MECHANICAL BEHAVIOUR OF POLYMER BASED BAMBOO COMPOSITE 2

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Report submitted in partial fulfillment of the requirements

For the award of the degree of

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

Σ	Summation
+	Addition
^{2}	Squares
-	Divide
*	Multiply
^{0}C	Degree Celsius
%	Percentages

LIST OF ABBREVIATIONS

BF	Bamboo Fiber
PP	Polypropylene
PMC	Polymer Matrix Composite
CMC	Ceramic Matrix Composite
MMC	Metal Matrix Composite
ASTM	American Society for Testing and Material
GPa	Giga Pascal
MPa	Mega Pascal
SOP	Standard Operation Procedure
WA	Water Absorption
UTM	Universal Tensile Machine
UTS	Ultimate tensile strength
CFRP	Carbon Fiber Reinforced Polymer

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ABSTRACT

Composite is a combination of two or more constituent materials, when two materials with a different properties were combined, it produces a material which has superior properties than a single material. Natural fibers can be defined as a fiber that produces by a plant or animal, which is categorized as a renewable resource. Natural fibers are commonly used as a reinforced such as hemp, jute, kenaf, and sisal. Mostly, they contribute in a lot of sectors such as an automobile, furniture, packing construction and sport. This experiment used thermoplastic (Polypropylene) as matrix and natural bamboo from a "Gigantochloa Levis" species as the fiber of the composite. The first objective of this project is to design and fabricate a bamboo composite specimen by using a Polypropylene as a matrix. The second objective is to investigate the tensile and impact properties of the composite and lastly to characterize the bamboo specimen after fracture. Firstly, the process to extract the fiber from the raw bamboo is to separate the fiber from the raw bamboo culm. There are various extraction techniques, and for this experiment, mechanical extraction technique was implemented by using the Hammer Mill machine. Based on this technique, the raw bamboo was cut into a long strip before were put into the machine, and then the bamboo strip will be grinded to produce a bundle of fiber. After a bundle of fiber extracted, the next process is to mix up the matrix and reinforcement material. This mixing process is very crucial to ensure that the composites have a good bonding. For the mixing process, composite mixed into three different compositions which are 20% BF + 80 % PP, 30 % BF + 70 % PP and 40% BF + 60% PP by using Internal Brabender Mixer machine. After that, Hot Press & Cold Press technique was used to form a composite. This technique started with installing a mixed composite into a mold, and then the mold will be transferred to the hot press section. Next, the hot mold was moved to the cold press section for the curing process. This process repeated for three different compositions as mentioned before. By using this fabricating technique, the composite was formed with a dimension of 3mm x 150mm x 150mm sheet shape. Finishing process was required to obtain the desired specimen by referring to the ASTM D638 for Tensile Test and ASTM D256 standard for the impact test. Finally, the composite was cut manually by using Vertical Band saw machine to get the requirement shape specimen for Izod Impact Test and Tensile Test. For the prepared specimens, Impact Test and Tensile Test were conducted by using INSTRON 3369 test machine and CEAST 9050 test machine, respectively. In order to characterize the bamboo specimen, the broken specimens from the tests were collected and the characteristics of the composition are observed under Video Measuring System Machine. As a conclusion, based on the collected result, the increment of the bamboo fiber composition into the composite lead to lower tensile and impact properties. This occured because the interfacial bonding of composite became weak due to less amount of bonding agent. In this experiment, the one and only bonding agent for the composite is polypropylene. Thus, when the composition of polypropylene reduces, bonding agent of composite minimize. As a consequence, the interfacial bonding of composite became weak and easily to fail when force is applied.

ABSTRAK

Komposit adalah bahan yang terdiri daripada dua atau lebih bahan konstituen, apabila dua bahan dengan sifat yang berlainan telah digabungkan, ia menghasilkan bahan yang mempunyai sifat yang berbeza daripada bahan tunggal. Gentian asli boleh ditakrifkan sebagai gentian yang dihasilkan oleh tumbuhan atau haiwan, ia juga sumber yang boleh diperbaharui, contoh beberapa serat semula jadi yang biasa digunakan sebagai gentian ialah kenaf dan sisal. Ia juga banyak digunakan dalam beberapa sektor seperti automotif, perabot, pembungkusan pembinaan dan sukan. Untuk eksperimen ini, termoplastik (Polypropylene) digunakan sebagai matriks dan serat buluh asli dari spesies ("Gigantochloa Levis") digunakan sebagai tetulang komposit. Objektif projek ini adalah untuk mereka bentuk spesimen komposit buluh dengan menggunakan "Polypropylene" sebagai matriks, untuk menyiasat tegangan dan kesan impak dan akhir sekali untuk mencirikan spesimen buluh selepas patah. Pertama sekali, untuk mendapatkan serat daripada buluh mentah, ia memerlukan proses untuk mengekstrak gentian berasingan daripada tangkai buluh mentah, terdapat pelbagai jenis teknik pengekstrakan dan bagi eksperimen ini, teknik pengekstrakan mekanikal telah digunakan. Berdasarkan teknik ini, buluh mentah telah dipotong menjadi jalur halus sebelum dimasukkan ke dalam mesin "Hammer Mill", mesin ini akan mengisar jalur buluh sehingga ia menjadi serat habuk. Selepas serat habuk diekstrak, proses seterusnya adalah untuk campuran antara matriks dan bahan tetulang, proses pencampuran adalah sangat penting untuk memastikan bahawa komposit mempunyai ikatan yang baik. Untuk proses pencampuran, mesin "Internal Brabender Mixer" telah digunakan, untuk proses pencampuran, komposit dicampurkan ke dalam tiga komposisi yang berbeza iaitu 20% BF + 80% PP, 30% BF + 70% PP dan 40% BF + 60% PP. Selepas itu, proses terakhir untuk menghasilkan komposit adalah proses fabrikasi, komposit difabrikasikan dengan menggunakan teknik "Tekan panas & Tekan sejuk". Teknik ini dimulakan dengan memasang komposit campuran ke dalam acuan, selepas itu acuan yang dimasukkan ke dalam seksyen tekanan panas dan apabila ia selesai, acuan panas terus bergerak ke bahagian sejuk mesin untuk proses pengawetan. Proses ini diulangi mengikut tiga komposisi yang berbeza seperti yang dinyatakan di atas. Dengan menggunakan teknik fabrikasi ini, komposit telah ditubuhkan dengan lembaran bentuk 3mm x 150mm x 150mm dan proses pemotongan diperlukan untuk membentuknya ke dalam standard spesimen yang dikehendaki (ASTM D638 untuk ujian tegangan dan ASTM D256 untuk ujian impak). Akhirnya, komposit dipotong secara manual dengan menggunakan mesin pemotong tegak, apabila selesai, ujian impak Izod dan ujian tegangan diuji ke atas spesimen. Dalam usaha untuk mencirikan spesimen buluh selepas diuji, spesimen yang telah patah disebabkan ujian telah dikumpul dan pencirian komposisi komposit akan ditunjukkan di bawah mesin pengukur optik. Kesimpulannya, berdasarkan keputusan yang dikumpul, penambahan komposisi serat buluh ke dalam komposit akan membuatkan penurunan sifat mekanikalnya, perkara ini berlaku kerana apabila gentian buluh telah ditambah, ikatan dalaman komposit menjadi lemah, perkara ini disebabkan kurangnya ejen pelekat, untuk eksperimen ini, satu satunya ejen pelekat adalah polipropilena, apabila komposisi polipropilena kurang ia bermaksud agen pelekat komposit kurang, perkara ini akan membuat ikatan antara muka komposit lemah dan mudah untuk gagal apabila daya dikenakan ke atasnya.

CHAPTER 1

INTRODUCTION

1.1 THEORY OF BAMBOO

Bambusa or we recognize as bamboo in the botanical features a range of about 7 to 10 subfamilies of the group and there are 1575 kind variety of species ranging from the type of wood to bamboo herbs. Each particular species of bamboo have different types of properties and qualities. Bamboo is easily approachable globally, 64% of the bamboo plantation came from Southeast Asia, 33% is grown in South America, and the rest come from Africa and Oceania because it takes only several months to regrow. However, a production that using a bamboo naturally was rich with traditional elements and suitable for variety. Bamboo also as a great potential to be used as a substitute for solid wood, especially in manufacturing, design, and construction applications. There are a lot of product that made up from bamboo, such as roofing, umbrella stand, wedding favors and many others (Abdul Khalil et al., 2012).

1.2 THEORY OF BAMBOO COMPOSITE

Composite is a material that made up from two or more constituent material with different properties of mechanical and chemical. When two materials with a different property were combined, it produces a composite material which has different properties from a single material. Natural fibers can be defined as a fiber that produces by a plant or animal, and also act as a renewable resource. Examples of some natural fiber that commonly used as a reinforced are hemp, jute, kenaf and sisal. Its application distributing largely in a lot of sectors such as an automobile, furniture, packing construction and sport (Hojo et al., 2014).

The natural fiber also has many advantages compared with synthetic fibers such as low cost, low density and less damage to processing equipment. Nowadays, the natural fiber used for composite reinforcement rising rapidly among researcher because they are renewable sources and excellent reinforcing properties for polymer composite (Rassiah et al., 2014). Bamboo fibers were one of the families of natural fiber. It has also become most important non-wood species which grows widely in most tropical and subtropical area (Chaowana, 2013).

Bamboo cellulose fiber embedded in a lignin that aligned along the bamboo providing a maximum tensile strength, flexural and rigidity in this direction. There are several journal and researcher that published on the bamboo reinforced based composite using polymer either thermoplastic or thermoset as a matrix form of composite. Composite matrix is the important parameter that characterizes the properties of the composite. Thermoplastic and thermoset are basically having different mechanical and chemical properties and this factor will affect the properties of the composite.

A thermoplastic polymer that commonly used as a matrix for bamboo reinforced composite is a polypropylene (PP). Bamboo strips polypropylene (BSPP) composites have better characteristics that including high bending, acoustic characteristics and high sound good moisture which makes them suitable as raw material and ideal to replace glass fibers which currently used for the substrate that renowned automotive.

Besides that, thermoset polymer that commonly used as a matrix for bamboo reinforced composite is an epoxy.

The potential and importance of the bamboo used in thermoset composites are expected to have the same trend as thermoplastic composites. Bamboo fiber reinforced epoxy composites are subject to wear and friction environment to achieve widespread acceptance for use in many applications. The bamboo strips available epoxy composite materials attractive for use in the marine sector around the world has resulted in a bamboo boat hulls using vacuum bagging and compression molding processes (Abdul Khalil et al., 2012).

Furthermore, there are several methods to extract the bamboo fibers, for example by mechanical extraction, chemical extraction or combined the mechanical and chemical extraction. First, the mechanical extraction method can take the form of different procedures such as steam or heating steam explosion, retting, crushing, grinding and roll mill. These methods have been used to produce fiber for the application of bamboo fiber reinforced composites in a variety of industries. Second, chemical extraction procedures using alkali or acid retting, chemical methods, chemical assisted nature (CAN) or degumming to reduce or to remove fiber lower lignin content. These treatments also have side effects on other components of the microstructure of bamboo including pectin and hemicellulose.

Lastly, a combination of mechanical and chemical extraction method is the compression molding technique (CMT) and roller mill technique (RMT). This combination is commonly used to removes the fibers after chemical and alkali treatment (Zakikhani et al., 2014). Other than that, various types of the fabricating technique were introduced by the previous researchers, for example, hand lay-up technique, resin injection technique, hot press method, filament winding and pultrusion. Every single technique has their own advantages and disadvantages, the different technique also used based on their application and function.

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