

DESIGN AND ANALYSIS OF PRESSING MECHANISM FOR IMPROVING 3D PRINTING PROCESS

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**DESIGN AND ANALYSIS OF PRESSING MECHANISM FOR IMPROVING 3D
PRINTING PROCESS**

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**A report submitted
in fulfilment of the requirements for the degree of
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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DECLARATION

I declare that this project report entitled “Design and Analysis of Pressing Mechanism For Improving 3D Printing Process” is the result of my own work except as cited in the references

Signature :

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Date :

PENGAKUAN

Saya akui laporan ini yang bertajuk “Reka Bentuk dan Analisis Mekanisme Menekan Untuk Memperbaiki Proses Percetakan 3D” adalah hasil kerja saya sendiri kecuali yang dipetik daripada sumber rujukan.

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APPROVAL

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

Signature :

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bin Alkahari

Date :

DEDICATION

To Allah S.W.T

For blessing me with a wonderful life

To my beloved mother

A strong and gentle soul who taught me to believe in hard work

To my father

For always supporting me and encouraging me not to give up in life

To my peers

For always cheer me up

ABSTRACT

Three-dimensional printing is a method in which a digital model is transformed into physical object by adding material layer by layer. Despite rapid progress of 3D printing, there are still several area that can still be improve. In 3D printed object, there are many porous areas because of the circular shape of the printed filament. As amount of porous increase, the strength of the printed object decrease. The purpose of this paper is to design new pressing mechanism that act as an attachment to the existing 3D printer and to analyse the effectiveness of the developed system. The selection for the pressing mechanism was made using morphological chart. The prototype for this mechanism was integrated to the existing Fused Deposition Modeling (FDM) 3D printer to apply pressure during printing process. For the pressing mechanism to be tested, a dog bone sample was printed to use for the experiment. Original dog bone samples are compared to the sample with pressure applied on it. Infill density and printing speed are the parameter chosen to be tested. Through the length, width, thickness, surface roughness test, tensile test, and porosity test, the mechanical properties and the dimension of parts fabricated by the new mechanism were obtained. Results show that sample with pressure for infill density parameter were better compared to original sample. As for the speed parameter, sample with pressure applied did improved the porosity percentage of the sample but only at lower printing speed. The pressing mechanism does help improved the strength of the printed object but at the cost of sacrificing the actual dimension of the samples.

ABSTRAK

Pencetakan tiga dimensi adalah satu kaedah di mana model digital diubah menjadi objek fizikal dengan cara menambah bahan lapisan demi lapisan. Walaupun proses pencetakan 3D mengalami kemajuan yang pesat, masih ada yang boleh diperbaiki. Dalam objek cetakan 3D, terdapat banyak liang-liang disebabkan oleh bentuk bulat filament. Apabila kawasan berliang meningkat, kekuatan objek yang dicetak menurun. Kajian ini bertujuan untuk mencipta mekanisme penekan baharu yang bertindak sebagai bahagian tambahan kepada pencetak 3D sedia ada dan bertujuan untuk menganalisis keberkesanan sistem yang dibangunkan. Cara pemilihan reka bentuk untuk mekanisme menekan adalah menggunakan kaedah carta morfologi. Prototaip mekanisme ini dipasang ke pencetak 3D FDM yang sedia ada untuk memberikan tekanan ke atas filamen ketika proses mencetak. Untuk menguji mekanisme menekan, sampel tulang anjing telah dicetak. Sampel asal dibandingkan dengan sampel yang dikenakan tekanan ke atasnya. Ketumpatan dan kelajuan mencetak merupakan parameter yang dipilih untuk diuji. Melalui ukuran dimensi, ujian kekasaran permukaan, ujian tegangan, dan ujian keliangan, sifat mekanik sampel yang dicetak oleh mekanisme diperoleh. Keputusan menunjukkan sampel yang menerima tekanan untuk ketumpatan penuh lebih baik berbanding sampel asal. Untuk parameter kelajuan mencetak, sampel yang menerima tekanan ada menambah baik peratusan keliangan sampel tetapi hanya untuk kelajuan mencetak yang perlahan. Mekanisme menekan memang membantu meningkatkan kualiti objek yang dicetak, tetapi dalam pada masa yang sama memberi kesan kepada ukuran asal sampel tersebut.

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TABLE OF CONTENTS

	PAGE
DECLARATION	
PENGAKUAN	
APPROVAL	
DEDICATION	
ABSTRACT	i
ABSTRAK	ii
ACKNOWLEDGEMENT	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	vii
LIST OF FIGURES	ix
ABBREVIATION	xii
CHAPTER 1: INTRODUCTION	1
1.1 Background	1
1.2 Problem Statement	2
1.3 Objectives	2
1.4 Scope of Project	2
CHAPTER 2: LITERATURE REVIEW	3
2.1 Introduction	3
2.2 History	3
2.3 Rapid Prototyping	5
2.3.1 General Principles of 3D Printing	6
2.4 Technique in 3D Printing	9
2.4.1 Fused Deposition Modeling (FDM)	10
2.5 Pressure	12
2.5.1 Stainless Steel Plate	13
2.6 Infill Density	13
2.7 Printing Speed	15
2.8 Tensile Testing	17
2.8 Summary of Chapter 2	18

CHAPTER 3: METHODOLOGY	19
3.1 Introduction	19
3.2 Project Flow Chart	19
3.3 Morphological Chart	21
3.4 Concept Design	23
3.5 Prototype	25
3.6 Analysis	27
3.6.1 Surface Roughness	27
3.6.2 Tensile Test	28
CHAPTER 4: RESULTS AND DISCUSSION	29
4.1 Design Selection	29
4.2 Design Improvement	30
4.3 Detail Design and Final Design	30
4.3.1 Pressing Mechanism Assemble Drawing	31
4.3.2 Parts for Pressing Mechanism	32
4.4 Force calculation	36
4.5 Results	38
4.5.1 Experiment	38
4.6 Effects of Fill Density	41
4.6.1 Length	41
4.6.2 Thickness	43
4.6.3 Width	45
4.6.4 Surface Roughness	47
4.6.5 Tensile Test	49
4.6.6 Porosity Test	55
4.7 Effects of Speed	58
4.7.1 Length	58
4.7.2 Thickness	60
4.7.3 Width	62
4.7.4 Surface Roughness	64
4.7.5 Tensile Test	66
4.7.6 Porosity Test	72

CHAPTER 5: CONCLUSION AND RECOMMENDATION	75
5.1 Conclusion	75
5.2 Recommendation	76
REFERENCES	77
APPENDIX	80

LIST OF TABLES

TABLE	TITLE	PAGE
Table 2.1:	Technique of Rapid Prototyping	9
Table 3.1:	Morphological Chart for The Project	21
Table 4.1:	Length of Original Sample and Sample with Pressure for Fill Density Parameter	41
Table 4.2:	Thickness of Original Sample and Sample with Pressure for Fill Density	43
Table 4.3:	Width of Original Sample and Sample with Pressure for Fill Density Parameter	45
Table 4.4:	Surface Roughness of Original Sample and Sample with Pressure for Fill Density	47
Table 4.5:	Tensile Test of Original Sample for Fill Density	51
Table 4.6:	Tensile Test of Sample with Pressure for Fill Density	51
Table 4.7:	Porosity Table of Original Sample for Fill Density	55
Table 4.8:	Porosity Table of Sample with Pressure for Fill Density	56
Table 4.9:	Length of Original Sample and Sample with Pressure for Speed Parameter	58
Table 4.10:	Thickness of Original Sample and Sample with Pressure for Speed Parameter	60
Table 4.11:	Width of Original Sample and Sample with Pressure for Speed Parameter	62
Table 4.12:	Surface Roughness of Original Sample and Sample with Pressure for Speed	64
Table 4.13:	Tensile Test of Original Sample for Speed Parameter	68
Table 4.14:	Tensile Test of Sample with Pressure for Speed Parameter	68

Table 4.15: Porosity Table of Original Sample for Speed Parameter	72
Table 4.16: Porosity Table of Sample with Pressure for Speed Parameter	73

LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 2.1: SLA-1		4
Figure 2.2: Tessellation of surface of CAD model		7
Figure 2.3 : Rapid Prototyping process chain		8
Figure 2.4: FDM		10
Figure 2.5: Two nozzles, one for modeling material and one for support material		11
Figure 2.6: Pressure on uppermost layer surface		12
Figure 2.7: Infill patterns at 15% density		14
Figure 2.8: Different densities of honeycomb infill pattern		14
Figure 2.9: graph of max stress against printing speed		15
Figure 2.10: Quality of printed specimen against printing speed		16
Figure 2.11: Test specimen nomenclature		17
Figure 2.12: Schematic Diagram of Tensile Testing Machine		18
Figure 3.1: Flow chart of the project		20
Figure 3.2: Concept design 1		23
Figure 3.3: Concept design 2		24
Figure 3.4: Front view of the extruder, nozzle and metal plate		25

Figure 3.5: Back view of the motor part and metal plate	25
Figure 3.6: Top view of electric motor, extruder and nozzle	26
Figure 3.7: TR200 Portable Surface Roughness Tester	27
Figure 3.8: Universal Testing Machine (UTM) Instron 8872	28
Figure 4.1: Sketch of the isometric view of pressing mechanism	29
Figure 4.2: Assembly view of pressing mechanism	31
Figure 4.3: Exploded view of pressing mechanism	31
Figure 4.4: Bottom part of the pressing mechanism	32
Figure 4.5: Plastic bar that transfer the vertical movement	32
Figure 4.6: Housing of motor	33
Figure 4.7: Motor	33
Figure 4.8: Connector that transfer motor rotation to the plastic bar	34
Figure 4.9: Steel plate	34
Figure 4.10: Bearing to help with the vertical movement	35
Figure 4.11: Steel path that attach to motor housing and help with bearing movement	35
Figure 4.12: Distance between to circle	36
Figure 4.13: Dimension for dog bone drawing	38
Figure 4.14: CAD drawing for dog bone sample in Solidworks	39
Figure 4.15: Printed dog bone sample	39
Figure 4.16: Sample of dog bone during surface roughness test	40
Figure 4.17: Dog bone sample after tensile test	40
Figure 4.18: Length against fill density graph of original sample and sample with pressure	42
Figure 4.19: Thickness against fill density graph of original and sample with pressure	44
Figure 4.20: Width against fill density graph of original sample and sample with pressure	46

Figure 4.21: Surface roughness against fill density of original and sample with pressure	48
Figure 4.22: Tensile test graph of the original sample for fill density	49
Figure 4.23: Tensile test graph of the sample with pressure	50
Figure 4.24: Maximum load against fill density of original sample and sample with pressure	52
Figure 4.25: Tensile stress against fill density of original sample and sample with pressure	53
Figure 4.26: Tensile strain against fill density of original sample and sample with pressure	54
Figure 4.27: Porosity against fill density of original sample and sample with pressure	57
Figure 4.28: Length of original sample and sample with pressure for speed parameter	59
Figure 4.29: Thickness against speed graph of original sample and sample with pressure	61
Figure 4.30: Width against speed graph of original sample and sample with pressure	63
Figure 4.31: Surface roughness against speed graph of original and sample with pressure	65
Figure 4.32: Tensile test graph of the original sample for speed parameter	66
Figure 4.33: Tensile test graph of the sample with pressure for speed parameter	67
Figure 4.34: Maximum load against speed of original sample and sample with pressure	69
Figure 4.35: Tensile stress against speed of original sample and sample with pressure	70
Figure 4.36: Tensile strain against speed of original sample and sample with pressure	71
Figure 4.37: Porosity against speed parameter of original sample and sample with pressure	74

ABBREVIATION

3D	– 3 Dimensional
AM	– Additive Manufacturing
ABS	– Acrylonitrile Butadiene Styrene
CAD	– Computer-Aided Design
DC	– Direct Current
FDM	– Fused Deposition Modeling
PLA	– Polylactic Acid
RP	– Rapid Prototyping
SLA	– Stereo Lithography
SLS	– Selective Laser Sintering
STL	– Standard Tessellation Language
USB	– Universal Serial Bus
UV	– Ultraviolet

CHAPTER 1

INTRODUCTION

1.1 Background

Three-dimensional printing is a process where a digital model is turned into a physical three-dimensional object by adding material layer by layer until it complete at a time (O. Diegel, 2014). This is where the term of additive manufacturing come from. Nowadays, three-dimensional printing is not uncommon as it used to be. Three-dimensional printing is now being used whether in medic, industries and even for personal use. Heavy industries in production usually use three-dimensional printing as a test model before they start their mass production by using injection moulding. This is because based on from (Anonymous,2018) three-dimensional product that are printed can be analyse to review the design to detect any problem in the design. This can save the company a lot of money. Despite 3D printing process having progress rapidly, there are still several area that can still be improve. One is about the strength and the porosity of the printed object. The most interesting idea to tackle this problem is to apply pressure after printing each layer. By doing this, each layer of filament that are printed can be flatten and make it stronger.

1.2 Problem Statement

In 3D printed object, the mechanical properties of it is lack in strength. This lack of strength is because the filament that are arrange layer by layer is circular in shape. This as a result can produce many porous areas for the printed object. As the amount of porous increase, the strength of the printed object decrease.

1.3 Objectives

The objectives of this project are as follows:

- To design new pressing mechanism during 3D printing.
- To fabricate additional mechanism as attachment to the existing 3D printer.
- To analyse the effectiveness of the developed system.

1.4 Scope of Project

The scope of this project are as follows:

- Using low cost 3D printer (open source system / entry level printer)
- Using FDM process parameter such as layer thickness and infill density
- Using thermoplastic material such as ABS and PLA.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter focus more on the project development that is base from the previous studies. Any study that were related to the project were referred to help better understanding about this project such as the quality of the object printed by FDM. 3D printer that are integrated with pressing mechanism to enhance the structure of the object printed were never find before because this project are the first of its kind. This pressing mechanism also help to improve the quality of the product. The mechanism of the 3D printer integrated with pressing mechanism were explained in this chapter. Additive manufacturing also were explained briefly in this chapter.

2.2 History

3D printing uses computer technology to create solid objects of three dimensions. 3D printing combines thin horizontal cross sections of the additive process or layering of the material with a computer program for printing solid objects. You can create almost anything from 3D printing, including toys, weapons or parts of the machine. The history of 3D printing is important in order to understand the future of production.

Japanese inventor Hideo Kodama in 1981 was the first person recorded attempting 3D printing in the additive process. He created a product using UV lights to harden polymers and create solid objects. Charles Hull invented stereolithography, a 3D printing process that uses technology to create prototype version before manufacture the actual product. This way, more money and time can be save because the company can test it on the prototype rather test it on the actual product. The object is layer by layer printed, solvent rinsed, and ultraviolet light hardened. Computer Aided Design (CAD) are used to create 3D models.

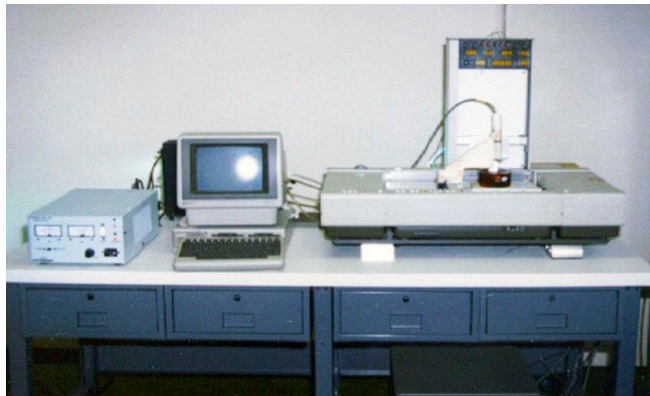


Figure 2.1: SLA-1 invented by Charles Hull in 1987 (H. Bensoussan, 2016).

Figure 2.1 shows the first-ever 3D printer that are invented by Charles Hull. This 3D printer transform manufacturing process and enabled designs with complexity.

Selective Laser Sintering (SLS) is another more advanced 3D printing/additive manufacturing form. It uses additive production and a polymer—usually nylon—powder to create objects. SLS uses a laser to combine the powder, layer by layer, in more complex forms than SLA can create. Fused Deposition Modeling (FDM) by Scott Crump is the most common form of 3D printing nowadays. It is known as the "3D desktop printers" because it is the most widely used technology form. The printer heats a thermoplastic cable into a liquid form in order to form an object and extrudes it layer by layer (Brooke Hahn, 2018).

2.3 Rapid Prototyping

Rapid Prototyping (RP) is a technology used to construct a physical model or prototype directly from three-dimensional Computer-Aided-Design (3D CAD) data in a very short time (Harun et al., 2016). The 3D printer enable designers to quickly create tangible prototypes rather than two-dimensional images of their designs. Such models have many uses. They provide excellent visual aids to communicate ideas within colleagues or customers in addition to design testing (Mahindru & Mahendru, 2013).

2.3.1 General Principles of 3D Printing

This is the general process of 3D printing:

1. Designing 3D model. Any type of CAD Software that can design 3D model can be use.
2. Generation of STL files. As there are many CAD software, hence to standardized and bring uniformity all files are saved in .STL format. Where STL is stand for Standard Tessellation Language.
3. Support are generate for overhang parts.
4. STL files are check for any defect.
5. STL file is transmit to slicing software.
6. The STL model is slice into thin cross sectional layer (Slic3r)
7. Part building layer by layer
8. Finishing prototype

Firstly, it begins with 3D product modelling. There are many type of software for 3D designing in the market nowadays. All of design software have their own pros and cons, so user have to decide which software suit best. After the designing process is finish, the design have to be convert to the CAD drawing to a STL file. Different surfaces of a CAD model are approximate in a piece by a series of triangles and the vertices of triangles and their surface norms are listed in tessellation. After the STL file are generate, overhang part in the drawing need to have support generate for it. Usually, slicing software can auto generate support for this overhang parts. Then, these STL files are check for any defects and are repaired if found to be