



EFFECT OF LASER ENGRAVING PARAMETERS ON SURFACE MORPHOLOGY AND QUALITY ON CEMENT



**BACHELOR OF MANUFACTURING ENGINEERING
TECHNOLOGY (PROCESS AND MANUFACTURING) WITH
HONOURS**

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**Faculty of Mechanical and Manufacturing Engineering
Technology**



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MORPHOLOGY AND QUALITY ON CEMENT**

Muhamad Amirul Bin Zubir

**Bachelor of Manufacturing Engineering Technology (Process and Manufacturing)
with Honours**

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MUHAMAD AMIRUL BIN ZUBIR

**A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Manufacturing Engineering Technology (Process and Technology) with
Honours**



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**UNIVERSITI TEKNIKAL MALAYSIA MELAKA
Faculty of Mechanical and Manufacturing Engineering Technology**

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I declare that this thesis entitled “Effect of Laser Engraving Parameters on Surface Morphology and Quality on Cement” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature

:



Name

:

MUHAMAD AMIRUL BIN ZUBIR

Date

:

14 / 01 / 2022



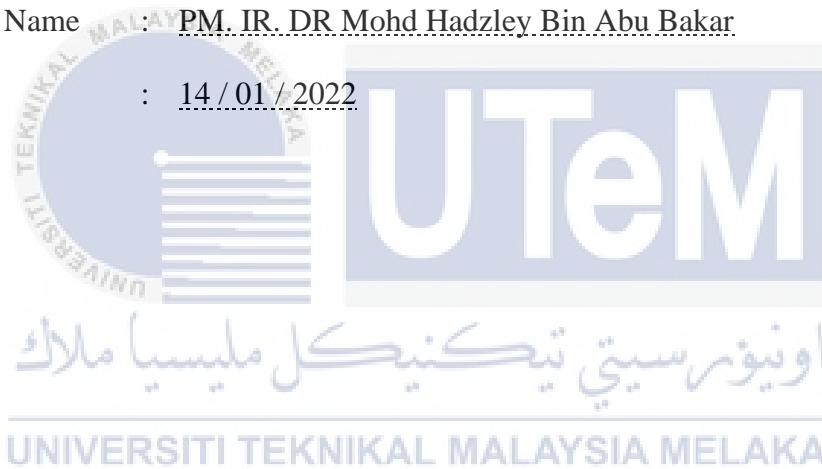
APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Process and technology) with Honours.

Signature : 

Supervisor Name : PM. IR. DR Mohd Hadzley Bin Abu Bakar

Date : 14 / 01 / 2022



DEDICATION

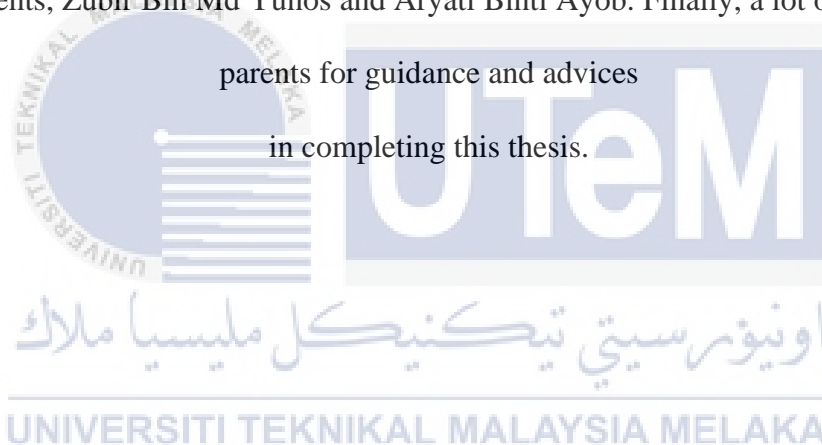
The only difference between success and failure is their ability to act, and the ability to act comes after self-efforts and guidance from our surrounding. Alhamdulillah praise to Allah

for the strength, guidance and knowledge that was given by

Allah for me to complete this study. A special appreciation, I dedicate this thesis to my beloved parents, Zubir Bin Md Yunos and Aryati Binti Ayob. Finally, a lot of thanks to my

parents for guidance and advices

in completing this thesis.



ABSTRACT

In today's modern age, laser engravings have become the foremost promising technologies to be utilized to engrave or mark an object. The purpose of the research is, to investigate the optimum parameter for the best engraving quality on cement. Etching is an engraving technique that involves using metal, wood, rubber, tissue, and other materials to create a design. People in ancient times used Etching as a daily tool to cut stone, metal, swords, and pots, and they have been known since the 11th century. The second objective of this research is to investigate and analyze the effect of changing laser Engraving parameters on surface morphology and quality on cement slab. The effect of laser engraving process on surface roughness measurement on cement can be determined by input parameters such as feed rate, speed, number of passes, spot diameter, laser frequency, wave length and laser power. As a result, it shows that better output parameter prediction applicability and capabilities to such industrial of laser Engraving or laser marking leading to effective selection of machining parameters. 60 watts H60WPM fiber laser machine is used to complete to engrave the cement. Laser Engraving is a modern technology within the machining by exhausting materials and removes the material layer by layer. To elucidate the structure of the etched portions and to characterize the cement surface, a microscopic inspection was performed. When the settings are modified, the surface roughness of each laser material will vary. Increased laser speed and use of the best laser power for the material will result in a smoother surface roughened. The higher the speed, the smoother the surface. When the speed is lower it will be engraved in more depth. Higher speed is suitable for low hardness material and the lower speed is suitable to engrave the high hardness material.

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ABSTRAK

Pada zaman moden hari ini, ukiran laser telah menjadi teknologi yang paling menjanjikan dan ia boleh digunakan untuk mengukir atau menandakan objek. Tujuan penyelidikan ini adalah, untuk mengkaji parameter optimum untuk kualiti ukiran terbaik pada simen. Proses goresan ialah teknik ukiran yang melibatkan penggunaan logam, kayu, getah, tisu dan bahan lain untuk mencipta reka bentuk. Orang pada zaman dahulu menggunakan teknik goresan sebagai alat harian untuk memotong batu, logam, pedang, dan periuk, dan ia telah dikenali sejak abad ke-11. Objektif kedua penyelidikan ini adalah untuk menyiasat dan menganalisis kesan perubahan parameter Ukiran laser terhadap morfologi dan kualiti permukaan pada papak simen. Kesan proses ukiran laser terhadap pengukuran kekasaran permukaan pada simen boleh ditentukan oleh parameter input seperti kadar suapan, kelajuan, bilangan hantaran, diameter titik, frekuensi laser, panjang gelombang dan kuasa laser. Hasilnya, ia menunjukkan bahawa kebolegunaan ramalan parameter keluaran yang lebih baik dan keupayaan untuk Ukiran laser industri atau penandaan laser yang membawa kepada pemilihan parameter pemesinan yang berkesan. Mesin laser gentian H60WPM 60 watt digunakan untuk melengkapkan untuk mengukir simen. Ukiran Laser ialah teknologi moden dalam pemesinan dengan melembutkan bahan dan mengeluarkan bahan lapisan demi lapisan. Untuk menjelaskan struktur bahagian terukir dan untuk mencirikan permukaan simen, pemeriksaan mikroskopik dilakukan. Apabila tetapan diubah suai, kekasaran permukaan setiap bahan laser akan berbeza-beza. Peningkatan kelajuan laser dan penggunaan kuasa laser terbaik untuk bahan akan menghasilkan permukaan yang lebih licin menjadi kasar. Semakin tinggi kelajuan, semakin licin permukaannya. Apabila kelajuan lebih rendah ia akan diukir dengan lebih mendalam. Kelajuan yang lebih tinggi sesuai untuk bahan kekerasan rendah dan kelajuan yang lebih rendah sesuai untuk mengukir bahan kekerasan tinggi.

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LIST OF SYMBOLS AND ABBREVIATIONS

D,d	-	Diameter
CNC	-	Computer Numerical Control
W	-	Watt
mm	-	Milimeter
CO ₂	-	Carbon dioxide
“	-	Inch
rpm	-	Revolution per minute



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CHAPTER 1

INTRODUCTION

1.1 Background

Etching is an engraving technique that involves using metal, wood, rubber, tissue, and other materials to create a design. People in ancient times utilised these carvings as a daily tool to cut stone, metal, swords, and pots, and they have been known since the 11th century. Sharp and hard materials, such as stone, are utilised to carve the tools. Friction between the tool and the workpiece will generate a sculpture, and the depth of the gravure will be determined by the amount of friction. To construct a sculpture on the workpiece with these hand-tools, a large amount of labour is required.

The optical device engraving method's primary functioning rule is that the irradiation machine emits laser pulses that deliver an excessive amount of focused energy to the work in order to ablate the fabric that has to be eliminated. By altering essential technique parameters such as the irradiation average power, the irradiation scanning speed, and thus the repetition rate of the optical device pulses, the style and thus the amount of warmth energy provided to the fabric by the irradiation pulses may be altered. The laser may be a versatile technology that has the specified flexibility for processing a good range of materials for various applications, like cutting, welding, drilling, engraving, rapid Manufacturing, ablation, and another application like medical, communications, military, etc (Hubeatir et al., 2018). Laser engraving is one among the beam milling methods. during this method, a high-intensity beam moves over the surface in accordance with the specified geometry.

During the interaction of the beam with the fabric , an amount of laser energy is absorbed by the fabric (Dubey, 2008).

Laser marking term is also used as a generic covering broad spectrum of surfacing techniques including laser bonding, printing and hot-branding. Two terms are sometimes confused by those without experience or knowledge in the experiment. The laser engraver machine and laser marking are the same type of machine.

1.2 Problem Statement

The new parameter during this thesis is predicated on industrial laser cutting and welding machines. This approach consists of a good quality surface. In practical applications of laser engraving, the quality of the engraved surfaces is the critical factor. Recently methods for studying the influence on the quality of the main process variables have been developed, which seek to improve quality rather than explain the engraving mechanism. Several problems have been analyzed based on a method for choosing the optimum machining parameters for laser engraving machines. This problem occurs because many issues need to be resolved. The problem that existed when engraving is the contrast of the surface engraving acrylic cannot be achieved. This happens when the acrylic is not the cast acrylic. Then another problem is the cast acrylic may not produce contrast (engraving clear) because of the laser beam being out of focus.

However, the tests carried out in the research investigations will undoubtedly face some challenges and difficulties. The characteristics and tools utilized to avoid or eliminate

difficulties are the focus of this research. Furthermore, research might give an overview and subsequently a suggestion for change.

1.3 Research Objective

The main aim of this research is to study the best laser engraving parameter on Cement Slab. Specifically, the objectives are as follows:

- a) To investigate and analyze the effect of changing laser engraving parameters on surface morphology and quality on cement.
- b) To find optimum control parameters that will produce optimum engraving quality of the cement slab when laser engraving applied.
- c) To analyze the characteristics of structural and micro structure changes produced by the laser engraving on cement.

1.4 Scope of Research

The scope of this research are as follows:

- (i) Using laser engraver HSCLASER model H60WPM in FTKMP
- (ii) Experiment and analyze the engrave quality by using the acrylic material which is cement.
- (iii) Study the laser engraving parameters to achieved the best result.
- (iv) Investigate suitable value of parameters that should be setting in order to get the good depth of 3D and 2D design.
- (v) To use this engraving process, 2D and 3D files are need to provide, such as a vector graphics or drawing of an image.
- (vi) This research project will focus primarily on application laser engraving on cement, the capability of laser engraving machine to

develop design on the cement, and also to determine whether this machine can be used to engrave 3D and 2D design on the cement.

(vii) Observing the characteristics of structural and micro structure changes produced by the laser engraving surface of cement.

1.5 Project Planning

The most important task before begin the project is to create an imaginary of the project. It is to ensure the project successfully completed between targeted time. Gantt chart is present every stage of the project from the beginning until the completion of project. Gantt chart refers to possible period of time to run the project.



ACTIVITIES		Degree Project 1 - 6th semester (weeks)														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Topic selection and research planning	P	█														
	A		█	█												
Understanding Topic 1. History 2. Problem Statement 3. Objectives 4. Project Scopes	P	█	█													
	A			█	█											
Literature Review	P		█	█	█	█	█	█	█	█						
	A			█	█	█	█	█	█	█	█	█	█			
Research Methodology	P															
	A								█	█	█	█	█	█		
Report submission	P														█	█
	A														█	█
Presentation	P														█	█
	A														█	█

1.1 Gantt chart (PSM 1)

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The prior study's scope is provided by the literature review. It serves as a guide for carrying out the experiment. The literature review is critical in gathering data and information for this thesis. Another research on laser engraving to achieve better surface finish by using parameter analysis, effect of power, different wavelength, different feed rate, pulse frequency, beam speed, and the other many parameters that can affect the material removal rate, indentation of engraving, and surface finish onto the product are included in the content of the literature review (Hubeatir et al., 2018).

Engraving is the technique of incising a design into a typically flat and hard surface. The surface design is permanent and cannot be erased. The laser beam is used in the engraving process to ablate the material based on the desired design. A laser is a device that generates light by an underlying process based on the stimulated emission of electromagnetic radiation. An appropriate laser engraver must be selected to allow the engraving process to carry out the required assignment. The procedure works by repeating the process on each thin layer based on the desired pattern (Badrishah et al., 2018).

2.2 Type of Material

Two types of acrylics are commonly used in laser engraving and both are suitable for different applications and result.

2.1 Differences between cast & extruded acrylic.

(<https://pediaa.com/difference-between-cast-and-extruded-acrylic/>)

CAST	EXTRUDED
Available in wide variety of colour	Limited in colour
More resistant to chemical	Less chemical resistant
More scratch resistant	Less scratch resistant
Hard to flame polish	Easy to flame polish

2.2.1 Cast Acrylic

The acrylic liquid is poured into the mould, resulting in a cast acrylic sheet of varying size and shape. This type of acrylic is ideal for engraving since it provides a crisp white colour when engraved and is great for plaques and awards. It can be cut using a laser cutting machine, but the edge will not be flame-polished. To avoid the smoke from destroying the clear surface of the acrylic, mask it with transfer tape if deep engraving is needed. Another issue with deep acrylic engraving is that the strong heat generates a white, crusty coating that builds along the margins of the engraved region and is hard to remove without causing harm. Engraving gently and without masking appears to be the best all-around option (Budetti, 2004).

2.2.2 Extrudes Acrylic

Extruded acrylic is another type of acrylic that is machine shaped into sheets. Extruded acrylic is created at a higher volume of production. Extruded acrylic is less expensive than cast acrylic. Extruded acrylic cuts cleanly and gives a flame-polished edge, but it cannot be engraved. This sort of acrylic performs better when sliced rather than etched.