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EFFECTS OF FIBER REINFORCEMENTS WEAVE PATTERNS ON THE MECHANICAL PROPERTIES OF HYBRID INTRAPLY LAMINA

Mohd Amirhafizan Bin Hj. Husin

Master of Science in Manufacturing Engineering

2016

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EFFECTS OF FIBER REINFORCEMENTS WEAVE PATTERNS ON THE MECHANICAL PROPERTIES OF HYBRID INTRAPLY LAMINA

MOHD AMIRHAFIZAN BIN HJ. HUSIN

A thesis submitted in fulfillment of the requirements for the degree of Master of Science in Manufacturing Engineering

Faculty of Manufacturing Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2016

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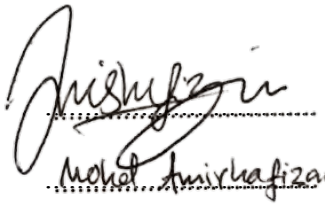
DECLARATION

I declare that this thesis entitled "effects of fiber reinforcements weave patterns on the mechanical properties of hybrid intraply lamina" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Manufacturing Engineering.

Signature : .....

Supervisor Name : .....

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DEDICATION

To my beloved mother, late father and family who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRACT

Laminate hybrid composites can be classified into two structure types such as interply and intraply structure. This research focuses on the effect of weave designs on mechanical properties of the single ply or also known as intraply hybrid composite lamina made by vacuum infusion technique. The eighteen (18) specimen of intraply composites lamina were made by kenaf fiber and glass fiber as a reinforcement and unsaturated polyester resin as a matrix with three types composition which were kenaf fiber in warp and weft direction (100 % kenaf), kenaf fiber in warp direction and glass fiber in weft direction (WK – WG), and lastly glass fiber in warp direction and kenaf fiber in weft direction (WG – WK) in various weave designs which were plain, twill, satin, basket, mock leno and leno weave. By using different weave designs and different materials in warp and weft direction had significantly affect the mechanical strength. The lamina intraply composites from WG – WK had significantly highest tensile strength and better mechanical properties which were plain, twill, satin, basket, mock leno and leno weave increased about 61.1 %, 93.9 %, 101.0 %, 95.8 %, 145.7 % and 49.1 % respectively compared pure kenaf. The most effectiveness of weave design for lamina composite were twill weave and satin weave in WG – WK with tensile strength 93.85 MPa and 97.35 MPa respectively. Lastly the leno weave was found to be not effective weave design for lamina intraply composite. This is due to the structure and the fiber content of leno weave.

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ABSTRAK

Komposit berlamina hibrid boleh diklasifikasikan kepada dua (2) jenis struktur seperti antara lapisan dan struktur bersilang. Kajian ini memberi tumpuan terhadap kesan reka bentuk anyaman terhadap tingkah laku mekanikal lapisan tunggal atau lapisan nipis komposit bersilang hibrid yang dibuat melalui teknik penerapan hampagas. Lapan belas (18) spesimen lapisan nipis komposit bersilang telah dihasilkan menggunakan gentian kenaf dan gentian kaca sebagai bahan penguat dan resin poliester tidak tepu sebagai bahan pengikat dengan tiga (3) jenis komposisi berbeza iaitu 100% gentian kenaf dalam meledingkan dan ke arah kain (100 % kenaf), gentian kenaf ke arah meledingkan dan gentian kaca ke arah kain (WK - WG), dan akhir sekali gentian kaca ke arah meledingkan dan serat kenaf ke arah kain (WG - WK) dalam pelbagai reka bentuk anyaman iaitu anyaman polos, anyaman kepar, anyaman satin, anyaman bakul, anyaman leno dan anyaman mock leno. Dengan menggunakan reka bentuk anyaman yang pelbagai dan bahan-bahan yang berbeza dalam proses meledingkan, arah kain telah memberikan kesan yang ketara terhadap kekuatan tegangan. Komposit lapisan nipis bersilang daripada WG - WK mempunyai kekuatan tegangan yang ketara tertinggi dan sifat-sifat mekanikal yang lebih baik iaitu anyaman polos, anyaman kepar, anyaman satin, anyaman bakul, anyaman leno dan anyaman mock leno meningkat kira-kira 61.1 %, 93.9 %, 101.0 %, 95.8 %, 145.7 % dan 49.1 % masing-masing terhadap 100 % kenaf. Untuk reka bentuk anyaman yang paling berkesan untuk komposit lapisan nipis bersilang ialah tenunan kain kepar dan tenunan satin dalam WG - WK dengan masing-masing kekuatan tegangan 93.85 MPa dan 97.35 MPa. Akhir sekali, tenunan leno ialah reka bentuk anyaman yang tidak berkesan untuk komposit lapisan nipis bersilang, hal ini disebabkan oleh struktur dan kandungan seratnya.

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ACKNOWLEDGEMENTS

First and foremost, I would like to take this opportunity to express my sincere acknowledgement to my supervisor Dr. Mohd Yuhazri Bin Yaakob from the Faculty of Manufacturing Engineering Universiti Teknikal Malaysia Melaka (UTeM) for his essential supervision, support and encouragement towards the completion of this thesis.

I would also like to express my greatest gratitude to Hasoloan Haery Ip from Faculty of Manufacturing Engineering, for his advice and suggestions in completing this project.

Particularly, I would also like to express my deepest gratitude to Mr. Farihan, the technicians from composite laboratory Faculty of Manufacturing Engineering. Mr. Azhar technician from material lab Faculty of Mechanical Engineering for their assistance and efforts in all the lab and analysis works.

Special thanks to all my colleagues, my beloved mother, late father and siblings for their moral support in completing this degree. Lastly, thank you to everyone who had been associated to the crucial parts of realization of this project.

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LIST OF ABBREVIATIONS

ASTM	-	American Society for Testing and Materials
CNT	-	Carbon Nanotube
GIC	-	Fracture energy
KIC	-	Fracture toughness
LCM	-	Liquid Composite Molding
MEKP	-	Methyl Ethyl Ketone Peroxide
PLA	-	Polyactic acid
PVA	-	Polyvinyl alcohol
RTM	-	Resin Transfer Molding
SEM	-	Scanning Electron Microscope
UPE	-	Unsaturated polyester
UTM	-	Universal Testing Machine

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LIST OF SYMBOLS

σ	-	Stress
ε	-	Strain
σf	-	Stress at failure
εf	-	Strain at failure
ᵒ	-	Degree
ᵒc	-	Degree Celcius
mm	-	Millimetre
m	-	Meter
g	-	gram
g/cm³	-	Gram per centimeter cube
g/cm²	-	Gram per centimeter square
m/s	-	Meter per second
Wt. %	-	Weight percentage
%	-	Percentage
E	-	Modulus
MPa	-	Mega pascal
GPa	-	Giga pascal
μm	-	Micrometer
Kg	-	Kilogram
L	-	Length

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W	-	Width
H	-	Height
KPa	-	Kilo pascal
Hz	-	Hertz
W	-	Watts
V	-	Volts
J	-	Joules
N	-	Newton

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LIST OF PUBLICATIONS

Journal

1. Yuhazri, M.Y., Husin, M.A., Ching, L.Y. and Sihombing, H., 2015. A Review on Potential of Development New Weave Pattern Design using Glass Fiber and Kenaf Fiber for Intraply Composite. *International Journal of Integrated Engineering*, *7*(2), pp. 1-9.

Intellectual Property

1. LY2015002111 - Kenaf Engineered Fabric – UTEMKEF
2. 2016003280 – Kenaf Engineered Fabric – UTEMKEF

Article News Published

1. Fabrik baharu pelbagai guna. Sinar Harian, 30 December 2015, p.8.

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CHAPTER 1

INTRODUCTION

1.1 Background

Over the last decade, natural fiber reinforced polymer composite have been used by European automobile, especially in the manufacturing of door panels (Sanyang *et al.,* 2016), (seat back; headliners; package trays) (Kim *et al.,* 2011), dashboard (Sapuan *et al.,* 2011), and trunk liner (Faruk *et al.,* 2014). This trend has reached to other parts of the world, like United States and Asia (Ahmad *et al.,* 2015). In the Malaysia context, since there are abundant available natural fibers in Malaysia that can be economically processed into natural fiber polymer composites, the fiber gains became the top national commodity crop under the supervision of the Malaysian National Kenaf and Tobacco Board. This is due to the natural fiber composite has better ductility, toughness and increase tensile as well as flexural and impact strength significantly (Mansor *et al.,* 2013).

One of the mostly natural fibers used as the reinforcement for polymer composite in Malaysia is kenaf fiber. Theoretically, there are two or more different types of reinforcement materials for the hybrid composites (which are bounded in the same matrix and depending on the way of constituent's materials that are mixed together). The kenaf based polymer composites can be produced using either thermoset or thermoplastic matrix. Since kenaf fiber has superior toughness and high aspect ratio compared to other natural fibers (Salit, 2014), the major advantage of a natural composite material is the ability of controlling fiber alignment through arranging the layers and the direction of the fiber.

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