Faculty of Mechanical and Manufacturing Engineering Technology

EFFECT OF STITCHING ON KENAF WOVEN FABRIC EMBEDDED THERMOPLASTIC BINDER SYSTEM IN INTRAPLY COMPOSITE

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Bachelor's Degree of Mechanical and Manufacturing Engineering Technology (Process and Technology) with Honours.

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A thesis submitted in fulfilment of the requirement for the degree of Bachelor's Degree of Mechanical and Manufacturing Engineering Technology

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2018

DECLARATION

I hereby, declared that this report entitled “Effect of stitching on woven kenaf fabric embedded thermoplastic binder system in intraply composite” is the results of my own research except as cited in references.

Signature : ……

Name : ANG SIEW KHIM

Date : 15 January 2019

APPROVAL

I hereby declare that I have read this thesis and in my own opinion this thesis is sufficient in terms of scope and quality for the award of bachelor's degree of Mechanical and Manufacturing Engineering Technology (Process and Technology).

Signature : ……

Supervisor Name: **ASSOC. PROF IR. TS. DR. MOHD YUHAZRI BIN YAAKOB**

Date : 15 January 2019.

DEDICATION

Dedicated to my beloved father, Ang Chee Yen,
my appreciation grandmother, Low Lee Lee
my loving mother, Lee Pei Hua,
my adored sister, Ang Siew Yun,
my helpful and caring senior, Amirhafizan.
my teammates, Michelle Lye Chuok Fang, Duncan Ling Ruey Shan, Finiks Anak Kanis
and my special friends, Lau Sin Hong and Chiam Shiun Sheng,
giving me moral support, cooperation, encouragement and understandings.
I love you all forever. Thank you.

ABSTRACT

A capable composite material depends strongly on its mechanical and physical properties. Due to the constant development of composite material nowadays, a new approach by introducing the types of stitch on the weave kenaf fabric is proposed in this research. This study is necessary due to lack of information with no scientific or study in stitching on kenaf fabric. This research aims to fabricate the kenaf fibre reinforced thermoplastic composite at different stitch parameter by using hot press machine. Secondly, to study the effect of mechanical and physical properties of the composite in intraply composite system. Thirdly, this research focus to investigate the failure type and fracture mode behaviours after mechanical and physical tests. All the fabrications and testing methods are according to ASTM standards. Thus, this research is proposed by investigating the best stitching design that will contribute to the high performance in physical and mechanical properties of the intraply composite system. The best stitching designs with reference of the specific strength is Tilt 60/60. The higher the alignment of angle, the better the strength of the intraply composite. This is further developed to Paintball safety jacket for good impact purpose. Last, usage of natural fibre reduced weight and more recyclable.

ABSTRAK

Bahan komposit yang kukuh akan bergantung kepada sifat mekanikal dan fizikalnya. Oleh kerana perkembangan berterusan bahan komposit kini, pendekatan baru dengan memperkenalkan jenis jahitan pada fabrik kenaf ditenun dalam penyelidikan ini. Kajian ini diperlukan kerana kekurangan maklumat berdasarkan sains atau kajian dalam jahitan kain kenaf. Penyelidikan ini bertujuan untuk menyiasat dengan menyusun komposit termoplastik bertetulang gentian kenaf pada parameter stitch yang berbeza dengan menggunakan mesin penekan panas. Kedua, untuk mengkaji kesan sifat mekanikal dan fizikal komposit dalam sistem komposit intraply dengan ketiga-tiga fokus kajian ini untuk menyiasat jenis kegagalan dan tingkah laku mod patah selepas ujian mekanikal dan fizikal. Semua fabrikasi dan kaedah ujian mengikut piawaian ASTM. Oleh itu, kajian ini dicadangkan untuk menyiasat reka bentuk jahitan terbaik yang akan menyumbang kepada prestasi tinggi dalam sifat fizikal dan mekanikal sistem komposit intraply. Daripada mencari reka bentuk jahitan terbaik, penyelidikan ini juga berharap untuk mencadangkan rekabentuk yang terbaik untuk menenun kain kenaf sebagai sistem komposit intraply ke bidang automotif dan aeroangkasa terutamanya disebabkan isu-isu semasa atau penyelidikan berkaitan dengan pengurangan berat pada pengangkutan awam berat pada masa kini. Berdsarkan Analisa berkaitan dengan spesifikasi kekuatan, jahitan bentuk Tilt 60/60 adalah terbaik dan akan mencipta kepada jaket keselamatan Paintball. Dengan pengunnaan fiber akan lebih ringan dan senang untuk kitar semula.

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LIST OF ABBREVIATIONS

ABBREVIATIONS		TITLE
ASTM	-	American standard testing method
SEM	-	Scanning electron microscopy
NCF	-	Non-crimp fabric
2D	-	Two dimensional
DCUY	-	Double covered un-commingled yarn
UTM	-	Universal testing machine
PP	-	Polypropylene

LIST OF SYMBOLS

SYMBOL		TITLE
°	-	Degree
%	-	Percent
MPa	-	Mega pascal
GPa	-	Giga pascal
°C	-	Degree Celsius
mm	-	Millimetre
kg/m^2	-	Kilogram per square meter
kg/m^3	-	Kilogram per cube meter
mm/min	-	Millimetre per minutes
kN	-	Kilo Newton
kV	-	Kilo volt
:	-	Ratio
J	-	Joule
RM	-	Ringgit Malaysia
vol	-	Volume
g/m^2	-	Gram per square meter
g/mm^2	-	Gram per square millimetre
±	-	Plus minus (tolerances)
µm	-	Micrometre
J/cm^2	-	Joule per square centimetre

N/mm^2	-	Newton per square millimetre
Hz	-	Hertz
W	-	Watt
avg	-	Average

CHAPTER 1

INTRODUCTION

This chapter mostly explained and clarified about the historical background of stitching, woven fabric and intraply composite material. The idea generation for this research problem occurred based on fundamental theories taken from books, journals, magazines, product catalogues and online resources. Hence, various issues are mentioned and listed so that improvements can be done in this research.

1.1 Background of Research

Composite material is a combination of two or more materials that will result in performance of the mechanical behaviour at the end of the stage. Composite material itself consist of a matrix and a reinforcement that can improve performance of the specific composites. By implementing composites in daily life in different application can strengthen one material strength, stiffness and ability. Yang *et al*. (2012) published a paper in which they mentioned about composite material are being adapted mostly in renewable industry field, automotive and aerospace. Composite material also ease manufacturers with best quality and better life spend which enhanced together with lesser weight and maintenance fees that creates a lesser bad effect to the environmental. Beier *et al.* (2009) expressed in their study about carbon fibre that managing types of stitching as it embedded together with low melting point thermoplastic as binder can improve mechanical strength, cost reduction and excelled of the out-of-plane of the composite material when it is applied on the aerospace industry nowadays. Effects of stitching, weave type, binder system in one composite material

might give an impact to the mechanical behaviour. Carvelli *et al.* (2010) have proposed a study about the structures and directions of stitch did show an effect to the fatigue performance during the testing by using tensile cyclic load. Hence, to accelerate the performance of the interlaminar structure, several textiles technologies should be applied namely stitching, weaving, knitting or braiding as this can manufacture the best structure of composite materials before testing was carried out.

Thiruchitrambalam *et al.* (2012) had performed a review by referring from previous papers abstracted from other researchers that preparation of fibre-reinforced composite by using maleated polypropylene, poly-lactic acid and polyethylene are the categories from thermoplastics as matrix system which will result an enhancement in mechanical properties with high modulus and tensile strength when the percentage of the fibre increases. Furthermore, Chen *et al.* (2007) had also fabricated non-woven composites with using natural fibres like kenaf, bagasse and ramie when it is reinforced together with polypropylene as matrix, they finally revealed that the bonding of natural fibres and its's matrix show a tight relationship which it will affect another at the end of the composite's mechanical properties.

Diversely, numerous researches have attempted to explain by using thermosets as binder system while applying in the natural-fibre reinforced composites. When thermosets included epoxy resins, polyester resins or vinyl ester resins are reinforced with natural fibres it concludes an excellent result in the mechanical properties. 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 the composite materials. Percentages 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