EFFECT OF DIFFERENT MACHINING PARAMETERS ON SURFACE ROUGHNESS OF ALUMINUM ALLOYS BASED ON Si AND Mg CONTENT

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To

My beloved family

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ABSTRACT

Aluminum alloys are being extensively used almost in all engineering fields owing to their wide range of mechanical properties. Machining of the aluminum alloys is one of the research area that focusses primarily on improved machining with high production rate. In machining of aluminum alloys, some common problems are faced, i.e. surface roughness, build-up edge on cutting edge, burr formation and continuous chip formation. This research was carried on three different aluminum alloys namely AA6061T6, AA5083 and LM6 to investigate the optimum drilling parameters for improved chip morphology, surface roughness, build-up edge and burr formation. The drills were performed by using a MAHO three axis CNC drilling machine with a HSS drill bit at three different spindle speeds and feed rates. It was found that the surface roughness was different for each aluminum alloy and it was found to be decreasing with increased spindle speeds. The BUE was found to be minimum for AA6061T6 and AA5083 but was quite high for LM6.

ABSTRAK

Aloi aluminium sedang meluas digunakan hampir dalam semua bidang kejuruteraan kerana pelbagai mereka sifat-sifat mekanik. Pemesinan daripada aloi aluminium merupakan satu bidang kajian yang memberi tumpuan terutamanya kepada pemesinan yang lebih baik dengan kadar pengeluaran yang tinggi. Dalam pemesinan aloi aluminium, beberapa masalah yang dihadapi, iaitu kekasaran permukaan, kelebihan membina-up pada hujung pemolongsan, pembentukan burr dan pembentukan serpihan berterusan. Kajian ini telah dijalankan di tiga aloi aluminium yang berbeza iaitu AA6061T6, AA5083 dan LM6 untuk menyiasat parameter penggerudian optimum untuk morfologi cip bertambah baik, kekasaran permukaan, BUE dan pembentukan duri. Latih tubi telah dijalankan dengan menggunakan MAHO tiga paksi CNC mesin gerudi dengan gerudi bit HSS di tiga kelajuan gelendong yang berbeza dan kadar snapan. Didapati bahawa kekasaran permukaan adalah berbeza untuk setiap aloi aluminium tetapi ia telah didapati berkurangan dengan peningkatan kelajuan gelendong. BUE didapati minimum untuk AA6061T6 dan AA5083 tetapi ia adalah agak tinggi untuk LM6.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

AA	-	Aluminum alloy
wt%	-	Weight percent
%	-	Percentage
CNC	-	Computer numerical control
BUE	-	Build-up edge
rpm	-	Revolution per minute
BHN	-	Brinnel hardness number
VHN	-	Vickers hardness number
GP	-	Guinier Preston
SHT	-	Solution heat treated
SHTA	-	Solution heat treated and artificially aged

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Aluminum alloys are being given a big attention by automotive, aerospace and train companies because these aluminum alloys can replace the steel and cast iron mechanical components as they are lighter and have high-strength. The weight savings will lead to a reduction in the fuel consumption and environmental impact. The 6xxx, 5xxx and LM6 aluminum alloys which possess a number of important properties as medium strength, formability, weldability, corrosion resistance and low cost, are being extensively studied. The A6061 aluminum alloy is a heat treatable precipitation hardening alloy that contains magnesium and silicon as the major alloying elements and has good mechanical properties and is one of the worth aluminum alloys that is highly demanded by automotive and aerospace industries (Demir and Gündüz, 2009). Current research has shown that the strength of aluminum alloys in general can be improved significantly by the addition of alloying elements such as Cu, Mg, Ti and Li. The Mg_2Si intermetallic compound is reinforced by in-situ in aluminum based composites that exhibit high melting temperature, low density, high hardness, low thermal expansion coefficient and high elastic modulus. Contrary to this, the presence of coarse primary and eutectic Mg_2Si phases lead to poor mechanical properties. For the present technological productions, efforts have been made to develop near net shape from these aluminum alloys but some level of finishing is need to be done to complete the assembly process (Ramulu, Rao and Kao, 2002). Therefore, it is important to establish optimum machining parameters for different aluminum alloys based on silicon and magnesium content for different hardness values for better production rates and good surface roughness, since very little information is available about the optimum machining parameters for a better surface roughness of A6061T6, LM6 and A5083 containing different weight percent of Si and Mg. Therefore, this study is concerned to establish a comparison of very basic optimized machining parameters for these alloys by performing drilling operations for surface roughness.

1.2 Problem Background

It has been aforementioned that there is an increasing trend of using aluminum alloys in automotive and aerospace industries as cost-effective, environment-friendly lightweight materials and some of them are renowned A6061T6, A5083 and LM6 aluminum alloys. For mass production of these aluminum alloys, it becomes imperative to look at the mechanical properties, machinability and the aftermaths of machining on surface roughness of these aluminum alloys. The term machinability is a broad term and refers to either ease or difficulty of machining a material. The machining of a material includes turning, facing, cutting, lapping, honing, drilling, threading, milling and reaming etc. Among all these machining operations, drilling is the most important machining operation because it contributes 40% of machining operations almost on all the cast parts produced from aluminum alloys in automotive and aerospace industry before final assembly. While performing drilling operations, the chip form is often used to assess the machinability of soft, ductile alloys, especially the aluminum alloys and the chip control is an important issue especially in drilling operations involving ductile work materials such as aluminum alloys. Chip control usually involves two tasks; that of the breaking of chips to avoid the formation of long continuous chips which can become entangled in the machinery, and that of the removal of chips from the cutting zone to prevent damage to the machined surface.

In this study it is aimed to discuss the optimized machining parameters for the above mentioned aluminum alloys for the better surface roughness on the basis of different weight percentages of Si and Mg.

1.3 Problem statement

The cast parts machining properties are of prime importance because these machining operations are accomplished by removal of material from the machined surface and easy machining results in cost effective products.

A6061T6, LM6 and A5083 aluminum alloys are being extensively used in aerospace and automotive industry owing to their light weight and improved mechanical properties and are environmental friendly.

It is found that the machinability of aluminum alloys is mostly defined in terms of reinforced particles in aluminum matrix (metal matrix composites) or high Si content, but there is very little information available about the machinability of aluminum alloys based on Mg content. Therefore, there is the need to investigate for the optimized machining parameters for aluminum alloys based on Si and Mg content

1.4 Research Objectives

It is well known that Si is one of the crucial alloying elements necessary to enhance the fluidity of molten metal for sound castings and also contributes for high hardness and strength of aluminum alloys. Contrary to this it has been found from research that increasing Si content increases the tool wear during material removal for aluminum alloy castings. Similarly the presence of Mg in aluminum alloys also improves the hardness and strength of aluminum alloys.

Hence, the purpose of this study is to find a comparison of surface roughness between A6061T6, LM6 and A5083 by using different machining parameters based on their different weight percentage of Si and Mg content to achieve acceptable chip forms and improved drill holes in terms of surface roughness.

1.5 Scopes of the Study

The areas of focus of this study are as under:

1- Preparation of castings (A6061, A5083 and LM6) by using cast iron permanent mold under similar casting conditions.

2- T6 heat treatment of A6061casting.

3- Microstructure examination of the A6061T6, LM6 and A5083 through optical microscope

4- Hardness test of the castings

5- CNC drilling of the castings at different spindle speed and feed rate.

6- Surface roughness test of the samples.

7- Chip morphology

8- Measurement of bur height

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