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MECHANICAL PROPERTIES OF TREATED ARENGA PINNATA FIBRE REINFORCED NANOMODIFIED EPOXY COMPOSITE

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Natural fibres have attracted researchers and manufacturers attention due to their numerous advantages such as abundance of resources, environmental friendly, less harm to human body, good mechanical properties and low density. In order to increase the usage of natural fibre, lots of researches have been done on natural fibres as reinforcement to polymer matrix. In this study, plant based natural fibre called Arenga Pinnata was selected and its properties were studied. Arenga Pinnata fibre was selected due to its remarkable characteristics especially high durability and resistance to sea water. Focus of this study is to evaluate the effect of fibre volume fraction, filler inclusion and fibre surface treatment on physical and mechanical properties of Arenga Pinnata fibre reinforced epoxy composite (APREC). Mechanical properties of natural fibre reinforced polymer (NFRP) mostly depend on the fibre and polymer properties and also interfacial bonding in between them. Thus, nanosilica was used to enhance the mechanical properties of epoxy matrix and Arenga Pinnata had been treated using silane in order to improve interfacial bonding between fibres and matrix. The APREC samples, with 10vol%, 15vol%, 20vol%, and 25vol% fibre volume fractions, were produced using hand-layup and cold-pressing techniques. Flexural, tensile and compression tests were performed in order to obtain modulus of elasticity, strength and strain to failure of APREC. The morphological structure of fractured specimens was observed using scanning electron microscopy (SEM) in order to evaluate the fracture mechanisms involved. Preliminary tests were conducted on both unidirectional (UD) and random orientation APREC. Based on the results, the performance of UD APREC was better than random orientation APREC. The flexural modulus and strength of UD APREC were 5.31% and 35.73% higher than those of random APREC, respectively. Therefore, UD APREC was selected and used for evaluation of the effect of fibre volume fraction, filler inclusion and fibre surface treatment. The results showed that nanosilica addition and silane treatment improved mechanical properties of UD APREC. Flexural modulus and strength of UD APREC was increased by 5.42% and 3.59% with addition of 5wt% nanosilica, 8.53% and 13.25% with silane treatment, and 15.46% and 13.75% with both, respectively. Nanosilica addition and silane treatment showed positive improvement to UD APREC on tensile behaviour where tensile modulus increased by 2.45%, 1.67%, and 3.34% for the addition of nanosilica, silane treatment, and both procedure, respectively. The addition of 5wt% nanosilica in silane- treated UD APREC exhibited the highest tensile strength where the increment of 4.86% was observed compared to pure UD APREC. Nanosilica addition gave the best improvement on compression properties of UD APREC compared to flexural and tensile properties when the compressive modulus of UD APREC with nanosilica addition shown 46.61% increment, meanwhile maximum compressive strength was obtained by UD APREC with addition of nanosilica and silane treated fibre which gave 5.92% increment. Overall results for this study indicated that the addition of 5% nanosilica and the used of silane treated fibres give the best mechanical properties of APREC. It can be concluded that the addition of nanosilica and silane treatment on Arenga Pinnata fibres enhanced the flexural, tensile, and compressive properties of UD APREC.

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF STUDY

Natural fibres have attracted the attentions of researchers and manufacturers since way back of years due to their advantages such as the abundance of resources all around the world that make them low cost, environmentally safe due to their biodegradability nature, less harm to human body, good mechanical properties and low density. Every type of natural fibres has their own characteristics because of their growing environment and chemical structure. For this study, natural fibre from the plant called Arenga Pinnata was utilised. The main cause that lead to the selection of Arenga Pinnata fibres was due to its well-known characteristics where it has high durability and resistance to sea water when compared to other natural fibres [1]–[7]. These characteristics are the main advantages of Arenga Pinnata fibres.

The usage of Arenga Pinnata can be track back for centuries when there was boat that had been found in the Indonesian coast that used Arenga Pinnata fibres as ropes that bind together some of the important parts of the ship which were exposed to sea water. This boat then had been given the name "Kapal Punjulharjo" where Punjulharjo is the name of the place that boat was found. In Malaysia, Arenga Pinnata tree was planted by British East India Company in Penang to produce high durability rope from Arenga Pinnata fibres in 1800 [1]. There are other uses of Arenga Pinnta fibres such as roofs, filters, brooms, and shelter for fish breeding [2]. Advance use of Arenga Pinnata fibres was reported by Ishak and his colleagues [1] where it had been used in road constructions for soil stabilisation as a substitute for geo-textile fibreglass reinforcement [1] and also used for underwater and underground cables [3]. The latest study that had been published on Arenga Pinnata fibre was the thermal modulus of Arenga Pinnata fibre polymer composite on the effect of moisture absorption done by Abdullah et al. [4] and they concluded that Arenga Pinnata fibre polymer composite can be used in many applications.

Nanotechnology has been constantly studied and used extensively throughout the globe as new technology development. Researchers started to implement this