EFFECT OF LAYER THICKNESS AND RASTER ANGLE ON TENSILE PROPERTIES OF CARBON FIBER REINFORCED ABS PRINTED PART

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DECLARATION

I declare that this project entitled “Effect of Layer Thickness and Raster Angle on Tensile Properties of Carbon Fiber Reinforced Abs Printed Part” is the result of my own work except as cited in the references

Signature: :……..……

Name: :……..

Date: :……..

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in term of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design and Innovation).

Signature :.....

Supervisor's Name :.....

Date :.....

DEDICATION

To my beloved mother and father

ABSTRACT

Additive Manufacturing (AM) technologies have been developed as a fabrication method to obtain a functional parts in a short time. One of the famous AM techniques is Fused Deposition Modeling (FDM). With the advantages of minimal wastage and ease of material change, FDM is widely used in fabricating a thermoplastic parts and prototypes. Although it is well known, FDM printing material limited to acrylonitrile butadiene styrene (ABS) or poly lactic acid (PLA). This paper present the research done to determine the influence of layer thickness and raster angle on the tensile properties of ABS and on a new material, carbon fiber reinforced ABS. The sample with three different layer thicknesses (0.18mm, 0.25mm and 0.31mm) and raster angles (30^o, 45^o and 90^o) were tested according to the ASTM D638 standard. It was found that both process parameter affect the tensile strength result. The ideal tensile properties for both material samples were found at layer thickness of 0.18mm and a raster angle of 90^o. The result revealed that parts build with larger layer thickness produced lower tensile strength. To analyze the performance of carbon fiber reinforced ABS, a comparison was made between the tensile properties of 3D-printed acrylonitrile butadiene styrene (ABS) and carbon fiber reinforced ABS parts. The result shows that the highest tensile strength of ABS parts were 48% higher than those highest tensile strength for carbon fiber reinforced ABS.

ABSTRAK

Teknologi *Additive Manufacturing* (AM) telah dicipta sebagai kaedah fabrikasi untuk mendapatkan bahagian yang berfungsi dalam masa yang singkat. Salah satu teknik AM yang terkenal adalah *Fused Deposition Modeling (FDM).* Dengan kelebihan pembaziran yang minimum dan memudahkan perubahan material, FDM digunakan secara meluas dalam menghasilkan bahagian termoplastik dan prototaip. Walaupun ia terkenal, bahan cetak FDM terhad kepada *acrylonitrile butadiene styrene* (ABS) atau *poly lactic acid* (PLA). Kertas kerja ini membentangkan penyelidikan yang dilakukan untuk menentukan pengaruh ketebalan lapisan dan sudut raster ke atas sifat-sifat tegangan ABS dan bahan baru, gentian karbon bertetulang ABS. Sampel dengan tiga ketebalan lapisan (0.18mm, 0.25mm dan 0.31mm) dan sudut raster (30^o, 45^o and 90^o) telah diuji mengikut standard ASTM D638. Ia telah mendapati bahawa kedua-dua proses parameter itu memberi kesan kepada hasil kekuatan tegangan. Sifat-sifat tegangan yang ideal untuk kedua-dua sampel bahan ditemui pada ketebalan lapisan 0.18mm dan sudut raster pada 90^o. Hasilnya menunjukkan bahawa bahagian yang dibina dengan ketebalan yang lebih besar menghasilkan kekuatan tegangan yang lebih rendah. Untuk menganalisis prestasi gentian karbon bertetulang ABS, perbandingan dibuat antara sampel cetakan 3D *acrylonitrile butadiene styrene* (ABS) dan gentian karbon bertetulang ABS. Hasilnya menunjukkan kekuatan tegangan tertinggi bahagian ABS adalah 48% lebih tinggi daripada kekuatan tegangan tertinggi bagi gentian karbon bertetulang ABS.

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CAD	Computer Aided Design
FDM	Fused Deposition Modeling
ABS	Acrylonitrile butadiene styrene
STL	Stereolithography
PLA	Poly Lactic Acid
RP	Rapid Prototyping
DOE	Design Of Experiments
PEEK	Polyther Ether Ketone
MPa	Mega pascal

LIST OF SYMBOL

^{o}	Degree
ε	Strain
σ	Stress
δ	Change in length

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Cany Mendosa et al (2015) stated that Additive Manufacturing (AM) is a process where the physical stated of a model was created by the data from three-dimensional computer aided design (CAD) at a quick rate. The advantages of additive manufacturing compared to subtractive manufacturing is minimal wastage.Additive manufacturing first emerged in 1987 with stereolithography (SL). Fused deposition modeling (FDM) is one of the AM techniques that utilizes plastic materials, for example, Acrylonitrile butadiene styrene (ABS) to create models or even practical items. FDM works by depositing a molten layer that come through the heated nozzle to the build platform until it becomes the desired components. Because of the growth of this technology and limitation to the material used, it is crucial to have knowledge of the mechanical properties from the part produced, which can be different from their nominal value.

In this study, the tensile strength of parts produced by FDM machine is evaluated. The test is subjected to compare between pure ABS and carbon fibre reinforced ABS specimens. ABS is comprised a versatile family of readily process able resin used for creating items displaying phenomenal strength, great dimensional solidness and good chemical resistance. Carbon fiber used in this study is a carbon fiber reinforced ABS with 15% of carbon. Back at 1879, the inventor of carbon fibre, Thomas Edison, used carbon fibres as filaments for early light bulb even though that fibres lacked the tensile strength of today's carbon fibres, the fibres are ideal for conducting electricity.

The tensile test conducted in this study was according to ASTM D638 standard. Tensile test is a fundamental type of mechanical test to get the tensile strength of the material to evaluate the maximum stress that can be withstand by a structure in tension. In this study, two process parameter selected are layer thickness and raster angle as it is founded by Fahraz et al (2014) that the layer thickness and raster angle are among the most affected parameter. According to Wenzheng et al (2015), the layer thickness which is known as the height of deposited slice from the FDM nozzle. The layer thickness parameter is used to examine the impact in creating thicker or thinner layers on the outcome quality. The direction of the beads of material relative to the loading of the part is also refers as raster angle or orientation which is measured from the x-axis on the bottom part layer. The deposited road can be built at different angle to fill the interior part. Es-Said et al (2000) declared that raster angle make the alignment of polymer atom along the direction of deposition when the tensile test, flexural and impact strength is fabricated which is depends on the orientation of the sample Sample with three different layer thickness (0.18mm, 0.25mm and 0.31mm) and raster angle (30^o, 45^o and 90^o) were built using FDM machine and their tensile properties were tested.

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1.2 PROBLEM STATEMENT

It is imperative to decide the right parameters of the FDM machine keeping in mind the end goal is to deliver a section which can satisfy the tensile properties. There are essentially some of parameters which are critical and will impact the details of the delivered part, and these parameters are the layer thickness and raster angle. The mixes of various setting of the parameters will create parts with various particulars. FDM is one the famous rapid prototyping technology, still, in most FDM equipment, they restricted to ABS and PLA printing material.

1.3 OBJECTIVE

The objectives of the project are:

- To study and understand the process parameter of FDM influencing the performance on tensile strength.
- To study and compared the tensile strength between pure ABS and carbon fiber reinforced ABS samples.

1.4 SCOPE OF PROJECT

The study covers the AM process which is the Fused Deposition Modeling (FDM). Besides that, the study also discusses about the parameters of the FDM machine and software for the CAD and STL file which is CATIA software and Flashprint .The focus for this study are the layer thickness and raster angle. The parameters upgraded with a specific end goal to accomplish great execution regarding tossing separation. The material utilized as a part of delivering the part is pure ABS and Carbon fibre reinforced ABS. The universal testing machine was used to decide the tensile properties of the Specimen.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides an overview of previous research on tensile strength of the ABS and composite and also the previous knowledge that involved in the research. It introduces the frames work for the case study that comprises the main focus of the research described. The main purpose of the literature review work was to survey previous study on tensile strength of ABS and composite. This was in order to scope out the key data collection requirements for the primary research to be conducted, and it formed part of the emergent research design process, Denscombe (1998).

In this chapter, the reader will be explained about the related knowledge of the project which covers the introduction of rapid prototyping and fused deposition modeling. The detail of the material tensile strength and process parameter used that affect its mechanical properties in the previous study.