UNIVERSITI PUTRA MALAYSIA

MECHANICAL PROPERTIES OF UNTREATED AND ALKALINE TREATED KENAF AND RAMIE FABRIC REINFORCED EPOXY COMPOSITES

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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DEDICATION

*First of all and before every thing , I submit in humility and gratitude to my beloved creator " **Allah Subhana Wa Taala** " for having blessing me this opportunity and protecting me from major obstacles in fulfilling this thesis.*

I would not be truly thankful also if I did not express gratitude towards my mum, Rokiah and my dad, Md. Rezali, who always motivate and support during my works in finishing my thesis.

Finally, this thesis is dedicated to all those who believe in the richness of learning.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master Science

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June 2008

Chairman: Profesor Dr. Mohd. Sapuan Salit, PEng., Ph.D

Faculty: Engineering

This research work is concerned with the determination of tensile, flexural and impact properties of kenaf and ramie fabric reinforced epoxy composites at three and eleven layers of fibre and different treatment (i.e. alkaline or non-alkaline) methods. The specimens were prepared using hand lay-up technique. The tensile and flexural tests were performed using an INSTRON 5507 universal testing machine and the high velocity impact test were performed using Ballistic Automated Network Gun systems (BANG) at projectile speed of 73 m/s, 160 m/s, 230 m/s and 278 m/s. In this study, the fibre has been treated by 6% alkaline treatment. Two main purposes of this thesis are to determine and compare the result of tensile, flexural and impact properties for kenaf and ramie composite, and also for composite (kenaf and ramie) with and without 6% of alkaline treatment. The result shows that 6% of alkaline treated of composites possess decreased value of tensile and flexural strength for kenaf and ramie composite because of high percentage of alkaline treatment. However, the increased value of impact properties found after adding 6% of alkaline

treated. The outcome of the result clearly shows that ramie composite is better than kenaf composite in tensile and flexural properties. But in impact properties, the outcome result shows that kenaf composite is better than ramie composite.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master

SIFAT MEKANIKAL KOMPOSIT KENAF DAN RAMIE FABRIK BERTETULANG EPOKSI MATRIKS TANPA DAN DENGAN RAWATAN KIMIA ALKALI

Oleh

KHAIRUL AZMI BIN MD REZALI

Jun 2008

Pengerusi: Profesor Dr. Mohd. Sapuan Salit, PEng., Ph.D

Fakulti: Kejuruteraan

Penyelidikan ini adalah berkaitan untuk menentukan sifat tegangan, lenturan dan hentaman untuk komposit epoksi gentian fabrik kenaf dan ramie pada 3 dan 11 lapisan fabrik dengan dan tanpa rawatan kimia alkali. Pembuatan spesimen komposit ini dijalankan dengan menggunakan teknik bengkalai tangan dan pemampatan acuan. Ujian tegangan dan lenturan dibuat dengan menggunakan mesin INSTRON 5507 dan ujian hentaman pula dibuat menggunakan sistem rangkaian senjata ballistik automatik (BANG) pada halaju peluru 73 m/s, 160 m/s, 230 m/s and 278 m/s. Fabrik dalam penyelidikan ini telah dirawat dengan 6% rawatan alkali. Tujuan kajian ini adalah bertumpu kepada dua tujuan utama iaitu mendapatkan hasil sifat tegangan, lenturan dan hentaman halaju tinggi pada komposit kenaf dan ramie, dan untuk komposit (kenaf dan ramie) yang ditambah dan tidak ditambah dengan 6 peratus rawatan kimia alkali. Keputusan menunjukkan 6% rawatan alkali memberikan nilai yang berkurangan pada sifat tegangan dan lenturan untuk komposit kenaf dan ramie disebabkan jumlah peratusan pada alkali yang terlalu tinggi. Walau bagaimanapun,

peningkatan nilai dapat ditunjukkan pada sifat hentaman selepas 6% rawatan alkali. Keputusan tesis ini juga menunjukkan komposit ramie adalah lebih baik berbanding komposit kenaf pada sifat tegangan dan lenturan. Tetapi pada sifat hentaman, keputusan menunjukkan komposit kenaf adalah lebih baik daripada komposit ramie.

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And lastly, my great appreciation to anyone who has directly and indirectly contributes to success in this project. All of your kindness will never be forgotten

I certify that a Thesis Examination Committee has met on 17 November 2008 to conduct the final examination of Khairul Azmi bin Md. Rezali on his thesis entitled "**Mechanical Properties of Untreated and Alkaline Treated Kenaf and Ramie Fabric Reinforced Epoxy Composites**" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

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Date: 10 April 2009

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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Date: 10 April 2009

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

KHAIRUL AZMI MD. REZALI

Date: 25 May 2009

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

NOMENCLATURE

LIST OF ABBREVIATIONS

AP	Armor Piercing
A_{t0}	original cross sectional area of tensile specimen
ASTM	American Standard Testing Method
BANG	Ballistic Automated Network Gun Systems
b_f	width of flexural specimen
b_t	width of tensile specimen
CNC	Computer Numerical Control
CNSL	Cashew nut shell liqud
COEX	Coconut shell powder-epoxy composite
E-Glass	A type of borosilicate glass used to produce glass fibers for reinforced plastics designed for applications requiring high electrical resistivity. Also known as electric glass
FMJ	Full Metal Jacketed
FMJ RN	Full Metal Jacketed Round Nose
GA^3	gibberellic acid
GF	Glass Fibre
G11N	Glass fabric fibre reinforced epoxy composite
HDPE	High Density Polyethylene
HIVAC	high velocity data acquisition system
h_f	thickness of flexural specimen
h_t	thickness of tensile specimen
H1	Treatment of Choline Chloride, Gibberellin (GA^3), Benzyladenine (6-BA) and $NaHSO^3$ at 20:9:5:800 mg kgÿ1
H3	Treatment of Choline Chloride, Gibberellin (GA^3), Benzyladenine (6-BA) and $NaHSO^3$ at 20:42:43:2350 mg kgÿ1
H_2CO	Formaldehyde is a chemical compound with the formula H_2CO

INTROP	Institute of Tropical Forestry and Forest Products
ITMA	Institute of Advanced Technology
JIS K	Japanese Industrial Standards for Chemical Engineering
JIS L	Japanese Industrial Standards for Textile Engineering
K3A	Kenaf of three layer alkaline treated fabric reinforced epoxy composite
K3N	Kenaf of three layer non-treated fabric reinforced epoxy composite
K11A	Kenaf of eleven layer alkaline treated fabric reinforced epoxy composite
K11N	Kenaf of eleven layer non-treated fabric reinforced epoxy composite
L_f	span between centre of support of flexural specimen
LR LRN	Long Rifle Lead Round Nose
MARDI	Malaysian Agricultural Research and Development Institute
m_f	mass of fabric fibre in air
m_{fa}	mass of fabric fibre suspended in acetone
$NaHSO_3$	Sodium hydrogen sulfite
NaOH	Sodium hydroxide
$NH_4\ NO_3$	Ammonium Nitrate
NIJ	National Institute of Justice
PAT/607 -/PCM	PAT-607/PCM is specially developed water based micro emulsion, no silicone or natural wax is used and the PAT-607/PCM film forms on polished and chromed steel perfectly
PA66	Polyamide 6, 6 (Nylon patented by Dupont)
PP	Polypropylene
REMOTE	Remote Online Monitoring and Testing system
R3A	Ramie of three layer alkaline treated fabric reinforced epoxy composite

R3N	Ramie of three layer non-treated fabric reinforced epoxy composite
R11A	Ramie of eleven layer alkaline treated fabric reinforced epoxy composite
R11N	Ramie of eleven layer non-treated fabric reinforced epoxy composite
SEM	Scanning electron microscopy
SJHP	Semi jacketed Hollow Point (SJHP)
SPI	Soy protein isolate
Technora	A para-aramid fiber independently developed by Teijin, which has been commercially available since 1987
Twaron	Brandname of Teijin Aramid for a para-aramid.
Twintex®	A thermoplastic textile composite consisting of direct glass filaments and co-produced, commingled thermoplastic fibres
UPM	Universiti Putra Malaysia
US	United States
W_f	weight layer of fabric fibre
W_m	weight of matrix
6-BA	6-benzylaminopurine
ρ_f	density of fabric fibre
ρ_a	density of acetone
ρ_m	matrix density
ρ_f,	fibre density
σ_{fm}	maximum flexural strength of flexural specimen
P_{fm}	maximum applied load to flexural specimen