UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EXPERIMENTAL STUDY ON MECHANICAL BEHAVIOR IN 3D PRINTED PART USING FUSED DEPOSITION MODELLING (FDM) METHOD: THE OIL PALM FIBER REINFORCED THERMOPLASTIC FILAMENT AS RAW MATERIAL

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Manufacturing Engineering Technology (Product Design) With Honours.

by

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FACULTY OF MECHANICAL AND MANUFACTURING ENGINEERING TECHNOLOGY

2018

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: EXPERIMENTAL STUDY ON MECHANICAL BEHAVIOR IN 3D PRINTED PART USING FUSED DEPOSITION MODELLING (FDM) METHOD: THE OIL PALM FIBER REINFORCED THERMOPLASTIC FILAMENT AS RAW MATERIAL

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I hereby, declared this report entitled EXPERIMENTAL STUDY ON MECHANICAL BEHAVIOR IN 3D PRINTED PART USING FUSED DEPOSITION MODELLING (FDM) METHOD: THE OIL PALM FIBER REINFORCED THERMOPLASTIC FILAMENT AS RAW MATERIAL is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering Technology (Product Design) With Honours. The member of the supervisory is as follow:

Signature: ……………………………………………….

Supervisor : TS. MOHD NAZRI BIN AHMAD

ABSTRAK

Serat semulajadi semakin banyak permintaan dalam pelbagai bahan komposit polimer. Objektif penyelidikan ini adalah bagi mengkaji sifat-sifat mekanik dan morfologi gentian kelapa sawit mengukuhkan polimer termoplastik. Dalam penyelidikan ini, kami memilih serat kelapa sawit sebagai bahan pertama. Serat kelapa sawit (OPF) adalah serat yang diekstrak daripada tandan buah kosong yang terbukti menjadi bahan mentah yang baik untuk komposit bio. Kandungan selulosa serat kelapa sawit (OPF) dalam lingkungan 43% - 65% dan kandungan lignin dalam lingkungan 13% -25%. Prosedur fabrikasi termasuk pengeringan dan penghancuran harus dipertimbangkan untuk mengembangkan komposit. Sampel dibentuk dengan mempelbagaikan isipadu serat kepada beberapa peratus (5%, 10% dan 15%) dan acrylonitrile butadiene styrene (ABS) sepenuhnya dicampur bagi memperoleh berat 250 gram untuk menandakan bahan untuk setiap komposisi. Selepas itu, komposisi ini diuji untuk sifat-sifat mekanik seperti ujian tegangan dan lentur serta meneliti morfologi komposit dengan menggunakan analisis mikrostruktur. Oleh itu, keputusan menunjukkan kehadiran OPF dalam spesimen mempunyai persamaan 83% dengan sifat-sifat mekanikal ABS.

ABSTRACT

Natural fibers (NFs) are increasingly in demand across a wide range of polymer-composite materials. The objective of the research was study about the mechanical properties and morphology of oil palm fiber reinforce thermoplastic polymer. In this investigation, we pick the oil palm fiber as first material. Oil palm fiber (OPF) is a fiber extracted from empty fruit bunches which proved to be a good raw material for bio composites. Oil palm fiber (OPF) cellulose content is within 43% -65% and lignin content within 13% -25%. The fabrication procedure included alkalinised, dried and crushing should be considered in order to develop the composite. The samples were set up by changing volume part (5, 10 and 15% volume division) and the acrylonitrile butadiene styrene (ABS) were completely blended to acquire a mix of 250 gram signify material for every composition. After that, these compositions were tested for mechanical properties such as tensile and flexural test and also for their morphology by using microstructure analysis. Thus, the result shows the present OPFs in specimen has 83% similarity with ABS mechanical properties.

DEDICATION

All the praises and thanks to be to Allah S.W.T for His Love.

This thesis is dedicated to my beloved husband, family and all my friends. Not to forget special thanks to my project supervisor and all lecturer that give me guideline and provision during my study in UTeM.

Thank you very much for all plentiful help and encouragement.

ACKNOWLEDGEMENTS

In the name of Allah S.W.T, the Most Gracious and the Most Merciful. Alhamdulillah, all praises to Allah for the strengths and His blessing in completing this final year project.

Firstly, I would like to forward my sincere appreciated to my supervisor Ts. Mohd Nazri bin Ahmad for his guidance and generous assistance throughout the accomplishment of the work contain in the thesis.

I am also express my earnest appreciation and thanks to laboratory assistant engineer at material testing and rapid prototyping for providing helpful and significant information about testing machine and 3D printing.

Last but not least, to those who contribute towards the accomplishment of this thesis especially my beloved husband, family, my classmates and friends, I offer my deepest and genuine gratefulness for their support, opinion and suggestion.

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$\boldsymbol{\sigma}$	**-**	Tensile strength at yield
E	**-**	Tensile modulus (MPa)
F	**-**	Force applied (kN)
$\boldsymbol{\epsilon}$	**-**	Strain of the specimen (mm/min)
A	**-**	Cross section area
$\boldsymbol{\sigma}$	**-**	Stress applied on test specimen
P	**-**	Load at yield (max load)
$\boldsymbol{\sigma_{max}}$	**-**	Flexural strength (MPa)
$\boldsymbol{E_H}$	-	Flexural modulus (MPa)
L	-	Support span (mm)
d	-	Thickness (mm)
b	-	Width (mm) ($a^2 + b^2 = c^2$)
R	-	Rate of crosshead motion, mm/min
Z	-	Rate of straining of the outer fiber, mm/min; Z equal to 0.01

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter discusses the project related, the problem statement, the objectives and project scope. The tittle of this project is an experimental study on mechanical behaviour in 3D Printed Part using Fused Deposition Modelling (FDM) Method: The Oil Palm Fiber Reinforced Thermoplastic Filaments as Raw Material.

1.2 Background

Lately, there has been a hasty development in study and invention in the natural fiber composite area. Attentiveness in natural fiber composite is upward for various motives containing their possible to substitute synthetic fiber reinforced plastics at lower cost with better-quality sustainability, rise reliance on non-renewable vitality ratio of substantial bases, low impurity releases, low greenhouse gas releases, vitality reclamation improve and the end of life biodegradability of appliances.

The use of oil palm fiber in reinforcing polymers data has detailed in the writing. The investigation of elastic and flexural properties of these composites uncovered that composites with great quality could be effectively created utilizing oil palm fiber as the reinforcement. There are various diverse backgrounds of natural fiber, for instances pulp, bamboo, wood, hemp, bagasse, cotton, and vegetable (e.g., jute, flax, ramie, and sisal). Recognized with carbon fibres and glass fiber, natural features give various compensation, for example, suppleness through taking care of and less causing machine wear, minimal wellbeing dangers, vital fiber stage proportion, and adequately extraordinary ductile and flexural modulus. (Cerqueira, Baptista and Mulinari, 2011)

The point of this task is to explore the structure of oil palm fiber reinforced thermoplastic fiber in the few factors, for example, physical and mechanical properties. The oil palm fiber is a build-up generally created in high extents in the agro-business. The utilization of characteristic fiber in support have been a huge advantages of research. This developed important means an plenty, insignificant effort, and eagerly obtainable source of unlimited lignocellulosic biomass.

Malaysia is the world's largest palm oil exporter, the main source of lignocellulos comes from empty coconut fruit bunches as palm oil waste. Currently, no technology has yet been created to remove this waste and lack of landfill for this waste. Therefore, many palm oil refineries use the combustion process to remove these residues. The effects of this combustion can contribute to environmental pollution. Many researchers have been carried out to convert palm fruit bunches as waste to become a variety of value-added products.

1.3 Problem Statement

Sanousi et al, (1987) states that the use of synthetic plastic materials cannot be eliminated in the environment and thus lead to endless accumulation on the ground and can begin serious pollution (Sanousi and Abdelrahman, 1987). In last forty to fifty years, in the manufacture of synthetic composites, it comprising fine fibers in various plastics (polymers) dominating the market (S. Kindo, 2010). Though, with the cumulative global energy catastrophe and ecological risks, researches all over the world are shifting their attention towards another solution to synthetic fiber. While many advances have been made in elastic and flexural properties of these composites uncovered that composites with great quality could be effectively created utilizing natural fiber as the reinforcement.

However, sample preparation can be very challenging when mechanical properties is intended to locate voids, cracks and other defects, since damage can very easily be introduced in the preparation process (Cerqueira, Baptista and Mulinari, 2011). In response to this problem, this study recommends to investigate the composition of oil palm fiber reinforced thermoplastic filament in the several factors such as physical and mechanical properties.

1.4 Objective

The objectives of the current study are:

i. To investigate the effects on the tensile and flexural properties of 3D printed part by oil palm fiber reinforced thermoplastic filament by using standard measurement of the ASTM D638 and ASTM D790.

ii. To determine the fundamental mechanism of bonding between length Acrylonitrile butadiene styrene (ABS) and Oil palm fiber (OPF) by using microstructure analysis.

1.5 Scope of the study

This project will be focused on the effects on the mechanical behaviour of new filament from oil palm fiber reinforced thermoplastic composites. The fabrication process involved alkalinised, dried and milled need to be considered in order to develop the composite. In order to investigate the mechanical behaviour of this new filament, a mechanical and physical test are carried out in this project. The tests that involved are a tensile test and flexural test. The morphological analysis of modified fibres to evaluate the fiber dispersion in the composite is performed using a microstructure analysis.