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An Experimental Study on The Effects of Milling Process Parameters Towards Product Surface Quality

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Abstract: The surface finish was emphasized in the machining process because it refer to the quality of the product. Surface finish was referred to surface roughness. To obtain high quality of surface roughness it is important to monitor machining parameters such as cutting speed and depth of cut. For this study, the main effect of machining parameters has been analyzed is cutting speed, and depth of cut on the mill steel. This study will conduct to see the relationship between milling parameter and surface roughness. The workpieces have been machined using a conventional milling machine Hwacheon HMV-1100 without coolant and the surface finish will be measured using surface roughness tester. In this study, it was found that the lowest value of surface roughness, which is 0.442 um, has been obtained with machining parameters of 750 rpm cutting speed, 0.2 mm depth of cut and feed rate of 0.1 mm/rev. The highest value of surface roughness, which is 2.171 µm, has been obtained with machining parameters of 370 rpm cutting speed, 0.4 mm depth of cut and feed rate of 0.1 mm/rev. In conclusion, the impacts of cutting speed and depth of cut are the variables parameter that influence the mild steel"s surface finish.

Keywords: Milling, Surface Roughness,Mild steel, Cutting Speed, Depth of cut

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1. Introduction

Turning, milling, grinding and other machining processes impersonate on the surface. additional factor like selection of cutting tools, machine conditions, speed, feed, vibrations and other environmental influences will further affect this irregularity [1].

One of the key quality features of an end-milled product is surface roughness, which is used to define and evaluate the product's quality. Correct cutting parameters are important before the procedure begins to provide good surface roughness. This high-quality milling surface can help with fatigue resistance, corrosion resistance, and creep life. To create precise surface quality for these items, it is therefore essential to understand how to regulate machining parameters. Spindle speed, feed rate, and cut depth are control elements for machining parameters, whereas tool diameter, chip tool, and tool wear are uncontrollable variables. Because there are so many elements that determine surface roughness, it's more difficult to obtain and maintain track of the physical measurements. Some of these elements are under control, while others are not. Feed, cut speeds, tool shape, and tool setup are all controllable process parameters. Other variables such as tool, work piece, and machine vibration, tool wear and deterioration, and work piece and device material variability are difficult to regulate [2].

2. Materials and Methods

The Hwacheon HMV-1100 conventional milling and surface roughness tester was used in this study. The machining material be used in this project are mild steel with the dimension 80 mm in length, 77mm of wide and the thickness is 38.5 divide into 9 specimens with difference the set of cuts parameter.

2.1 Machining Process

Before running any machine, there is a one important thing must to do which is setup the machine such workpiece, the table, the taper in the spindle. when using the clamp to secure a workpiece, must be sure that workpiece are tight to avoid the workpiece not spring or vibrate under cut during the milling process as per Figure 2. The safety equipment such glove, apron, and spectacles must be apply. After that set the parameter such spindle speed and depth of cut accordingly before press start button start the machining. During the machining process avoid the eyes and hand to closed at cutting spindle to avoid the waste metal. Stop the machine after process has been done and set again the parameters accordingly with another workpiece. The workpiece had finish machining was measure their surface finish with surface finish roughness tester.

Figure 1: Hwacheon HMV-1100 conventional milling machine

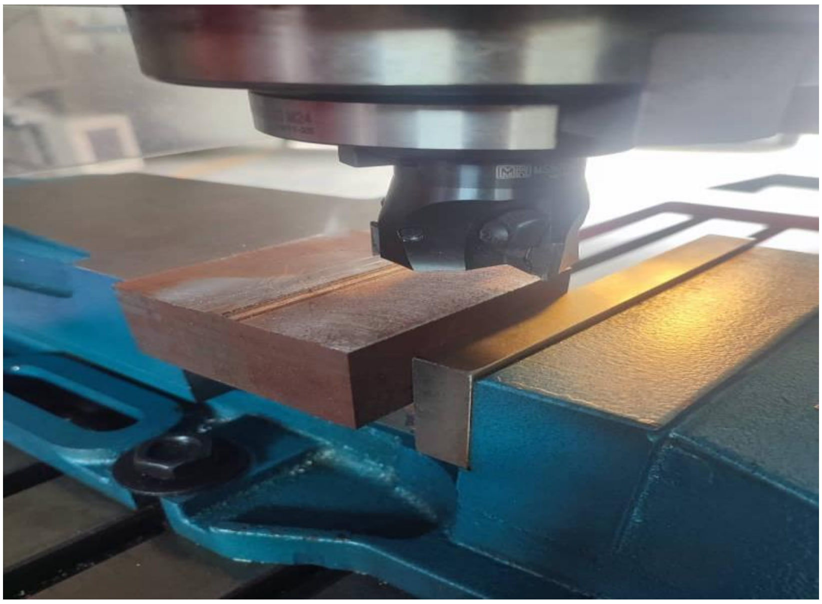

Figure 2 : Setup workpiece on table clamp

2.2 Surface roughness measurement

Refer Figure 3,Mitutoyo SJ-410 surface roughness has been used in this study to measure surface roughness workpiece after milling process to determine their surface quality. Refer Figure 4, the needle of surface roughness must touch on the workpiece before press start. The result data and the graph will show in the display monitor. The graph also can be printed out by machine. The relationship between parameter and surface roughness has been analyzed.

Figure 3: Surface roughness tester

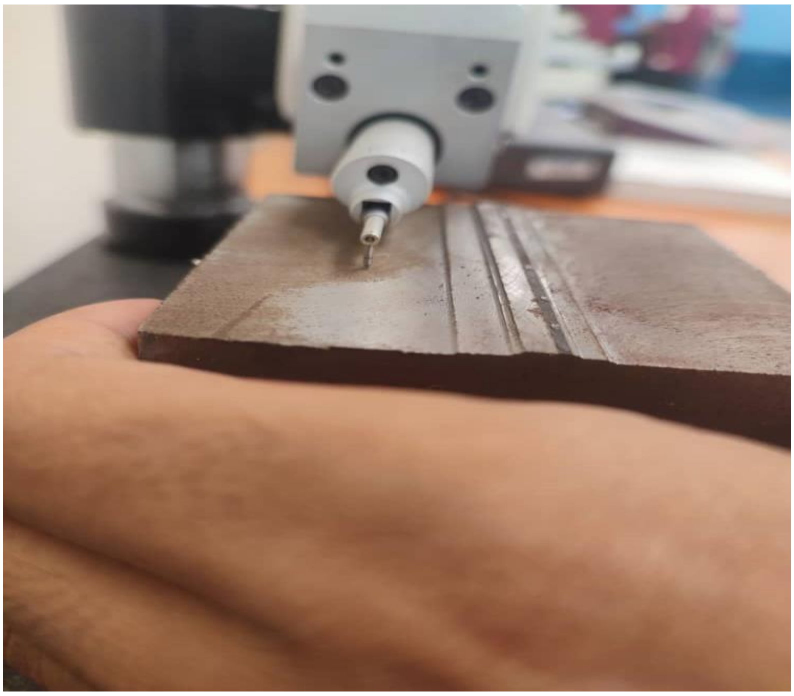

Figure 4 : The stylus surface roughness touch workpiece

3. Results and Discussion

The purpose of this study is to analyze the relationship between parameters milling machining and their surface roughness and determine the suitable parameters conventional in milling machine. From the data and result were collected by surface roughness tester was discovered in this topic.

3.1 Results

Refer Figure 5, each specimen was measure three time in the parallel line A, B and C. Table 1 below shows result value of the surface roughness that been measured. The spindle speed of this machine starts from 95 rpm to 1400 rpm and depth of cut was 0.2mm, 0.3mm, and 0.4mm. Based on common practice and safety reason, the allowable maximum spindle speed is 750rpm. To obtain more accuracy value of surface roughness in workpiece surface. The measured was repeat by three time in different place parallel line. After that obtain the value of average surface roughness.

Table 1: Surface Roughness Result

Specimen No.	Machining parameters		Surface roughness, Ra (µm)			Average of surface roughness, Ra (µm)
	Spindle speed (rpm)	Depth of cut (mm)				
1	370	0.2	1.224	1.957	1.508	1.502
2	370	0.3	1.993	1.676	2.061	1.654
3	370	0.4	1.257	2.263	2.258	2.171
4	520	0.2	1.209	1.143	1.105	1.168
5	520	0.3	1.111	1.526	1.320	1.352
6	520	0.4	0.635	1.645	1.566	1.441
7	750	0.2	1.306	0.338	0.353	0.442
8	750	0.3	1.336	1.596	1.156	1.353
9	750	0.4	1.336	1.554	1.425	1.438

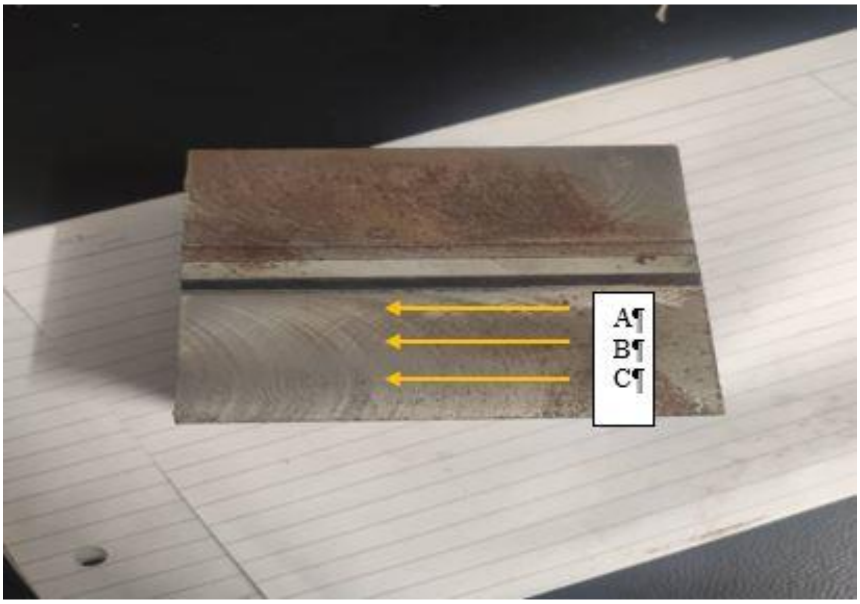

Figure 5: Surface roughness running path on work piece

Figure 6 shows the graph surface roughness against depth of cut for the 0.2 mm, 0.3 mm and 0.4 mm. Based on the graph, the value of depth of cut decrease, the surface roughness was also decrease. machining parameter with 0.2 mm depth of cut produce a smaller surface roughness. the more valueless depth of cut of workpiece during cutting process, the value of surface roughness also decreases. To obtain the good surface finished, the value surface roughness needs to be small.

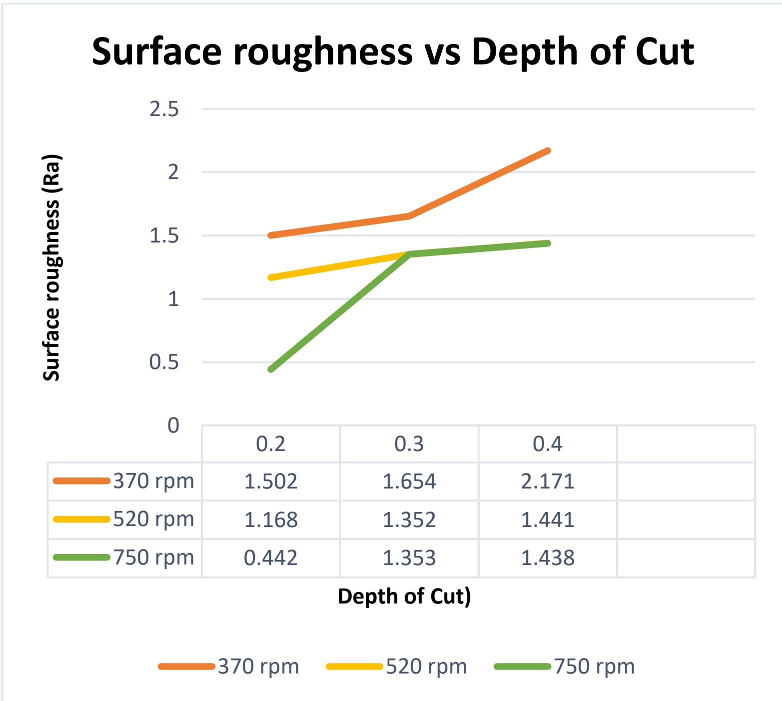

Figure 6: Graph surface Roughness (Ra) Against Depth of Cut (Mm)

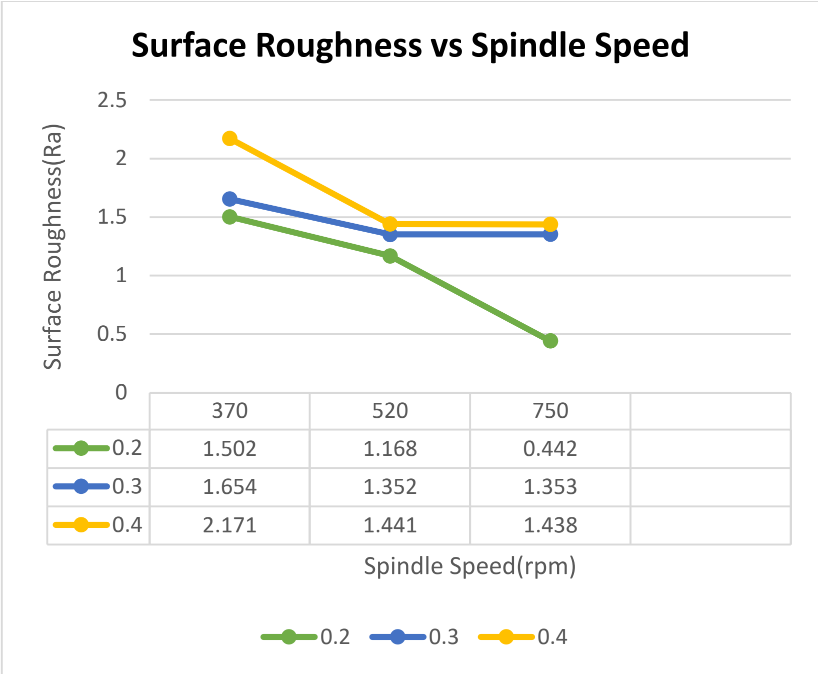

Figure 7: Surface roughness (Ra) against Spindle Speed (rpm)

Referring to figure 4.5, the graph shows the relationship between surface roughness and spindle speed for 370 rpm, 520 rpm and 750 rpm. The 750 rpm was selected as highly recommended for the 0.4 depth of cut to obtain the best surface finishing compared to 370 rpm and 520 rpm spindle speed. From the data that has been discussed, the higher spindle speed will cause the valueless of surface roughness. More valueless surface roughness was obtained, so the better surface finished was obtain.

Table 3: surface roughness result (coarse- Fine)

No.	Machining Parameters		Surface roughness (µm)
	Spindle speed (rpm)	Depth of Cut (mm)	
1	370	0.4	2.171
2	370	0.3	1.654
3	370	0.2	1.502
4	520	0.4	1.441
5	750	0.4	1.438
6	750	0.3	1.353
7	520	0.3	1.352
8	520	0.2	1.168
9	750	0.2	0.442

3.2 Discussions

Table 3 shows the value of surface roughness arranged in coarse to fine value. The value of surface roughness has rearranged from the highest value 2.171 µm (coarsest) with spindle speed at 370 rpm and 0.4 depth of cut and the lowest value is 0.442 µm (finest) with spindle speed 750 rpm and 0.2 mm depth of cut. From the table 3, the surface roughness at range below 1 µm, its best choice to used 750 rpm with depth of cut 0.2 mm compared to others. For the spindle speed 520 rpm, it is recommended to apply 0.2 mm and 0.3 mm depth of cut. To obtain the value of surface roughness in range 1.3 µm to 1.6 µm, its is recommended to used a spindle speed at 750 rpm at 0.3 mm and 0.4 mm. while for the spindle speed at 370 rpm, it high recommended for 0.2 mm depth of cut compare to 0.3 mm and 0.4 mm.

4. Conclusion

This study has been carried out to analyze the parameters spindle speed and depth of cut was effect on surface finished for conventional milling machine and identify suitable parameters setting for the process. The effect and relationship between the spindle speed, depth of cut on the surface finish has been recognize based on the analysis from chapter 4. Based on the table 4.2, the value 2.171 µm is the higher surface roughness obtain for the 370 rpm and 0.4 depth of cut using conventional milling machine. the rotation of spindle speed is increasing, the surface roughness is decreasing. Spindle speed also refers into cutting speed. The increasing of cutting speed will reduce cutting force but, high cutting speed will lead to high friction resulting in an increase temperature of the cutting tool. This will lead to the increasing of tool wear that will affect surface roughness [3]. which research that found the theory the higher surface roughness will result in lower spindle speed and high depth of cut. Based on the results, finest surface finish obtain was when using spindle speed 750 rpm compared to 520 rpm and 370 rpm of spindle speed. While for the depth of cut, it was determined that using the lower depth of cut 0.2 mm is recommended than 0.3 mm and 0.4 mm to obtain a god surface finish.

In conclusion, all objective of this study has been achieved. The impacts of cutting speed and depth of cut are the variables that influence the workpiece's mild steel's surface quality. Spindle speed and depth of cut determined have a considerable impact on surface quality.

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