TENSILE AND FLEXURAL PROPERTIES OF *ARENGA PINNATA* FILAMENT (*IJUK* FILAMENT) REINFORCED EPOXY COMPOSITES

By

JANUAR PARLAUNGAN SIREGAR

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

Thanks to my beloved wife, parents and my loving family for their patience and support during the long preparation 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

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Chairman : Hasan Yudie Sastra, PhD

Faculty : Engineering

Natural fibers are low-priced and sustainable resources. With the increasing environmental protection consciousness, the natural fibers as a new group of environmental friendly materials are in considerable demand in recent years, in those unifying technological, economical and ecological aspects.

The aim of this study is to determine the tensile and flexural properties of *Arenga pinnata* filament as a natural filament and epoxy hardener as a matrix. This idea materialised to explore the new natural resources, considering on the abundance of available material resources in the local nature. The *Arenga pinnata* filament were mixed with epoxy and hardener also at the various filament weight percentages of 10%, 15% and 20% *Arenga pinnata* filament and with different filament arrangement such as long random, chopped random and woven roving. Hand lay up (HLU) process in this experiments were to produce specimen test with the curing time for the composite plates at room temperature

(25-30°C). The dimension of the specimen test for the tensile and flexural tests was adapted from the ASTM D638-99 and ASTM D790-99 respectively.

Results from the tensile and flexural tests of *Arenga pinnata* filament reinforced epoxy composite, show the addition of 10%, 15% and 20% of filament volume fraction every filament arrangement in epoxy has decrease the tensile and flexural strength values compare to pure epoxy resin (0% filament). On the other hand, the increase of filament volume fraction in epoxy has increase the tensile modulus and flexural modulus. Comparison of filament arrangement shows that the *Arenga* filament woven roving has the maximum of tensile and flexural strength, which are the value of tensile and flexural strength are 51 MPa and 100 MPa respectively. Scanning electron microscopy (SEM) test were carried out after tensile test to observe the interface of fiber and matrix adhesion.

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

SIFAT KETEGANGAN DAN KELENTURAN BAGI WAYAR DIPERKUAT *ARENGA PINNATA* BERTELULANG KOMPOSIT EPOKSI

Oleh

JANUAR PARLAUNGAN SIREGAR

January 2005

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Gentian semulajadi adalah merupakan sumber berkos rendah dan sumber terbaharui. Dengan timbulnya kesedaran tentang penjagaan alam sekitar, gentian semulajadi dianggap sebagai sumber bahan mesra alam dimana memenuhi permintaan pada masa kini meliputi dari segi aspek teknologi, ekonomi dan ekologi.

Matlamat dalam kajian ini adalah untuk menentukan sifat tegangan dan kelenturan bagi wayar *Arenga pinnata* sebagai wayar semulajadi dan resin epoksi dalam bentuk matrik. Idea khas ini dijana untuk menerokai sumber baru semulajadi mengenai timbunan/kewujudan sumber bahan yang diperolehi di alam tempatan. Wayar *Arenga pinnata* dicampurkan dengan resin epoksi dalam berlainan peratusan berat gentian iaitu 10%, 15% dan 20% daripada jumlah kandungan wayar *Arenga Pinnata*, dan disusun dalam pelbagai susunan secara rawak panjang, rawak potong dan anyaman. Eksperimen untuk membuat spesimen telah dikendalikan secara manual dalam masa pengeringan

pada plat komposit bersuhu bilik 25-30°C. Saiz bagi bahan spesimen untuk ujian tegangan dan kelenturan telah dipatuhi mengikut ASTM D638-99 dan ASTM D790-99. Hasil keputusan ujian tegangan dan kelenturan bagi wayar diperkuat *Arenga pinnata* bertelulang komposit epoksi, menunjukkan dengan penambahan daripada 10%, 15% dan 20% kandungan isipadu setiap susunan wayar dalam epoksi mempunyai penurunan nilai tegangan dan kelenturan berbanding dengan epoksi murni. Sebaliknya, penambahan kandungan ispadu wayar meghasilkan kenaikan nilai daripada tegangan modulus dan kelenturan modulus. Perbandingan susunan wayar dalam epoksi menunjukkan yang anyaman wayar *Arenga pinnata* mempunyai nilai tertinggi bagi tegangan maksimum dan kelenturan, manakala kekuatan tegangan dan kelenturan bernilai 51 MPa and 100 MPa masing-masing. Alat pengimbas mikro elektron telah digunakan untuk pemerhatian diantara permukaan wayar dan susunan matrik.

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I certify that the Examination Committee meet on 27th January 2005 to conduct the final examination of Januar Parlaungan Siregar on his Master of Science thesis thesis entitled "Tensile and Flexural Properties of *Arenga pinnata* Filament (*Ijuk* Filament) Reinforced Epoxy Composites" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded a relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or co currently submitted for any other degrees at UPM or other institutions.

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JANUAR PARLAUNGAN SIREGAR

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