www.arpnjournals.com

A STUDY OF SURFACE ROUGHNESS IN DIFFERENT MACHINING AXES USING SURFACE GRINDING MACHINE IN DIFFERENT MACHINING PARAMETER

Z. A. Latiff[1], F. Saad[2], B. Zubir and W. F. W. Maidin
[1]Universiti Kuala Lumpur Malaysian Spanish Institute, Kulim Hi-Tech Park, Kulim, Kedah, Malaysia
[2] Mechanical and Manufacturing Section, UniKL MSI, Malaysia
E-Mail: zulkarnain@unikl.edu.my

ABSTRACT

In grinding operations, surface grinding is the most common machining process which provides finishing process that uses the method of a rotating abrasive wheel to give them more refine look or attain a desired surface roughness for a functional purpose by smoothing the flat surface of metallic or non metallic materials. In grinding operation, there are many parameters that are important and need to be controlled in order to have the desired surface roughness such as the movement table speed, depth of cut and the position of workpiece being machined. All the parameters will give a great impact on the surface roughness. The objective of this study is to analyze the surface roughness that reflects to grinding cutter condition parameters and to identify the optimized grinding parameters to attain the good surface finish. The study is conducted by performing grinding operation to the workpieces according to the parameters and the surface roughness was checked for each of it. There are three parameters that were controlled in this study and they are the workpiece position which is vertical, horizontal and cross; the cutting depth which is 2μm, 7μm and 15μm; and three type of table speed which is low, medium and high table speed. The results from this study shows that the optimum workpiece position for roughing and finishing process is in cross position which the workpiece lay is crossing to the grinding wheel as the surface roughness for this condition is better than the other two position which is vertical and horizontal. Besides that, the study also confirm that in order to get the optimum surface roughness for roughing process is by using 15μm of cutting depth and for finishing process is by using 2μm of cutting depth and both process are using medium table speed.

Keywords: surface roughness, surface grinding, grinding parameters.

INTRODUCTION

Surface grinding is a manufacturing process which the grinding wheel moves relatively on a surface and remove the material so that a finishing flat surface is created. Parts may require surface grinding for several reason such as to produce a flat surface, a very smooth surface roughness and accurate thickness tolerance.

The most important thing in grinding is to get good surface finish with the desired surface roughness. Most parameters are difficult to quantify equally but have effect on surface roughness in order to achieve the desired surface finished. In grinding operation, there are many parameters that are important such as the table speed, depth of cut and the position of workpiece being machined. It will give a great impact on the surface roughness. Although there are many studies being done for different grinding parameters, but this study will be focusing more on the workpiece position when grinding.

Grinding speed: The performance of grinding wheels and quality of the finished workpiece is affected by how fast the abrasive grains sweep over the workpiece [1]. The speed affects surface quality, workpiece burn and material removal rates. Therefore the grinding speed is consider as the wheel speed (Demir, 2010).

Feed rate: The feed rate is refer to the movement of the wheel per stroke across the work surface. The feed in grinding depends on the work speed, wheel width and the required finishing. It is generally 3/4 to 2/3 of the

wheel face width for rough process and 1/4 to 1/8 of the wheel for finishing process (Boothroyd, 2005). When the feed rate is high, the wheel wear will increase and it will affect the dimensional accuracy of the parts.

Depth of cut: Depth of cut is the thickness of the material removed in surface grinding for a cut. Depth of cut depends on the cutting load, power of the machine and required finishing. Generally the depth of cut is around 0.02 to 0.03 mm for roughing process and 0.005 to 0.01 mm for finishing process (Demir, 2010).

Depth of cut is the dominant contributor to the feed force, accounting for 89.05% of the feed force whereas feed rate accounts for 6.61% of the feed force. In the thrust force, feed rate and depth of cut contribute 46.71% and 49.59%, respectively. In the cutting force, feed rate and depth of cut contribute 52.60% and 41.63% respectively, plus interaction effect between feed rate and depth of cut provides secondary contribution of 3.85% (Lalwani, 2008).

Objective

The objective of this study was to analyze the surface roughness that reflects to grinding cutter condition parameters and to identify the optimization in selective grinding parameters to attain the good surface finish.

www.arpnjournals.com

METHODOLOGY

WORKPIECE MATERIALS

For this study, carbon steel is used as the workpiece material. Carbon steel is sometimes referred to as 'mild steel' or 'plain carbon steel'. Typically carbon steel are stiff and strong. Figure-1(a) until Figure-1(c) shows the workpiece machining position used in this study and Table-1 indicate the mechanical properties of the Carbon Steel.
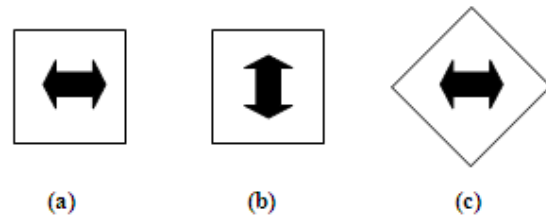

Figure-1 (a) Horizontal workpiece machining position for the study.

a) Vertical workpiece machining position for the study

b) Cross workpiece machining position for the study

Figure-1(a) shows the horizontal workpiece position that the workpiece's lay is parallel to the grinding wheel rotation while Figure-1(b) shows the vertical workpiece position that the workpiece's lay is perpendicular to the grinding wheel rotation. Figure-1(c) shows the cross workpiece position which the workpiece's lay is cross section with the grinding wheel rotation.

Table-1. Mechanical properties of carbon steel (Krar, 2004).

Properties	Young's Modulus	Poisson ratio	Density	Yield strength
Values	2e+011 N/m^2	0.266	7860 kg/m^3	3.73e+008 N/m^2

SURFACE ROUGHNESS MEASUREMENT

Regardless of the method production, all surfaces have their own characteristics, known as surface texture or roughness. The final surface depends on the rotational speed of the cutter, velocity of transverse, feed rate and mechanical properties of workpieces being machined. Typically, instruments called surface profilometers are used to measure and record surface roughness. A profilometer has a diamond stylus that travels along a straight line over the surface. The distance that the stylus travels is generally ranges from 0.08 to 25 mm. In this study, SURFPAK measurement device is used to measure the surface roughness of the workpiece. The details about SURFPAK Surface roughnes tester is as in Table-2.

The summary of machine and equipment used for the experiments are as in Table-2.

Table-2. List of equipment and machine used for the experiment.

	Item	Description
1	**Conventional Surface Grinding Machine**	**KAIR TBR-650**
2	Machining lubricant condition	Wet machining
3	Type of coolant	Fuchs
4	List of workpiece position	Vertical, Horizontal, Cross
5	Machining parameters	Constant grinding speed Specified table speed Specified depth of cut
6	Cutting tool	Wheel grider : 30A 46 J7VM
7	Workpiece material	Mild steel of 100mm x 90mm x 20mm
8	Measurement device	SURFPAK Surface roughness tester Mitutoyo 178-602A

SURFACE GRINDING MACHINING PROCESS

The experiments were conducted on the conventional surface grinding machine and have been carried out by difference workpiece position that is having the dimension of 100mm x 90mm x 20mm as in Figure-2.

In the experiment, the grinding speed and feed rate were fixed meanwhile the table speed and depth of cut

www.arpnjournals.com

will be differ according to the operations which is the low, medium and high operations. The experiment were carried out in three difference workpiece position which is vertical, horizontal and cross as in Figure-3, Figure-4 and Figure-5.
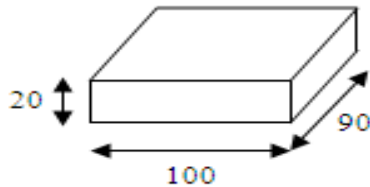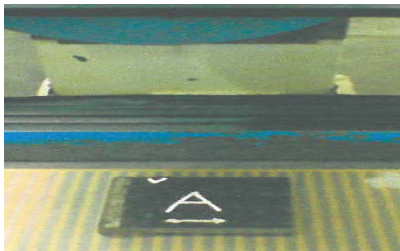

Figure-2. Workpiece dimension.
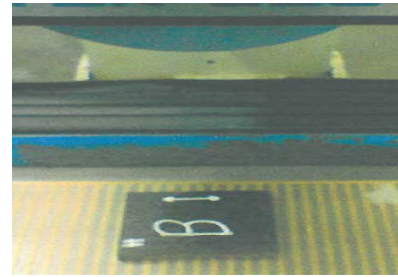

Figure-3. Workpiece in horizontal position.

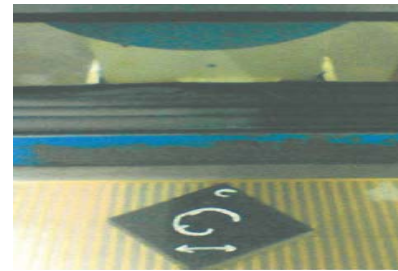

Figure-4. Workpiece in vertical position.

Figure-5. Workpiece in cross position.

RESULTS

The results from the experiments are the surface roughness value that had been measured by surface roughnes tester. The results is summarized in Table-3 until Table-5 depending on the workpiece position.

Table-3. Results for the horizontal workpiece position

Cutting depth, μm	Surface roughness, μm		
	Low table speed	Medium table speed	High table speed
15	0.8267	0.9457	0.8517
7	0.6397	0.7533	0.6720
2	0.4563	0.4787	0.3750

Table-4. Results for the vertical workpiece position.

Cutting depth, μm	Surface roughness, μm		
	Low table speed	Medium table speed	High table speed
15	0.8923	1.1047	0.8600
7	0.8463	0.7383	0.6857
2	0.4697	0.5743	0.5123

Table-5. Results for the cross workpiece position.

Cutting depth, μm	Surface roughness, μm		
	Low table speed	Medium table speed	High table speed
15	0.9350	1.4890	0.8803
7	0.8397	0.7447	0.6977
2	0.6487	0.6767	0.5550

www.arpnjournals.com

DISCUSSIONS

The results from the machining are tabulated in graph as in Figure-6, Figure-7 and Figure-8 according to the workpiece position.
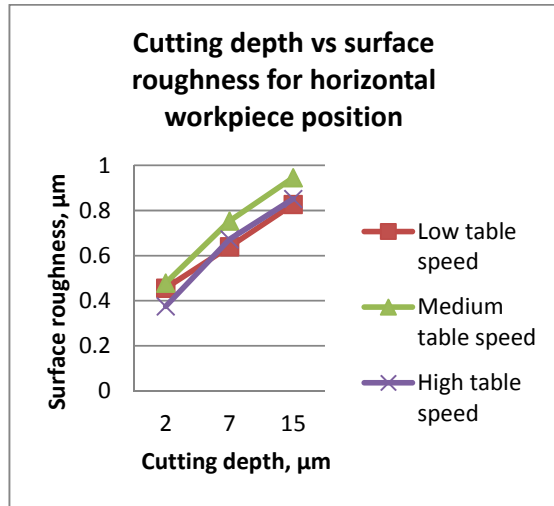

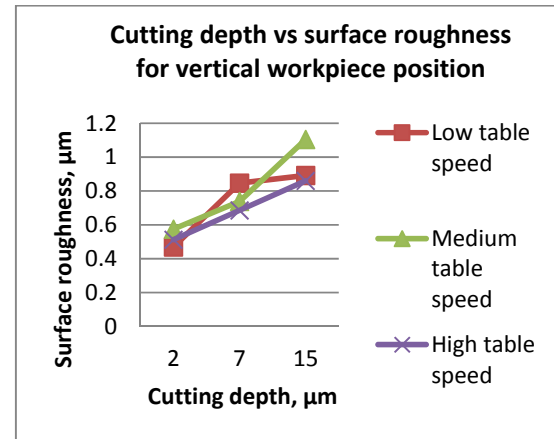**Figure-6.** Graph of cutting depth vs surface roughness for horizontal workpiece position.

Figure-7. Graph of cutting depth vs surface roughness for vertical workpiece position.
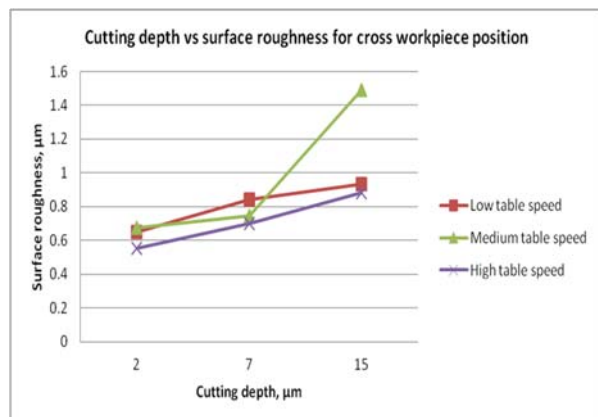

Figure-8. Graph of cutting depth vs surface roughness for cross workpiece position.

For all workpiece positions, the optimum surface roughness was resulted from the high table speed that shows the lowest surface roughness value of all cutting depth. This results were confirmed for the roughing process of 15µm of cutting depth and also for the finishing process of 2µm.

By that the results of the surface roughness got from the high table speed for the three workpiece position was compared in order to get the optimum workpiece position to grind. The results can be refered in Table-6 and the data was tabulated in the graph in Figure-9.

Table-6. Results for the high table speed for all workpiece position.

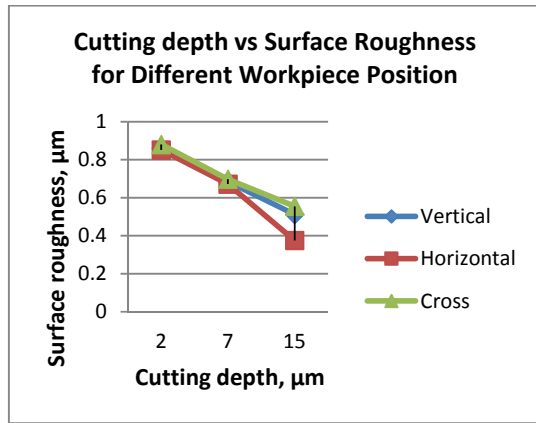| Cutting depth, µm	Surface roughness, µm		
	Vertical	**Horizontal**	**Cross**
15	0.375	0.5123	0.555
7	0.6720	0.6857	0.6977
2	0.8517	0.86	0.8803

Figure-9. Graph of cutting depth vs surface roughness for three different workpiece position at high table speed.

From the graph in Figure-9, it shows that the horizontal workpiece position has the lowest surface roughness value if compared to others workpiece position.

CONCLUSIONS

The present study was design to analyze the surface roughness that reflects to grinding cutter condition parameters and to identify the optimization in selective grinding parameters to attain the good surface finish by verifying the workpiece position, table speed and also cutting depth.

The main finding can be summarized as follow:

a) The optimum workpiece position for roughing and finishing process is in horizontal position which is the workpiece's lay is parallel to the grinding wheel rotation as the surface roughness for this condition is better than other position.
b) In order to get the optimum surface roughness for roughing process with 15μm depth of cut and finishing process with 2μm depth of cut is by having high table speed as this speed will give the lowest value of surface roughness for all depths.

The results conclude that in order to get the good surface finish, the best grinding parameters for roughing and finishing process are to use the horizontal workpiece position with high table speed.

REFERENCES

H Demir. 2010. An Investigation Into The Influences of Grain Size and Grinding Parameters on Surface Roughness and Grinding Forces When Grinding, Journal of Mechanical Engineering 56, Issue 7-8.

Geoffrey Boothroyd, Winston A. Knight. 2005. Fundamentals of Metal Machining and Machine Tools, Third Edition, CRC Press.

P. Krajnik, A. Sluga, J. Kopac. 2006. Radial Basis Function Simulation and Metalmodelling of Surface Roughness in Centreless Grinding, Journal of Ahievement in Material and Manufacturing Engineering, Volume 14, Issue 1-2.

Steve Krar, Arthur Gill, Peter Smid. 2004. Technology of Machine Tools, 6th Edition, McGraw-Hill Higher Education.

D. I. Lalwani, N. K. Mehta, P. K. Jain. 2008. Experimental Investigation of Cutting Parameters Influence on Cutting Forces and Surface Roughness in Finish Hard Turning of MDN250 Steel, Journal of Materials Processing Technology, Volume 206, Issue 1-3.

S. Malkin. 2014. Selection of Operating Parameters in Surface Grinding of Steels, Journal of Engineering for Industry, Volume 98, Issue 1.