STUDY THE INFLUENCE OF END MILL TOOL GEOMETRIES TOWARD MACHINING PERFORMANCES

NURUL AMIRA BINTI NOR AZLI

B.ENG (HONS.) MANUFACTURING ENGINEERING
UNIVERSITI MALAYSIA PAHANG

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NURUL AMIRA BINTI NOR AZLI

Report submitted in partial fulfillment of the requirements

for the award of the degree of

Bachelor of Engineering in Manufacturing Engineering

Faculty of Manufacturing Engineering

UNIVERSITI MALAYSIA PAHANG

June 2016

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Name of supervisor : DR. MUHAMMED NAFIS BIN OSMAN ZAHID

Position : PENSYARAH KANAN

FACULTY OF MANUFACTURING ENGINEERING

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

µm	Micrometer
H	Hour
mm	Millimeter
mm/min	Millimeter per Minute
rpm	Revolution per minute
kg	Kilogram

LIST OF ABBREVIATIONS

CNC	Computer Numerical Control
CAD	Computer Aided Design
CAM	Computer Aided Machining
3D	Three Dimensions
2D	Two Dimensions
CATIA	Computer Aided Three-dimensional Interactive Application
NC	Numerical Control
HSS	High Speed Steel
Ra	Arithmetic Average
EDM	Electric Discharge Machining

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ABSTRACT

This thesis deals with study the influence of end mill tool geometries toward machining performances. In this project, two type of end mill tool have been used which are ball nose end mill and bull nose end mill and two type of tool path have been selected which are one way next and zigzag tool path in order to determine the effects of both tool and tool path toward machining performances of surface roughness and machining time. The cutting parameter in this project are spindle speed, feed rate and depth of cut. The machine used in this project is Makino KE55 CNC milling machine. The impact of end mill tool geometry on the surface roughness was determined by the testing the workpiece using Surface Roughness Tester. The machining time was determined by the CATIA V5 software and by the real machining time. Measurement of surface roughness has indicated that the bull nose end mill gives lower surface roughness compare to ball nose end mill when machine an incline surface. In other hand, ball nose end mill give lower surface roughness for free form surface. For machining time, the real machining time is longer than the machining time by the CATIA. The machining data has indicated that ball nose has longer machining time compare to bull nose end mill for machining time of incline and free form surface. In term of tool path, for incline surface zigzag tool path gives better surface than one way tool path and for free form surface one way gives better surface roughness compare to zigzag tool path. This project would help engineer to select the best end mill tool geometry and tool path strategy

ABSTRAK

Tesis ini berkaitan dengan kajian pengaruh akhir geometri alat kilang ke arah prestasi pemesinan. Dalam projek ini, dua jenis mata alat ‘end mill’ telah digunakan iaitu alat ‘ball nose end mill’ dan alat ‘bull nose end mill’ dan dua jenis cara laluan pemesinan mata alat telah dipilih iaitu ‘one way next’ dan ‘zigzag’ cara laluan pemisinianuntuk menentukan kesan kedua-dua alat dan alat laluan ke arah prestasi pemesinan iaitu kekasaran permukaan dan masa pemesinan. Parameter pemotongan dalam projek ini adalah kelajuan gelendong, kadar suapan dan kedalaman pemotongan. Mesin yang digunakan dalam projek ini adalah mesin pengilangan Makino KE55 CNC. Kesan geometri ‘end mill’ pada kekasaran permukaan ditentukan oleh ujian bahan kerja menggunakan ‘Surface Roughness Teste’. Masa pemesinan ditentukan oleh perisian CATIA V5 dan pada masa pemesinan sebenar. Pengukuran kekasaran permukaan telah menunjukkan bahawa ‘ball nose end mill’ memberikan lebih rendah kekasaran permukaan berbanding dengan ‘bull nose end mill’ apabila mesin permukaan yang condong. ‘Ball nose end mill’ memberi kekasaran permukaan yang rendah untuk permukaan bentuk bebas. Untuk masa pemesinan, pemesinan masa yang sebenar adalah lebih lama daripada masa pemesinan oleh CATIA. Pemesinan data telah menunjukkan bahawa ‘ball nose end mill’ memberi lama masa pemesinan berbanding dengan ‘bull nose end mill’ untuk masa pemesinan bagi permukaan condong dan permukaan bentuk bebas. Dari segi jalan alat, untuk jalan alat zigzag permukaan condong memberikan permukaan yang lebih baik daripada jalan alat ‘one way next’ dan untuk permukaan bentuk bebas sehala memberikan yang lebih baik kekasaran permukaan berbanding dengan jalan alat zigzag. Projek ini akan membantu jurutera untuk memilih geomteri alat ‘end mill’ dan jenis cara laluan pemesinan yang terbaik.

CHAPTER 1

INTRODUCTION

1.1 RESEARCH BACKGROUND

Machining is considered as an important technique in manufacturing processes. It can be defined as the process of removing material from a work piece in the form of chips. Variety of work, part shapes and special geometry features can be formed through machining process. A part of that machining will also influence the dimensional accuracy and surface finish achieved on the workpiece. In machining process, the most significant concern is improving surface finish and minimizes the machining time that nowadays becomes an important issue where the important aim is to achieve desire and high surface quality and reduce the cost of production. Surface roughness greatly influences the performance of mechanical parts as well as production cost.

The end milling process is widely used in industry because of its versatility and efficiency. In milling machining process, the type of cutting tool is milling cutter, tool geometries selection and cutting parameters are important factors to achieve good surface finishing and meet the part tolerance. Basically, cutting tool geometries are different in term of shapes, angles and other geometric aspects. Despite cutting parameters, end mill

tool geometries will influence the surface finish on machined part The surface finishing is determine by the surface roughness of the workpiece that influence by lot of factors like the cutting tool geometry, depth of cut, cutting speed and feed rate. The basic geometry of an end mill includes cutter diameter, shank diameter, length of cutter, length of flutes, helix angle, clearance angle and rake angle which the factors to determine the machinability.

The basic geometry of an end mill includes clearance angle, rake angle, and helix angle shown in Figure 1.1 by (Technicae, Acta Facultatis, 2014).

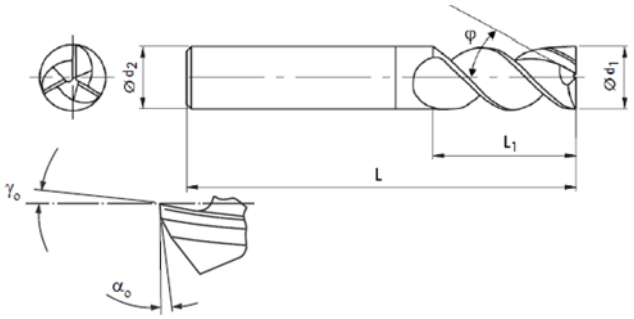

Figure 1.1: Basic geometry of end mill (a_o – tool orthogonal clearance angle, g_o – tool orthogonal rake angle, j – helix angle

Source: (Technicae, Acta Facultatis,2014)

The variety geometry of the end mill tool is used depending on the type of surface geometry and the material that being milled. The different type of geometries gives the different surface finish. Flat end mill, ball end mill and bull end mill is three main type of milling cutter. Common tool bit types of end mill are square end cutters, ball end cutters and rounded edge cutters. Flat end mill have square end cutter tool bit, while ball end mill is ball end cutter tool bit and bull nose is corner radius end tool bit. Flat end mill consist of square end cutter used in machining that require a flat bottom and sharp corner and widely used in 2D milling to produce pockets or slots. A ball nose end mill is used for 3D milling with complex shape and all non-flat surfaces. Bull nose end mill have rounded edge end mill or known as corner radius end mills is a combination of flat end mill and 90 degree

arcs in the corners. With rounded edges on the tips of the flutes, bull nose end mill is used for flat surfaces with corner radius and to create fillet on the bottom of a wall. With the rounded edges of the tips of the flutes, bull nose end mill can reduce chipping and lengthen the life of the tool. **Figure 1.2** also shows the implication of three type end mill toward the machined surface.

(a) (b) (c)

Figure 1.2: The implication of three type end mill toward the machined surface (a) Flat end mill (b) Bull nose end mill (c) Ball nose end mill

Source: http://www.mcmaster.com/#end-mills/=zujxva

Tool path style is one a factor that contributed to machining time. The cycle time can be reduced by selection of proper tool path strategy and modifying some of the design parameters by Prajapati, Rakesh et.al, (2013).

1.2 PROBLEM STATEMENT

Tool geometries and play in important role in machining process. The demand for high quality and fully automated production focuses attention on the surface condition of the product, especially the roughness of the machined surface because of its effect on product appearance, function, and reliability. For these reasons it is important to maintain consistent tolerances and surface finish. Basically there are three type of end mill cutting

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