavior of composite will be determine for tensile strength, toughness, energy absorb and etc.

(e) The types of matrix will be used on kenaf core in composite for heat insulation.

(f) To determine the temperature that suitable for kenaf core for heat insulation.

(g) To ensure the better matrix , rubber latex and polyurethane for heat insulation embedded with kenaf core as reinforcement.

1.5 Rational of Research

The rational of research are as follows:

(a) There are some studies applied on the synthetic fabric co-operate together with types of matrix but not yet exist applying types of matrix on the kenaf core for heat insulation. Thus, this research is implemented to discover the effect of matrix for heat insulation to kenaf core as reinforcement and rubber latex and polyurethane as matrix.

(b) This research is implemented to study the mechanical strength between the matrix and the reinforcement on heat insulation.

(c) An investigate in the amount temperature and the strength of matrix and the reinforcement behaviour when types of matrix is added to kenaf core in the composite.

(d) Provided scientific and relevant information for better understanding about the importance of matrix used which is added to kenaf core embedded with thermoplastic in the mechanical strength behaviour of the composite.

Collecting beneficial data and information of the effects of matrix used in the kenaf core after carrying out the experiment.

(e) Generated and created a brand-new experience throughout this experimental and technical research by improving the mechanical strength as applying the types of matrix on the kenaf core when embedded with reinforcement for heat insulation which might lead to a new exploration in the engineering field especially in aerospace industry.

1.6 Summary of Methodology

This research is divided into 6 parts. Part 1 which is about the raw materials selection. Part 2 is the definition of variables that might affects the final mechanical behaviour of heat insulation. Part 3 is about discussing how to fabricate the kenaf core for heat insulation. Part 4 is about the mechanical testing selected the data analysis which is tensile, impact and flexural test. Part 5 is about the data analysis and interpretation. Hence, for part 6 summarized and concludes the final findings of this research report.

Selecting raw material will be the first stage here we need to include pairing the reinforcement and the matrix to form a composite .This also will prove its behaviour and the testing stage. Part 2, is the most important and precise process because you need to take note to identify, select and design the best heat insulation using kenaf core. The parameters used are pure kenaf fibre only without mixing others and just contain one layer of composite will be produced. In the fabrication part, part 3 stated clearly with the most suitable thermosetting as it is reviewed from past researcher which is the best to used polyurethane and also rubber latex as the matrix system, hand lay-up technique and flexural process. Additionally, part 4 is all about the tensile testing, by understanding the studying the mechanical behaviour of the heat insulator and kenaf core used. Lastly part 5, which is basically explaining about the