The evaluation of machinability and surface roughness in conventional vertical milling machine

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ABSTRACT – 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. The optimized machinability and surface finish is stainless steel at feed rate of 37 mm/min and spindle speed of 1400 rpm.

1. INTRODUCTION

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 [1].

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 [2]. 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 [3]. 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 [4].

The objectives in the project are to analysis the machinability and surface finish of different types of material with high speed cutting tools using conventional vertical milling machine and study the effect of machining parameter on quality of surface finish of different material.

2. METHODOLOGY

The experiment is carried out with a conventional vertical milling machine and it model is JTM 1050VSE with a high speed steel end mill cutting tool. After the forty five test specimens are prepared, the milling process will be started. There are three machining parameters which are spindle speed, feed rate and depth of cut in this experiment. Spindle speed and feed rate are set as variable machining parameter. The values of spindle speed are 1000 rpm, 1200 rpm, 1400 rpm, 1600 rpm and 1800 rpm. For the values of feed rate are 37 mm/min, 141 mm/min and 240 mm/min. Depth of cut is set as constant machining parameter which is 0.2 mm for three different types of material which are aluminum, brass and stainless steel in this experiment.

Surface roughness test is conducted by using Mitutoyo Surface Tester SJ-301. Mitutoyo Surface Tester SJ-301 is used to measure the parameter of surface roughness of test specimens. Calibration of Mitutoyo Surface Tester SJ-301 needs to be done carefully. Therefore, a mitutoyo precision reference specimen with code 178-602 is used during calibration on the Surface Mitutoyo Surface Tester.

3. RESULTS AND DISCUSSION

From the Figure 1, Figure 2, Figure 3**,** all graphs show the effect of spindle speed to surface finish quality. The increasing of spindle speed results good surface finish quality [5]. Good surface finish quality means low value of surface roughness and vice versa. Meanwhile, spindle speed is inversely proportional to surface roughness. When spindle speed increases, the surface roughness of work piece decreases.

Surface finish quality of a material indicates the machinability of a material. Therefore, the machinability of material increases with increasing spindle speed. This is due to the reduction of built up edge chip formation by increasing the spindle speed. When the feed rate is constant at a certain value, surface roughness decreasing

when the increasing of spindle speed. This behavior can be observed in Figure 1, Figure 2 and Figure 3. However, the value of surface roughness is nearly constant at feed rate of 37 mm/min in Figure 3 for stainless steel. This is because spindle speed does not have much effect on surface finish quality with increment of spindle speed from 1000 rpm until 1800 rpm at feed rate of 37 mm/min.

From the Figure 1 and Figure 2, brass and aluminum have the lowest arithmetic mean surface roughness at spindle speed of 1800 rpm. Besides that, increasing spindle speed is able to improve the surface finish quality. On the other hand, stainless steel has the lowest surface roughness at 1400 rpm.

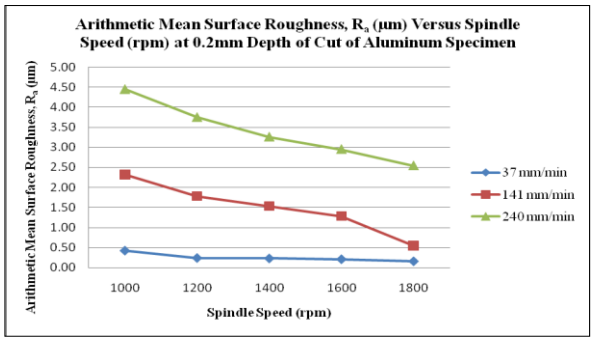

Figure 1 Arithmetic Mean Surface Roughness, R_a (µm) Versus Spindle Speed (rpm) at 0.2mm Depth of Cut of Aluminum Specimen.

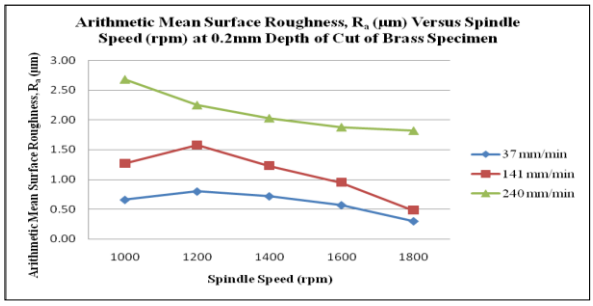

Figure 2 Arithmetic Mean Surface Roughness, R_a (µm) Versus Spindle Speed (rpm) at 0.2mm Depth of Cut of Brass Specimen.

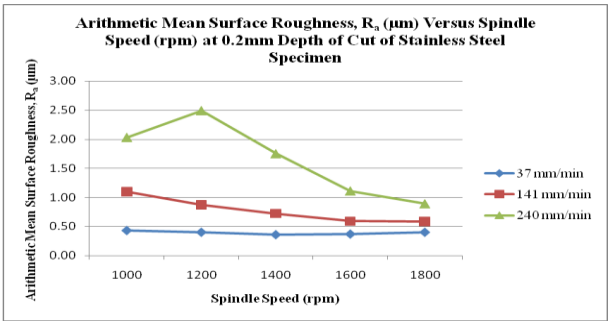

Figure 3 Arithmetic Mean Surface Roughness, R_a (µm) Versus Spindle Speed (rpm) at 0.2mm Depth of Cut of Stainless Steel Specimen.

4. CONCLUSIONS

The objectives in this project have been achieved. The optimized machinability and surface finish of aluminum and brass are at feed rate of 37 mm/min and spindle speed of 1800 rpm. Moreover, the optimized machinability and surface finish of stainless steel is at feed rate of 37 mm/min and spindle speed of 1400 rpm.

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