UNIVERSITI PUTRA MALAYSIA

MECHANICAL AND PHYSICAL PROPERTIES OF HYBRID BANANA PSEUDOSTEM/GLASS FIBRE REINFORCED POLYESTER COMPOSITES

NOR HANIFAWATI BT INAI

FK 2013 45

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By

NOR HANIFAWATI BT INAI

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

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MASTER OF SCIENCE
UNIVERSITI PUTRA MALAYSIA

2013

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DEDICATION

For all your encouragement and advice, this thesis is gratefully dedicated to:

My Beloved

Father and Mother

Husband

Family and Friends

Thank you very much for your continuous support and effort towards the completion of this thesis.

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

MECHANICAL AND PHYSICAL PROPERTIES OF HYBRID BANANA PSEUDOSTEM/GLASS FIBRE REINFORCED POLYESTER COMPOSITES

By

NOR HANIFAWATI BINTI INAI

March 2013

Chairman : Azmah Hanim Binti Mohamed Ariff, PhD

Faculty : Engineering

Over the last decade, polymers reinforced with natural fibre composites have been getting an increase attention from the academic world and various industries. Development of composites using natural fibres in combination with moisture and corrosion resistant synthetic fibres is one technique to enhance the strength and stiffness as well as moisture resistance of the resulting hybrid fibre composites. The main objective of this study is to determine the mechanical and physical properties of a biohybrid composite which consist of banana pseudostem fibres and glass fibres. The specimen made of various fibre contents (10%, 20%, 30% and 40% by volume) of banana pseudostem and glass fibres were prepared. This research investigates the effect of fibre content on the mechanical and physical properties of hybrid banana pseudostem/glass fibre reinforced polyester composites. This study also presents a detailed investigation of the properties of hybrid composites over a range of glass fibre and banana fibre ratios. Composites having a different volume ratio of banana:glass such as 0:1, 2.5:7.5, 5:5, 7.5:2.5 and 1:0 were fabricated using a compression moulding technique. Mechanical tests such as tensile, flexural and impact test were carried out in

accordance to ASTM D5083, ASTM D790 and ASTM D256 respectively. The moisture effect is an important aspect of this research, because natural fibres are very hydrophilic. This research indicates the variation of physical properties in these materials in response to water absorption. Composites were also analyzed by scanning electron microscopy (SEM) in order to study the morphological characteristic of composites fracture surfaces and microstructure. Based on the results, except for banana/polyester composites, it was found that the tensile and flexural properties of all composites increased with the gradual addition of 10 vol% fibre content. The highest mechanical properties have been obtained for 40% fibre filler of hybrid and non-hybrid composites. In the case of hybrid banana pseudostem/glass fibre composites, incorporation of 7.5 volume fraction of glass fibre gives the highest values of mechanical properties. In banana/polyester composites, as the banana fibre loading increases, the decrease in tensile and flexural properties is observed but these natural fibre composites show significant enhancement in elongation at break. The gradual addition of 10 vol% fibre loading to the unsaturated polyester matrix increased the impact strength of all composites.

It is interesting to note that the tensile, flexural and impact properties significantly increased by the incorporation of small amount of glass fibre in banana fibre composites, showing positive hybrid effect. It is also observed that the water absorption tendency and thickness swelling of composites decrease by the process of hybridization. In conclusion, hybridization of banana pseudostem fibre with glass fibre had positive effect on the mechanical and physical properties of its composites.

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

SIFAT MEKANIKAL DAN FIZIKAL KOMPOSIT POLIESTER TAK TEPU DIPERKUAT GENTIAN BATANG PISANG/KACA HIBRID

Oleh

NOR HANIFAWATI BINTI INAI

Mac 2013

Pengerusi : Azmah Hanim Binti Mohamed Ariff, PhD

Fakulti : Kejuruteraan

Sejak sedekad yang lalu, polimer yang diperkuatkan dengan bahan komposit gentian semulajadi telah mendapat perhatian daripada dunia akademik dan pelbagai industri. Pembangunan komposit menggunakan gentian semulajadi di kombinasi dengan gentian sintetik tahan lembapan dan hakisan ialah salah satu teknik untuk meningkatkan kekuatan dan ketegaran serta rintangan lembapan komposit gentian hibrid. Objektif utama kajian ini ialah untuk menentukan sifat mekanikal dan fizikal komposit biohibrid yang terdiri daripada gentian batang pisang dan gentian kaca. Spesimen diperbuat daripada pelbagai kandungan gentian (10%, 20%, 30% dan 40% merujuk kepada nisbah isipadu dalam komposit) batang pisang dan gentian kaca telah disediakan. Pengaruh kesan kandungan gentian terhadap sifat komposit poliester diperkuat gentian telah dikaji. Kajian ini juga menyelidik secara terperinci mengenai sifat komposit ke atas satu julat nisbah gentian kaca dan gentian pisang. Komposit mempunyai nisbah isipadu berbeza pisang:kaca seperti 0:1, 2.5:7.5, 5:5, 7.5:2.5 dan 1:0 telah difabrikasi dengan menggunakan teknik mampatan acuan. Ujian mekanikal seperti tegangan, lenturan dan hentaman dijalankan berdasarkan piawai

ASTM D5083, ASTM D790 and ASTM D256. Kesan lembapan adalah satu aspek penting dalam kajian ini kerana gentian semula jadi adalah sangat hidrofilik. Kajian ini menunjukkan variasi sifat fizikal dalam bahan ini sebagai tindak balas kepada penyerapan air. Komposit juga dianalisis menggunakan mikroskop imbasan elektron (SEM) untuk mengkaji morfologi permukaan gagal dan mikrostruktur. Berdasarkan keputusan, kecuali komposit pisang/poliester, didapati bahawa sifat tegangan dan lenturan semua komposit poliester meningkat secara beransur-ansur dengan pertambahan 10% kandungan gentian. Sifat mekanikal yang paling tinggi dapat dicapai bagi 40% pengisi dalam komposit hybrid dan bukan hybrid. Dalam kes hibrid gentian pisang/kaca komposit, penambahan 7.5 pecahan isipadu gentian kaca memberi nilai tertinggi sifat-sifat mekanikal. Apabila kandungan gentian batang pisang bertambah, komposit pisang/poliester menunjukkan pengurangan terhadap sifat tegangan dan lenturan tetapi komposit ini menunjukkan peningkatan yang signifikan terhadap pemanjangan pada takat putus. Penambahan secara beransur-ansur 10% berat kandungan gentian kepada matrik poliester tak tepu telah meningkatkan kekuatan hentaman semua komposit. Apa yang menarik perhatian adalah dengan sedikit campuran gentian kaca di dalam komposit gentian batang pisang, ia memberikan kesan peningkatan yang signifikan terhadap sifat tegangan, lenturan dan hentaman komposit seterusnya menunjukkan kesan hibrid yang positif. Dapat diperhatikan bahawa kecenderungan penyerapan air dan pembengkakan ketebalan komposit telah berkurang dengan proses penghibridan. Kesimpulannya, penghibridan gentian batang pisang dengan gentian kaca memberikan kesan positif terhadap sifat mekanikal dan fizikal kompositnya.

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I certify that a Thesis Examination Committee has met on ……. to conduct the final examination of Nor Hanifawati binti Inai on his thesis entitled "Mechanical and Physical Properties of Hybrid Banana Pseudostem/Glass Fibre Reinforced Polyester Composites" in accordance with the Universities and Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the candidate be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

Ir. Nor Mariah Adam, PhD, PEng
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairperson)

Mohd Khairol Anuar Mohd Ariffin, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Zulkiflle Leman, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Zuraida Ahmad, PhD
Associate Professor
Kulliyyah of Engineering
International Islamic University Malaysia
(External Examiner)

SEOW HENG FONG, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

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

Azmah Hanim Mohamed Ariff, PhD
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Ir. Mohd Sapuan Salit, PhD, PEng
Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Edi Syams Zainudin, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)

BUJANG BIN KIM HUAT, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

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 institutions.

_____

NOR HANIFAWATI BINTI INAI

Date: 25 March 2013

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