ANALYSIS OF APPLYING ULTRASONIC SYSTEM ON FDM NOZZLE USING ANSYS

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This report submitted in accordance with requirement of the UniversitiTeknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design) (Hons.)

by

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ABSTRAK

Pemodelan Endapan Terlakur ialah sejenis Pembuatan pantas yang membolehkan seorang pereka atau jurutera menzahirkan bentuk yang dingini dengan hanya melukis suatu rekaan di dalam komputer. Ianya juga merupakan Pembuatan Pantas yang paling menjimatkan. Disebalik kelebihan itu, ianya mempunyai kelemahan paling ketara iaitu tidak dapat menghasilkan permukaan akhir dengan baik. Pengkaji sebelum ini telah mengeluarkan beberapa buah fikiran untuk mengatasi masalah ini. Antara buah fikiran yang telah mereka kemukakan ialah menyalurkan getaran tinggi daripada transduser ultrasonik kepada mesin Pemodelan Endapan Terlakur terutama pada bahagian muncung. Walau bagaimapun buah fikiran ini masih belum terbukti lagi kebenarannya. Projek ini bertujuan untuk mengkaji sama ada bahagian muncung Pemodelan Endapan Terlakur mampu untuk bertahan sekiranya disalurkan getaran yang tinggi. Projek ini telah dijalankan dengan menggunakan perisian Solidworks dan juga ANSYS. Solidworks digunakan untuk melukis model 3 dimensi dan ANSYS digunakan untuk menjalankan analisis statik dan juga getaran. Frekuensi yang digunakan ialah 20 kHz ke 30 kHz dan 30 kHz ke 40 kHz. Daripada keputusan analisis yang diperolehi Faktor Keselamatan paling rendah yang diperolehi ialah 18.8975. Dengan itu dapat disimpulkan bahawa muncung Pemodelan Endapan Terlakur tidak mempunyai masalah untuk menampung getaran yang disalurkan daripada transduser ultrasonik

ABSTRACT

Fused Deposition Modeling is an Additive Manufacturing that allows a designer or engineer discloses a desired shape by simply drawing a design on the computer. It is also the most economical Additive Manufacturing. Despite these advantages, it has the biggest weakness that cannot produce a good surface finish. Researchers had previously released some ideas to solve this problem. Among the ideas that they put forward is to transmit high vibration from the ultrasonic transducer to the Fused Deposition Modelling machine, especially on the nozzle. However ideas have yet proven. This project aims to examine whether the nozzle Fused Deposition Modeling is able to withstand high vibration should be transmitted. This project was carried out using Solidworks and ANSYS software. Solidworks is used to draw 3 -dimensional model and ANSYS is used to perform static analysis and vibration. Frequencies applied are 20 kHz to 30 kHz and 30 kHz to 40 kHz. From the results of the analysis the lowest Factor of Safety obtained is 18.8975. Thus it can be concluded that the nozzle of Fused Deposition Modeling has no problem to withstand vibration transmitted from the ultrasonic transducer

DEDICATION

Especially dedicated to my family, friends and companions for the endless support and understanding.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AM	-	Additive Manufacturing
CAD	-	Computer Aided Design
CAE	-	Computer Aided Engineering
FDM	-	Fused Deposition Modelling
GPa	-	Giga Pascal
MPa	-	Mega Pascal
mm	-	Milimeter
m/s^2	-	Metre per second square
N	-	Newton
RM	-	Rapid Manufacturing
RP	-	Rapid Prototype
SLA	-	Stereolithography
SLS	-	Selective Laser Sintering
TMA	-	Thermal Mechanical Analysis

CHAPTER 1

INTRODUCTION

This chapter briefly discusses about the aims, objectives and scope. Other than that it includes an overview of the project implementation.

1.1 Introduction

Peiponen et al. (2009), have previously mentioned, the quality surface finish of every product is very important in industry sector. The product surface can be improve by go through a sequence of finishing process. The quality of surface finish is important because it relate with friction, appearance, aesthetic value etc.

According to Rajendradarbar et al. (2013), Additive Manufacture (AM) is a "technology that allow user to get their desire shape of product by using CAD software". The technology can construct complex shape of product nicely without face a lot of obstacles. Fused Deposition Modelling (FDM) is a type of additive manufacture. Brock et al. (2000), has previously mentioned that FDM produce their model by using semi molten plastic filament. This method is quite similar with MIG welding.

FDM is suitable to create a model with rough surface finish. Based on Rajendradarbar et al. (2013), the quality of surface finish is depending on parameter of the process. That's mean the parameter need to optimize in order to get good quality finish. By the way FDM always has problem with its surface finish. Lines

seam appear on the surface model. Researchers have proposed a few of idea to overcome this problem. One of the ideas is applying chemical treatment to the FDM part but these techniques require high cost.

Ultrasonic is a technology that has been proved able to increase the quality of surface finish. The vibration that have been generate from ultrasonic will help the machine to produce good surface finish. The best thing about ultrasonic are it is not cause chemical reaction. Applying ultrasonic to FDM can increase the surface finish of the product but this statement does not prove yet. A few analysis need to be setup in order to prove this statement. However, without do simulation first the ultrasonic cannot be simply applied to the FDM. This is because it may be can destruct the machine's function itself. The experiment can separate by do the analysis component by component.

Nozzle is the essential component in FDM system because nozzle conditions give significant effect to the surface finish. Vibration analysis needs to be done first on FDM nozzle to make sure the nozzle withstand high frequency.

Nowadays simulation of new design is widely used. Based on Maria (1997), simulation of a system is a model that developed to test the system. She also has previously mentioned that simulation is used before an existing system is altered or a new system built, to reduce the chances of failure to meet specifications, to eliminate unforeseen bottlenecks, to prevent under or over utilization of resources, and to optimize system performance.

(CAD) is the computer software that uses to assist users to draw new design, do analysis or optimization of a design. There are many CAD software in the market such as Solidworks, CATIA, ANSYS, AutoCAD and others. One of CAD function is to do simulation of new product or new system. The advantages of using CAD are if there are some corrections it can be made easily. Beside that CAD standard can help user to transfer CAD data from computer to other system like from computer to the FDM machine.

This project will use Solidworks to draw the 3D model of the system needed. After that ANSYS software will be use to run the simulation to get the result and effect by applying ultrasonic transducer to FDM machine.

1.2 Problem statement

FDM system is cheaper than others AM system however its surface finish is not so good like other expensive AM. A lot of ideas have been suggested from the researchers to solve this problem. One of the ideas is apply ultrasonic transducer to the FDM system. Applying ultrasonic may be suitable to solve this problem but the simulation needs to be done first to avoid any failure or damage to the real system, but before go to the whole system, the simulation to the FDM nozzle need to be done to know either the nozzle can stand with high frequency from ultrasonic.

1.3 Objective

a) To understand the operation of the Fused deposition modelling machine.
b) To learn to use ANSYS software.
c) To investigate whether FDM nozzle can withstand high frequency of ultrasound.

1.4 Scope of project

This project focuses about the impact of high frequency of ultrasound to FDM nozzle. The analysis run by ANSYS and 3D model developed by Solidworks. The nozzle dimension is same with FDM nozzle in FDM laboratory of Fakulti Kejuruteraan Pembuatan, UTeM. The raw materials of the nozzle component are from stainless steel and magnesium alloy. This project also focuses on mechanical properties. Others properties like thermal properties and others are neglect.

1.5 Activity planning

Activity planning is the plan to follow to accomplish this project. Table 1.1 and table 1.2 shows the Gantt chart for this project. The Gantt chart must be follow to ensure this project is still on track to avoid this project break the date line. Time given to accomplish every task is depend on constrain to do that task.

Table 1.1 : Gant chart for PSM 1

No	Task	Week													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Looking for title	■													
2	Research about the title	■	■												
3	Confirm the title			■											
4	Preparation of Chapter 1				■	■									
5	Show chapter 1 to the supervisor					■									
6	Edit chapter 1						■								
7	Preparation of Chapter							■	■	■					
8	Show chapter 2 to the supervisor									■					
9	Edit chapter 2										■				
10	Preparation of Chapter 3											■	■		
11	Show chapter 3 to the supervisor												■		
12	Edit chapter 3													■	
13	Submission the report														■
14	Presentation														

Table 1.2 : Gant chart for PSM 2

No	Task	Week													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Develop 3D drawing by Solidworks	■	■	■	■										
2	Do the analysis by ANSYS				■										
3	Interpret result					■	■								
4	Preparation of Chapter 4							■	■						
5	Show chapter 4 to the supervisor								■						
6	Edit chapter 4									■					
7	Preparation of Chapter 5										■	■			
8	Show chapter 5 to the supervisor											■			
9	Edit chapter 5											■			
10	Preparation of Chapter 6												■		
11	Show chapter 6 to the supervisor												■		
12	Edit chapter 6													■	
13	Submission the report														■
14	Presentation														■

CHAPTER 2

LITERATURE REVIEWS

2.1 Additive Manufacturing

Additive Manufacture (AM) can be defined as "technology that allow user to get the product with their desire shape by using CAD software". Without facing many obstacles the technology can built the product with complex shape nicely (Rajendradarbar, 2013).

Stucker (2011), has previously mentioned that Additive manufacturing techniques are the collection of manufacturing processes that join materials to make physical 3D objects directly from virtual 3D computer data. These processes typically build up parts layer by layer, as opposed to subtractive manufacturing methodologies, which create 3D geometry by removing material in a sequential manner. After more than 20 years of confusing terminology, in 2009, the ASTM International F42 Committee on Additive Manufacturing Technologies defined additive manufacturing as the "process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies." These technologies were also known as rapid prototyping, additive layer manufacturing, solid freeform fabrication, direct digital manufacturing additive fabrication, and other similar technology names over the years. In the technical community, an international agreed has coalesced around the use of "additive manufacturing," whereas in the popular press the technologies are known as "3D printing.