THE EVALUATION OF MACHINABILITY AND SURFACE ROUGHNESS IN CONVENTIONAL MILLING MACHINE

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SUPERVISOR DECLARATION

“I hereby declare that I have read this thesis and in my opinion this report is sufficient in term of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Structure and Material)”

Signature: ………………………..

Supervisor: ………………………..

Date: ………………………..

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This report is submitted in fulfillment of the requirements for the award Bachelor of Mechanical Engineering (Structure and Materials)

Faculty of Mechanical Engineering

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Dedicate to my parents, loving family

and also to my lovely friends.

Thank you for all your support

DECLARATION

“I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged.”

Signature: ………………………………….

Author: ………..…………………….........

Date: ....………………………………

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ABSTRAK

Zaman ini, kekasaran permukaan memainkan satu peranan yang penting dalam industry pembuatan. Untuk menghasilkan kualiti kekasaran permukaan yang baik, parameter pemesinan yang optimum adalah penting untuk pelbagai jenis bahan. Tujuan kajian ini adalah untuk mengetahui parameter pemesinan yang optimum untuk menghasilkan kualiti kekasaran permukaan yang baik untuk pelbagai jenis bahan dan menilai keupayaan dimesin bagi pelbagai jenis bahan. Tambahan pula, Bahan-bahan dalam kajian ini adalah aluminium, keluli tahan karat dan tembaga dan parameter pemesinan yang telah dipilih adalah kadar suapan dan kelajuan gelendong. Selain itu, alat pemotongan yang digunakan dalam kajian ini adalah “High Speed Steel End Mill”. Selepas proses pemesinan dan ujian kekasaran permukaan telah dijalankan, keputusan bagi setiap spesimen ujian akan dibandingkan dan mencari parameter pemesinan yang optimum bagi setiap jenis bahan dengan menganalisis nilai kekasaran permukaan. Hubungan antara kekasaran permukaan dan parameter pemesinan seperti kelajuan gelendong dan kadar suapan adalah seperti dalam graf-graf. Tambahan pula, nilai kekasaran permukaan adalah penting dalam menilai kebolehmesinan bagi setiap jenis bahan. Hasil kajian ini dapat membantu industri pembuatan untuk mengurangkan kos pengeluaran dan masa.

ABSTRACT

Nowadays, surface finish plays as an important role in manufacturing industries. To produce good quality of surface finish, optimized machining parameter is very important for different types of material. The purposes of this research are to analysis the machinability and surface finish of different types of material with high speed steel cutting tool using conventional milling machine and study the effect of machining parameter on quality of surface finish of different types of material. In addition, the materials have been used in this research are aluminum, stainless steel and brass. The machining parameters have been chosen are feed rate and spindle speed. While for the cutting tool in this research is high speed steel end mill. After milling process and surface roughness test have been conducted, the result of each test specimen will be compared and find the optimized machining parameter of each types of material by analyzing the value of surface roughness. Relationship between surface roughness and machining parameter such as spindle speed and feed rate is shown in graphs. Furthermore, value of surface roughness is important in evaluating the ease of machinability of each types of material. The results of this research are able to help manufacturing industry to reduce production cost and time.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

N	=	spindle speed, rev/min
n_t	=	number of teeth on the cutter
f	=	chip load in mm/tooth
N	=	Spindle speed, m/min
D	=	diameter of cutter in millimeter
R_y/R_{max}	=	maximum height of profile
R_a	=	arithmetic average roughness

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

This chapter shows preface for primary idea of research for this project. Topics that are included in this chapter are problem statement, scope of study objective and summary of report.

1.1 BACKGROUND

In this study, three types of material which are aluminum, brass, and stainless steel have been chosen. Aluminum is widely used in many applications. The advantages of aluminum are corrosion resistance, ease of machinability, good electrical conductivity, high strength to weight ratio and good malleability (Mathew A. Kuttolamadom et. al 2010). Aluminum widely used in many applications and industries. For examples, aluminum is used in packaging such as drink cans. Furthermore, aluminum also can be used as material for structural parts in aerospace and engine parts in automobile industries.

Brass is an alloy with combination of copper and zinc. Addition of zinc to copper is able to enhance the strength of brass. Brass is most suitable material to manufacture products due to its good strength, ease of machinability and high corrosion resistance. Brass has been used in architecture, plumbing hardware, fasteners and marine hardware. Besides that, brass also is used in radiator and tanks due to its high thermal conductivity (William D. Callister, J. & David G. Rethwisch 2008).

Stainless steel is a steel alloy with high corrosion resistance and the predominant element in stainless steel is chromium. Others alloying element are nickel, aluminum, nitrogen, sulfur, columbium, manganese, silicon, titanium, copper, and molybdenum. Chromium in stainless steel is able to increase or enhance corrosion resistance of it. Due to the high corrosion resistance, stainless steel is widely used as household hardware, platform accommodation in oil and gas sectors and surgical equipment in medical sectors. Besides that, stainless steel also is used in high temperature gas turbine, aircraft and nuclear power generating unit (William D. Callister, J. & David G. Rethwisch 2008).

Milling is a cutting process of cutting away material of a work piece by using multiple tooth cutters which is a cutting tool that produces a number of chips in one revolution. It is able to create a variety of features such as holes, pockets, slots and three dimensional contours. Milling process is able to produce different types of surface finish with different machining parameters. Machining parameters such as depth of cut, spindle speed and feed rate. Optimized machining parameters are able to save the production cost and time (Serope Kalpakjian 2010).

Surface finish is surface texture or as known as characteristics of surface. In industries, the quality of surface finish is very important. This is because quality of surface finish is able to affect the quality of product. Therefore optimized machining parameters are able to produce high quality of surface finish of machined workpiece. Surface finish also will affect the production cost in manufacturing industries (B. C. Routara et. al 2009). Manufacturing industries require high demand on the quality of surface finish but require low machining cost. Yet, better surface finish quality may cause higher manufacturing cost (Anjan Kumar Kakati et. al 2011) Therefore, optimized machining parameter is very important in manufacturing industries.

Surface roughness influences some functions of work piece such as fatigue resistance, contact causing surface friction, wearing, heat transmission, lubricant distribution plus hold ability and coating (Dr. Mike S. Lou et. al 1998)

Machinability of a material is defined as the ease of the material to be machined. Machinability is depending on surface finish, tool life, force and power required and chip formation characteristics. Therefore, material with good machinability as known as the material is machined with low cutting force and power, good surface finish and minimum tool wear. (William D. Callister, J. & David G. Rethwisch 2008)

1.2 OBJECTIVES

The objectives in the project are:

1. To analysis the machinability and surface finish of different types of material with high speed cutting tools using conventional milling machine.
2. To study the effect of machining parameter on quality of surface finish of different material.

1.3 SCOPE PROJECT

This project focuses on how to get optimized machining parameter by using conventional milling machine with high speed steel cutting tools and to evaluate the machinability and surface texture of different materials. Thus, surface finishes of different types of material are obtained by using different types of machining parameter which are spindle speed and feed rate. Materials which have been used in this study are stainless steel, aluminum and brass.

1.4 PROBLEM STATEMENT

In manufacturing industries, good quality of surface finish is important to products. Different types of material require different machining parameters to produce a good quality of surface roughness.

By finding a set of optimized machining parameter for different types of material, this is able to save the cost and time. Manufacturing industry is able to save the production cost and time by using the optimized machining parameters for different types of material.

A good quality of surface finish is able to decrease friction during contact of two surfaces, increase efficiency and wear resistance of two work pieces. Hence, to produce good quality of surface finish, optimized parameters such as cutting speed and feed rate for different materials must be obtained.

1.5 PROBLEM ANALYSIS

From the problems of this project, the optimized machining parameters such as feed rate and spindle speed must be evaluated for getting a good surface finish. Materials in this project are aluminum, stainless steel and brass. Therefore, different optimized machining parameters for different types of material will be evaluated in this project for getting a good quality of surface finish.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

The project covers the review of previous researches which are related to this final year project. The researches which are about surface roughness optimization machining parameter in machining composites material, milling process, machinability and effects of machining parameters on the surface roughness in the end-milling process.

2.1 MILLING PROCESS

Milling is a manufacturing process which removes unwanted material by feeding a work piece with a multiple tooth cutter. Milling process is able to create variety of features such as pockets, slots, holes and so on. Furthermore, milling process also is able to create three dimensional contours. Milling machine, cutting tool and a work piece is required during milling machine.

There are three basics of milling process which are end milling, peripheral milling and face milling as shown in Figure 2.1.1. The machined surface is created by the teeth on the peripheral milling and the axis of the cutter rotation is parallel to the workpiece surface. While for face milling, the axis of cutter rotation is directly perpendicular to the workpiece surface. The cutter is in vertical direction to the workpiece surface in end milling (Serope Kalpakjian 2010). End milling is most frequently been used in industries because end milling has ability to remove material faster and provide good quality of surface finish (N. Suresh Kumar Reddy and P. Venkateswara Rao 2005).

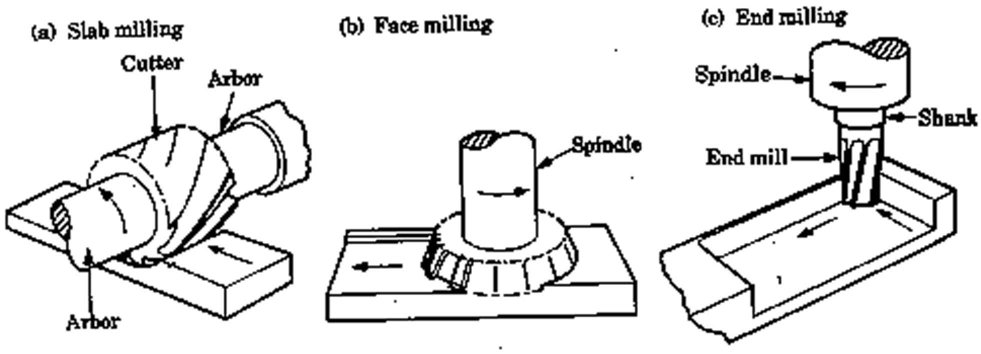

Figure 2.1.1: (a) Types of Milling Operation.

(Source: Serope Kalpakjian 2010)

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 (Mohammed T. Hayajneh, et. al 2007). In diagnosing the stability of milling process, the quality of surface finish of product is important and useful. The quality of surface finish which is produced by milling process is able to improve creep life, corrosion and fatigue strength.

2.2 HIGH SPEED STEEL CUTTING TOOL

Cutting tools are multiple tooth cutters which are used during machining process to removal unwanted material. Cutting tools must have characteristics such as hot hardness, toughness and impact strength, thermal shock resistance, wear resistance and chemical stability. Hardness, wear resistance and strength of cutting tool are maintained during machining process at the temperature encountered. This is because to ensure that the cutting tools will not undergo plastic deformation. Toughness and impact strength is important because cutting tools will not fracture when forces encountered due to vibration and chatter during machining operations. Thermal shock resistance is enable cutting tool to withstand the rapid temperature cycling faced during interrupted cutting. Wear resistance is enable the cutting tool has an acceptable tool life before the replacement of cutting tool is necessary. Chemical stability of cutting tool is able to avoid the adhesion, adverse reaction and tool-chip diffusion which will let tool wear occurs (Scope Kalpakjian 2010).

High speed steel cutting tools are created to machine workpiece or product at higher speeds. High speed steels have good wear resistance and can be hardened to various depths. There are two basics types of high speed steel which are molybedum (M-series) and tungsten (T-series). Molybedum (M-series) high speed steel consists of 10%Mo, with Cr, V, W and Co as alloying elements. While for Tungsten (T-series) high speed steel consists of 12% until 18 percent of with Cr, V, and Co as alloying element. The differences between molybedum high speed steel and tungsten high speed steel are molybedum high speed steel has higher abrasion resistance, less expensive than tungsten high speed steel. Besides that, molybedum high speed steel is less distortion during heat treating (Scope Kalpakjian 2010).

2.3 MACHINABILITY

Machinability can be defined as the metal or material can be machined into an acceptable range of surface finish. Machinability also can be determined in four factors which are cutting power is required, surface finish, tool life and chips are produced. Therefore, material which is ease of machinability is the material can be machined easily by low cutting force or power, good quality of surface finish is produced on the machine surface, do not wear the cutting tool which is used during the machining process and good curls or chip breakdown of chips. Method to evaluate the machinability of material is using the surface roughness method in this final year project. When lower value of surface roughness, the better of machinability of material. Material which is high strength or toughness is difficult to be machined and requires high cutting force or power to machine them. While for material which is low strength and toughness is more easily to be machined than high strength material (M.Ramesh et. al. 2011).some manufacturer consider tool life to evaluate the machinability of the material but there are some manufacturer consider surface finish as the main factor to evaluate the machinability of material (R. Venkata Rao and O. P. Gandhi 2001).

2.4 SURFACE FINISH

Surface finish is defined as surface texture of machined surface and plays as a crucial element in wear, lubrication and friction. In evaluation of the quality of machined products, surface roughness is very important (Suleiman Abdulkareem, et. al 2011). In general, it has been found that friction increases with average roughness. Surface roughness also affects several functional attributes of parts, such as wearing, heat transmission, lubricant holding ability, coating, and resisting fatigue (Mohammed T. Hayajneh, et. al 2007).

In manufacturing industry, quality of surface finish will affect the performance of product. Good quality of surface finish is able to help product to achieve high efficiency. For example, in an engine manufacturing company, good surface finish of piston is able to keep the horse power of the engine in high efficiency while low quality of surface finish will decrease the efficiency of the engine. Good quality of surface finish is able to increases the wear resistance of the product. Standard terminology for surface finish is shown in Figure 2.4.1. In evaluation of the quality of machined products, surface roughness is very important. Rougher surface or low quality of a product will wear more quickly and have high friction coefficient compare with good quality of surface finish (M. Ramesh et al 2011). Furthermore, good quality of surface finish is able to reduce the friction between two components during the assembly of products. Machining parameters which will affect the quality of surface roughness are feed rate, depth of cut, spindle speed, tool geometry, cutting fluid and geometry of chip formation. Furthermore, surface roughness is also affected by non-controlled influences which are non-homogeneity of workpiece, machine motion error, unpredictable random disturbances and tool wear (Miran Brezocnik and Miha Kovacic 2003).

In term of tool geometry, as the radius of tool increases and rake angle increases, the better quality of surface finish of machined surface. Thus, surface roughness depends on the friction which is created between the chips formed and tool surface during milling process. While for cutting fluid, it is able to reduce the friction of coefficient and the size of built up edge chips during machining process. An increase in feed rate and depth of cut and a decrease in spindle speed may results high surface roughness of the machined surface. Surface roughness depends on the feed rate because at a critical value of feed rate, the size of built up edge is negligible. When the surface speed reach at the critical value of surface speed, the value of surface roughness reduces greatly because of the reduction in the size of built up edge. (Mathew A. Kuttolamadom, et. al 2010)

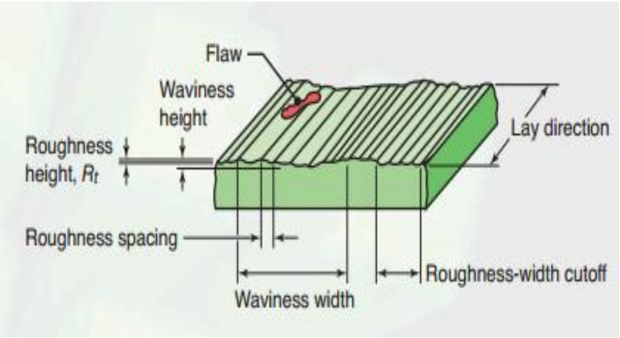

Figure 2.4.1: Standard Terminology To Describe Surface Finish.

(Source: Kalpakjian 2010)