THE IMPACT AND FLEXURAL STUDY OF THE POLYMERIC BIOCOMPOSITE

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…………………………………………………..
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DECLARATION

I hereby, declare this thesis entitled "The Impact and Flexural Study of The Polymeric Biocomposite"
is the result of my own research
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Signature	:	____________________
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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirement for the degree of Bachelor of Manufacturing Engineering (Engineering Materials). The members of the supervisory committee are as follow:

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ABSTRACT

The polymeric bio-composite material is a material constituent a polymeric matrix (resin) and a reinforcement of natural fibers which are usually derived from plants or cellulose. The objectives for this study are to study on the impact properties and flexural properties of the polymeric composite. The bio-material material that used to fabricate the specimens was based on commercially available unsaturated polyester. kenaf fibre from kenaf plant. Besides that, the fibre that used will treated with alkali treatment with various concentrations such as 3%, 6% and 9% NaOH but with same soaking times that is 12 hours. For the manufacturing process, the kenaf / polyester is prepared by using Resin Infusion Process (RIP) with several equipments and tools. 5 pieces specimens of each testing were tested with flexural and impact machine. Following by that, the morphology of the surface fracture is investigated using Scanning Electron Microscope (SEM). Based on this finding, the flexural properties was increasing gradually as the chemical concentration treatment in composite increased. It is observed that the flexural strength increased from 0.0251 GPa to 0.0934 GPa and flexural modulus increased from 2.298 GPa to 7.137 GPa respectively for untreatment fibre to 9% fibre. Lastly for the impact properties, the impact strength and impact modulus are indicated a rise from 3.57 kJ/m^2 to 15.77 kJ/m^2 as the fibre content increased from untreated to 6% concentration but decreased to 2.47 kJ/m^2 when used 9% concentration treatment on kenaf fibre. This is because this natural fibre is considered oriented short fibre composites with strong cellulossic microfibres of different lengths.

ABSTRAK

Bahan bio-komposit merupakan bahan yang terkandung polimerik matrik (resin) dan gentian semula jadi yang biasanya terdiri daripada tumbuhan dan cellulose. Projek ini bertujuan untuk mengkaji ujian hentaman dan kelenturan bagi polimerik komposik. Bahan matriks digunakan dalam membuat spesimen adalah berdasarkan kepada polyester tidak tepu yang didapati secara komersil dan gentian kenaf yang dijumpai daripada pokok kenaf. Selain itu, gentian kenaf yang dijalankan dengan proses rawatan alkali dengan kepekatan berbeza seperti 3%, 6% dan 9% tetapi dengan rendaman masa yang sama iaitu 12 jam. Bagi proses pembuatannya, komposit kenaf dan polyester adalah disediakan dengan menggunakan Proses Seduhan Resin. 5 keping specimen bagi setiap satu kajian diuji dengan ujian hentaman dan kelenturannya. Selepas itu, specimen yang diuji dengan ujian ujian hentaman dan dianalisis dengan Mikroskop Pengimbas Elektron. Berdasarkan kajian, sifat kelenturan akan semakain bertamabah kerana kepekatan kimia bertambah. Hal ini dapat dilihat bagi kekuatan kelenturan bertambah dari 0.0251 GPa ke 0.0934 GPa manakala kelenturan modulus pula bertamabah dari 2.298 GPa ke 7.137 GPa masing-masing bagi gentian tanpa rawatan kimia ke 9% gentian. Bagi sifat hentaman, kekuatan hentaman dan hentaman modulus menunjukkan peningkatan dari 3.57 kJ/m^2 ke 15.77 kJ/m^2 apabila kandungan gentian bertambah dari tanpa rawatan ke 6% kepekatan tetapi menurun ke 2.47 kJ/m^2 bagi kepekatan 9%.

DEDICATION

For my beloved family.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

%	-	percentage
°F	-	Degree of Fahrenheit
ASTM	-	American Society for Testing and Materials
b	-	Width of beam tested
CMC	-	Ceramic Matrix Composites
d	-	Depth of beam tested deflection curve
EB	-	modulus of elasticity in bending
FRP	-	Fibre reinforcement Polymers
HDPE	-	High Density Polypropylene
in.	-	inch
J	-	in unit joule
kN	-	kilo Newton
kJ/m^2	-	kilo joule per millimeter square
L	-	Support span
lbf /in	-	pound force per in
lbf	-	Pounds of Force
LDPE	-	Low Density Polypropylene
NaOH	-	Sodium Hydroxide
M	-	Slope of the tangent to the initial straight line portion of the load
MEKP	-	Methyl Ethyl Ketone Peroxide

mm	-	millimeter
MMCs	-	Metal Matrix Composites
MPa	-	Mega Pascal
N	-	unit SI Newton
N/mm	-	Newton per millimeter
NF	-	Natural Fibre
ºC	-	degree Celsius
P	-	load at a given point on the load deflection curve
Pa	-	in unit Pascal
PMCs	-	Polymer Matrix Composites
psi	-	pound per square inch
R	-	Rate of cross head motion
RIP	-	Resin Infusion Process
RTM	-	Resin Transfer Moulding
SEM	-	Scanning Electron Microscopy
SI	-	International System of Units
TLK	-	Treated Long Kenaf
UTM	-	Universal Tensile Machine
UT	-	Untreated fibre
% wt	-	percentage weight
Z	-	Rate of straining of the outer fibre
σ_f	-	stress in the outer specimen at midpoint

CHAPTER 1

INTRODUCTION

1.1 Introduction

Composite materials in research often require certain modifications in order to improve their properties. Nowadays, composites offer greatly reduced maintenance compared with steel and concrete and therefore offer whole life cost benefits. However, first cost is the major and often the only parameter used by clients in decision making despite much talk about whole life costing.

Composite materials are engineered materials formed through the physical combination of two or more materials; these are the fibres/fillers and the matrix; together with any additives which may be required to give the composite specific physical properties. The combination of the materials will differ in form or composition at the macro scale, for the purpose of improving or enhancing properties. (Wikipedia 2006). There are two categories of constituent materials: matrix and reinforcement.

The research work will focus on study of the mechanical properties of the composite focusing on impact and flexural properties in the laboratory scale. There are several processing stage in sampling fabrication by using vacuum infusion technique. This will followed by testing stage in order to investigate the mechanical properties and others. This analysis data of the finding after that will compared with existing materials used in order to verify that this new composite has the potential to be use as the substitution material in structural application.

1.2 Problem Statement

Metals are used as major application in many fields in long time ago. Even though metals are known for their outstanding mechanical properties, the costs of their raw materials somehow outweight the inherent benefits. But today, the selections of materials in the market are shifted to the lightweight composite. This scenario gives an opportunity to explore on producing a lightweight composite since the cost for producing in Malaysia is inexpensive compared with metals yet at the same time maintaining the outstanding mechanical properties. In this research, the main focus is to use kenaf as the substitute materials for the steel, as reinforcement in polymer matrix for polyester in order to produce a high impact composite but lightweight. Before that, the usage of kenaf mainly for furniture likes its counterpart the wood and bamboo. Now, this has force the researcher to find other substitution materials and kenaf is believed has the potential to replace this role as it functions as a good reinforce in suitable matrix material.

1.3 Objectives

The specific objectives of this research were to:

i. To investigate the impact properties of various chemical concentration treatment for kenaf/Polyester composite.

ii. To analyze the flexural properties of various chemical concentration treatment for kenaf/Polyester composite

iii. To study the fibre matrix interaction by scanning electron microscopy (SEM)

1.4 Scopes of Research Methodology

The scopes of research were:

(i.) Preparation of kenaf and polyester

(ii.) Characterization of kenaf and polyester

(iii.) Treatment of fibre prepared

(iv.) Resin Infusion Process

(v.) Testing to find out mechanical properties

- Flexural Test (ASTM D790)
- Impact Test (ASTM D256

(vi.) Scanning Electron Microscope (SEM) to study fibre matrix interaction

CHAPTER 2

LITERATURE REVIEW

2.1 Composite

Since there are so many different plastics with different properties and structures, so the subject of polymeric materials may seen overwhelming to the average material user. Plastics can be divided into two types relating to their elevated temperature which are thermoplastic and thermoset. (Budinski et al., 1999)

Composites have many engineering advantages over synthetic polymers and copolymers. Some of these advantages are :

i. Reinforcement of the resin resulting in increased tensile strength, flexural strength, compression strength, impact strength, rigidity and combination of these properties.
ii. Increased size stability.
iii. Improved fire retardancy.
iv. Corrosion protection.
v. Improved electrical properties; reduction of dielectric constant.
vi. Coloring.
vii. Improved processibility; controlled viscosities, good mixing, controlled orientation of fibress.

2.1.1 Thermoplastics

Thermoplastic, is a material that is plastic or deformable, melts to a liquid when heated and freezes to a brittle, glassy state when cooled sufficiently. A thermoplastic material will flow at elevated temperatures (above the glass transition temperature or crystalline melting point), and the solidified polymer can be reheated as many times as desired and it will do the same thing. These include polyethylene, polypropylene, polystyrene and polyvinyl chloride. (Budinski et al., 1999)

2.1.2 Thermoset

Thermosetting plastics (thermosets) are polymer materials that cure, through the addition of energy, to a stronger form. Thermoset, once their shape has been made by casting or by plastic flow at elevated temperature, will not longer melt or flow on reheating. Principle thermosets are epoxies, polyesters and formaldehyde-based resins. When the molecular weight has increased to a point so that the melting point is higher than the surrounding ambient temperature, the material will forms into a solid material during the reaction. After it is cured, a thermoset material cannot be melted and re-shaped. They do not lend themselves to recycling like thermoplastics, which can be melted and re-molded. (Budinski et al., 1999)

2.1.3 Elastomers

This term of polymer is used to describe a polymer that has rubber like properties. The derivation of the term comes from elastic, the ability of a material to return to its original dimensions when unloaded, and mer, the term used in polymer chemistry to refer to a molecule. Since recovery in some polymers is not rapid, so not all elastomers can meet their definition of a rubber. A more usable definition of an elastomer is a polymeric material that has elongation rates greater than 100% and a significant amount of resilience and it refer to a material's ability to recover from elastic deflections. It measured with the amount of energy lost in deflection. It means that a material with a good resilience when dropped from a height onto a rigid surface will rebound to almost its original height (Budinski et al., 1999).

2.2 Biocomposite

Biocomposites are composite materials comprising one or more phases derived from a biological origin. In terms of the reinforcement, this could include plant fibres such as cotton, flax, hemp and the like, or fibres from recycled wood or waste paper, or even by-products from food crops. Matrices may be polymers, ideally derived from renewable resources such as vegetable oils or starches. Alternatively, and more commonly at the present time, synthetic, fossil-derived polymers preponderate and may be either 'virgin' or recycled thermoplastics such as polyethylene, polypropylene, polystyrene and polyvinyl chloride, or virgin thermosets such as unsaturated polyesters, phenol formaldehyde, isocyanates and epoxies (Fowler et al., 2006).

2.2.1 The Reinforcement

Fibre reinforcement may be used in several different forms or arrangements, depending on the application and manufacturing route. They are categorised firstly in terms of length: