UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EFFECT OF DRILLING PARAMETERS ON THE SURFACE INTEGRITY OF ALUMINIUM ALLOY LM6 USING RESPONSE SURFACE METHOD (RSM)

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Process) with Honours

by

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process) with Honors. The member of the supervisory is as follow:

……

(Dr. Mohd Amran b. Md Ali)

ABSTRAK

Penggerudian adalah salah satu proses pemesinan yang paling penting untuk membuat lubang. Kekasaran permukaan adalah antara penunjuk penting yang berkaitan dengan kualiti dalam pemesinan dan parameter memainkan peranan yang penting untuk menentukan kualiti dan integriti permukaan lubang. Oleh itu, kajian ini menjelaskan hubungan antara kualiti permukaan dan kualiti lubang dengan pembolehubah parameter. Dalam kajian ini, terdapat tiga faktor yang akan menjadi kajian iaitu kelajuan gelendong, kadar suapan dan garis pusat gerudi. Kualiti dan integriti permukaan lubang diukur melalui kadar pembuangan bahan, kekasaran permukaan, dan pemerhatian penampilan lubang. Untuk mengkaji hubungan antara parameter dan kualiti permukaan, reka bentuk eksperimen; kaedah tindak balas permukaan telah digunakan dengan berkesan. Kaedah ini boleh mengurangkan bilangan percubaan dalam eksperimen. Kaedah ini mampu untuk merancang matriks eksperimen dan analisis data untuk mendapatkan kombinasi optimum parameter dengan menggunakan perisian Minitab 17 Statistik. Dari hasil yang diperolehi, ia menunjukkan bahawa semua parameter sangat mempengaruhi kadar pembuangan bahan dan kekasaran permukaan. Selain itu, terdapat interaksi antara parameter pada kekasaran permukaan, kadar pembuangan bahan dan pemerhatian penampilan lubang. Persamaan regresi untuk kekasaran permukaan dan kadar pembuangan bahan telah dibentuk.

ABSTRACT

Drilling is one of the most important machining process for making hole. Surface roughness is among important indicator that relate to quality in machining and parameter plays an important role to determine the quality and surface integrity of a hole. So, this study explains the relationship between the surface quality and the quality of the hole with the variables of parameters. In this study, there are three factors that going to be study which are spindle speed, feed rate and drill diameter. The quality and surface integrity of the hole were measured through material removal rate, surface roughness, and hole appearance observation. In order to study the relationship between the parameters and the surface quality, the design of experiments (DOE); response surface method (RSM) was used effectively. RSM can reduce the number of trials in experiment. This method is capable to plan experimental matrix and analysis the data to get optimize combination of parameters by using Minitab 17 Statistical software. From the result gained, it shows that all of the parameters significantly effects the material removal rate, and the surface roughness. Moreover, there are interaction between the parameters on the surface roughness, material removal rate and appearance observation of hole. Regression equation for surface roughness and material removal rate were developed.

DEDICATION

To my beloved parents and friends, Muhammad Firdaus, Siti Asiyah and Noorfa Idayu.

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In the name of Allah, Praise be to Allah, peace and prayers be upon His Prophet and Messenger. With Grace and Blessing from Allah, I have succeeded in completing my final year project together with the report. First and foremost, I want to express the highest and deepest appreciation to my supportive supervisor, Dr. Mohd Amran bin Md Ali for his supervision, guidance and support in completing this final year project.

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Al	-	Aluminium
ANOVA	-	Analysis of Variance
CNC	-	Computer Numerical Control
D	-	Drill diameter
DOE	-	Design of Experiment
HSS	-	High Speed Steel
mm	-	millimeter
mm/min	-	millimeter per minute
MRR	-	Material Removal Rate
Ra	-	Surface Roughness
RSM	-	Response Surface Method
RPM	-	Revolution per Minute
μm	-	Micron-meter

CHAPTER 1
INTRODUCTION

This chapter contains the introduction of the project background, problem statements, objectives and scopes of this project. Besides that, there is chapter organisation that explains about overall chapter in this report.

1.1 Background

Machining is a chip removal process to form a shape by using a specific machine. Nowadays, machining of materials are getting more advance as there are many developments of new alloys and engineered material which in time causes these material to have high strength and toughness as well as other material properties (Kalpakjian, 2006). Paul et al., 1997 stated that, machining is a material removal process which invented by removing the article on the role of unwanted materials and requires a machine tool, work-piece, fixtures and cutting.

Aluminium alloy is one of the materials that are used in industry. The important factors in selecting aluminium (AL) and its alloy are their high strength to weight ratio, resistance to corrosion by many chemicals, high thermal and electrical conductivity, nontoxicity, reflectivity, appearance, and ease of formability and of machinability; they are also nonmagnetic (Kalpakjian, 2006). One of the examples of aluminium alloy in industry is aluminium LM6.

Hole-making is a class of machining operations that are specifically used to cut a hole into a work piece. Machining, a material removal process, creates features on a part by cutting away the unwanted material and requires a machine, work piece, fixture and

cutting tool. Hole making can be performed on a variety of machines, including general machining equipment also exists for hole making, such as drill presses or tapping machines.

High silicon aluminium alloy, aluminium LM6 can be slightly hard to machine. This kind of alloy has a tendency to drag when machined, where it can cause a rapid tool wear due to high content of silicon. Thus, carbide tools with large rake angles and rather low cutting speed should be working with suitable cutting fluids. This alloy is frequently suitable for castings that are to be welded. Since it is high resistance to corrosion and excellent in cast ability, it is most suitable to use for marine and automotive parts such as meter cases, switch boxes and cast doors.

In drilling process, a drill bit enters the work-piece axially and cuts a blind hole or a through hole with a diameter equal to that of the tool. A drill bit is a multi-point tool and typically has a pointed end. A twist drill is the most commonly used. Parameter plays important role in improving the surface roughness and holes appearance in drilling process.

This study focused on the effect of drilling on surface integrity of Aluminium alloy, LM6. The effect is investigated of parameters like spindle speed, feed rate and diameter of drill bit are investigate onto the surface roughness and appearance observation of hole by applying the response surface method (RSM). Response Surface Methodology (RSM) is useful for the modeling and analysis of programs in which a response of interest is influenced by several variables and the objective is to optimize this response.

1.2 Problem Statement

Aluminium LM 6 is a high Silicon Aluminium alloy which can be rather difficult to machine. In present, machining of Aluminium Alloy LM6 in industry are widely used only in casting and turning. There is lacking of research on drilling Aluminium Alloy LM6. Drilling is one of the most important processes in industry, so that several researchers have studied in order to optimize the process quality. Material removal rate and surface roughness is important role in drilling process in order to study the performance characteristics of drilling process.

1.3 Objectives

The main objective of the project is to study the effect of drilling parameters on the surface integrity, in terms of surface roughness and holes appearance of Aluminium alloy, LM6. To achieve the main objective, a number of other objectives to be followed:

a) To explore the drilling parameters such as spindle speed, feed rate and diameter of drill bit on surface integrity of Aluminium alloy.
b) To design the experimental matric of drilling force using Design of Experiment by Response Surface Method.
c) To evaluate the machining characteristics such as material removal rate, surface roughness by using the Analysis of Variance (ANOVA).

1.4 Scope of Study

The experiment is conducted by using Mazak 630-5x CNC vertical milling machine in UTeM's Machine shop. The type of raw material used is aluminium LM6 that have 20mm in thickness. There are several parameters that selected which can affect the surface characteristic of aluminium LM6 after the experiment is done. For instances, spindle speed (rpm), feed rate (mm/min) and drill diameter (mm). The calculation is very important to calculate the machining characteristics. This study focuses on the drilling effect on Aluminium alloy, LM6 by using response surface method, (RSM). The Minitab 17 Statistical software is used in the experiment.

1.5 Organization of Final Project

This study consists of 5 chapters. In the first chapter, the introduction of the study was discussed. This chapter introduced briefly about the project and also provides the problem statement of the study, objectives and scope of the project.

Chapter 2 consists of literature review that is relevant to the present study of effect of drilling parameters on aluminium alloy, LM6 using response surface method.

Chapter 3 explains the method and working procedure used in this study from starting until completing this study.

Chapter 4 analyses and discusses the results that have been complete. The result collection from the experiment will be analyse in this chapter. Data and the finding during the experiment will be discuss further in this chapter.

In Chapter 5, the conclusions are drawn from the overall findings of the project along with recommendations for the future work.

1.6 Summary

This research is explained the effect of drilling parameters on material characterictics of Aluminium alloy LM6 in terms of MRR, surface roughness and surface appearance by using response surface method (RSM). This method can reduce the number of trials in experiment. In a nutshell, the introducing of this report can guide the ways to the further chapters.

CHAPTER 2
LITERATURE REVIEW

This chapter discusses about the literature review of the project. This section describes about findings of effects of parameters of drilling process, related to the topic "The Effect of Drilling Parameters on Surface Characteristics of Aluminium Alloy, LM6 using Response Surface Method (RSM). The main sources of information for this literature review came from research journal, reference books, printed or online articles.

2.1 Introduction

Aluminium is the most abundant metal and the third most plentiful chemicals element in the earth's layer, consist of over 8% of its weight. In composite materials, aluminium alloy are mostly used as a main matrix element. Basavaraju (2012), in his journal stated that since aluminium alloy has light weight, it has been in the net of researchers for improving the technology. The wide use of aluminium alloys is said by a very desirable combination of properties, combined with the simplicity where they may be formed in a great several of forms and shape.

LM6, an aluminium silicon alloy with a eutectic composition (12% silicon), is the most common alloy used, since its short freezing range, good fluidity and low shrinkage make it suitable for gravity and die casting. Cayless (2012), mentioned in his book that LM6 has excellent corrosion resistance and does not need to be painted for exterior use unless it is for aesthetics dictate. LM6 has an average durability and strength, and with high impact strength and ductility. Not only in a pressure die casting alloy,

aluminium LM6 can be used but is also suitable for both gravity and low pressure casting techniques.

2.2 Drilling Machine Operation

Hole-making is a class of machining operations that are specifically used to cut a hole into a work-piece. Hole-making can be performed on a variety of machines, including general machining equipment such as CNC milling machines or CNC turning machines.

Based on Marinov (2014), drilling operation produces a spherical hole in the workpiece using a rotary cutter called 'drill'. In manufacturing industries, it is possible that more holes are produced rather than any other form, and most of these were made by drilling. Venkata (2010) in his book mentioned that drilling makes up to 25% of all machining processes performed. In current years, new drill point geometries and TiN coatings have resulted in improved holes accuracy, longer life, self-centred action, and feed rate capabilities are increased.

Drilling operation can also be conducted in lathe, where the drill is held in tailstock and the work piece is held by the chuck. There are many machines that are able to use to drill, ream or thread holes in a part. Reaming is a similar process where a hole features is enlarged to a very specific or accurate size by introducing a rotating end and side cutting tool called a reamer. Some of the most usually used drilling machines are drill press, milling machine and lathes (Hoffman et al., 2014). Figure 2.1 shows the different types of drilling machine operation.

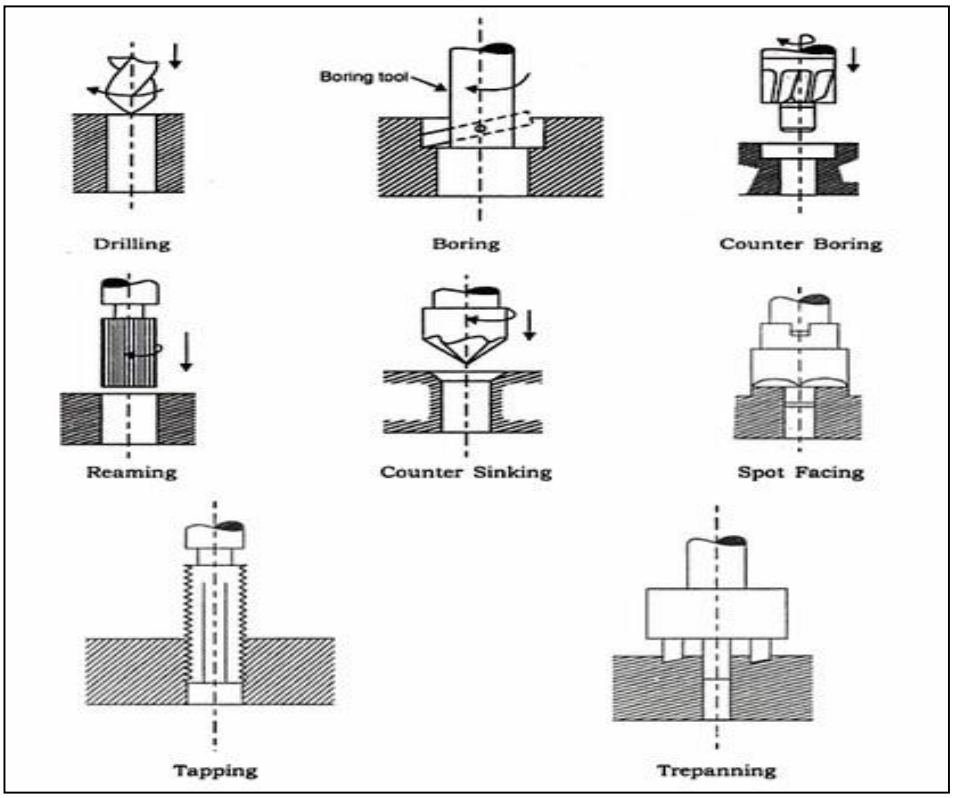

Figure 2.1: Different types of drilling machine operations. (Hoffman et al., 2014)

2.2.1 Types of Drilling Machine

In a production shop, drilling machine is the most simple and accurate machine that being used. The workpiece is held in stationary for example it's clamped in fixed position and the tool rotates to make a hole. There are a few types of drilling machine that are based on construction and based on feed. Types of drilling machine based on construction are portable, sensitive, radial, up-right, gang and multi-spindle. While based on feed are hand and power driven.

The most commonly used drilling machines for general drilling operations were discussed here. Mohan (2006) in his book mentioned that the three most commonly used drilling machines for general drilling operations are sensitive drilling machine, upright drilling machine and radial drilling machine as shown in Table 2.1. The drilling machine however is often a multi-function machining centre that also mills and sometimes turns.

Meanwhile, the operations of CNC drilling performed automatically. By CNC drilling, the tool can change the tools automatically in the desired sequence. CNC Drilling is commonly implemented for mass production.

Table 2.1: Type of drilling machine

Types of Drilling Machine	Description
Sensitive Drilling Machine  Figure 2.2: Sensitive Drilling Machine (source: its.fvtc.edu)	〉 Hole drilling from 1.5 to 15 mm 〉 Sensitive drilling machine because operator senses the cutting action so. (Mohan, 2006) 〉 Use for light duty application. 〉 Use for tool and die work, and for drilling very small hole. 〉 The spindle does not rotate but carries the spindle up and down. 〉 Able to operate at higher spindle speeds up to 30000rpm. 〉 The pressure on the drill is released to prevent the drill from breaking.
Up-right Drilling Machine  Figure 2.3: up-right drilling machine (source: its.fvtc.edu)	〉 Holes drilling up to 50mm. 〉 The table can be move vertically and radially. 〉 Use for handling much heavier work as compared to sensitive drilling machine. 〉 Spindle speeds ranges from 60 to 3500rpm.(Mohan,2006) 〉 Drill large size holes in different work pieces. 〉 Work table contains holes and slots to clamp work piece.