Effect of Cutting Speed, Feeding and Depth of Cut on the Surface Roughness Level of Steel ST 37 on Shaping Machines

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ABSTRACT

Application in the industrial world, the use of shaping machines by operators pay less attention to the surface roughness of objects produced. The roughness that occurs is influenced by machining parameters such as cutting speed, feed motion and cutting thickness. The purpose of this study was to determine the effect of cutting speed, feed motion and cutting thickness on the level of roughness of ST 37 steel surface in the shaping process. This type of research is an experimental method that determines the level of steel surface roughness from variations in cutting speed, feed motion, and cutting thickness to the level of roughness of ST 37 steel surface. The material used is 70 mm long, 25 mm wide, and 25 mm high. Data processing results from the level of roughness testing using the SPSS version 16.0 application. The results of the data analysis show that (1) the significant effect of cutting speed on the level of surface roughness is 5.5%. (2) the significant effect between feeding on the surface roughness level of 60.9%. (3) the significant effect of the depth of cut on the surface roughness level of 0.2% (4) the significant influence between cutting speed, feeding, and depth of cut on the level of surface roughness with a significant influence of 66.6%. Based on data analysis, it can be concluded that cutting speed, feeding the depth of cut is a factor that also influences the level of roughness of ST 37 steel in the shaping process.

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1. INTRODUCTION

The development of science and technology has a very important role in the progress of the country while affecting the success of development in the industrial field, it is seen from increasingly sophisticated technological advances. But that does not mean that conventional machinery has been abandoned, it is still needed to support modern machinery because the basis of machinery originating from conventional machinery in the industry both use a combination of digital and conventional machinery [1]. The machining process industry is a matter of quality of production. To increase productivity in the machining process followed by the quality of the workmanship in accordance with the desired specifications [2]). The machining process is the process of forming a workpiece into a finished object with the aim of getting the finished product with the expected size, shape and surface quality. The machining process has several processes, namely the lathe process, shaping process, milling process, grinding process, and drilling process [3].

A shaping machine is a machine used to make the surface of the workpiece flat and level. The process of shaping is a process that is almost the same as the turning process, which distinguishes the process of cutting motion [4]. The process of shaping machine is a machine tool with the main movement straight back and forth vertically and horizontally, the cutting motion of the tool on the workpiece is translational straight motion [5]. Surface characteristics play an important role in machinery production in the industry. One of the characteristics of the workpiece surface in the impregnation process is the level of surface roughness. These characteristics are an important part of a machine construction which aims to guarantee the quality of machining components [6].

The level of surface roughness is one of the geometric components of machining, so the level of roughness is part of the value of the quality level of the components produced. To reach the surface with a very small level of roughness is not easy [7]. Factors that can affect product quality in the machining process

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are cutting conditions, chisel geometry and steel material [8]. The cutting condition is an important role in the machining process because it will determine the quality of machining products. Cutting conditions need to be studied in order to optimize the machining process with the expected product results. Including Cutting speed, Feeding, Depth of Cut. This study will analyze the effect of cutting speed, feeding, and depth of cut on the level of steel surface roughness in the shaping process, the problem of this research is that the machining parameters in the shaping process are not analyzed before work and are not in accordance with operational standards. The average level of roughness of the surface of the workmanship material in shaping is N6-N12 with an average price of 0.8-50.0 [9]. The machining parameters in the shaping process do not concern workers or machine operators, so the process produces a better level of roughness so the operator hopes to know what steps to do before production. This problem the researcher explained the purpose of this study was to analyze the effect of cutting speed, feeding, and the depth of cut on the level of surface roughness in steel so that it would be a reference for doing good work on student and industrial operator practices.

2. MATERIAL AND METHOD

The method used in this study is experimental research, which is a method used to test several variations of treatment so that the parameters for setting objects in cutting speed, feeding and depth of cut will be obtained which produce the level of roughness in the workpiece that is in accordance with the workpiece. do a comparison of the results of the roughness level and analyze the effect of cutting speed, feeding and depth of cut on the level of steel surface roughness of ST 37 in the shaping process using the SPSS version 16.0 application. The workpiece profile can be seen in the picture with the ST 37 material below:

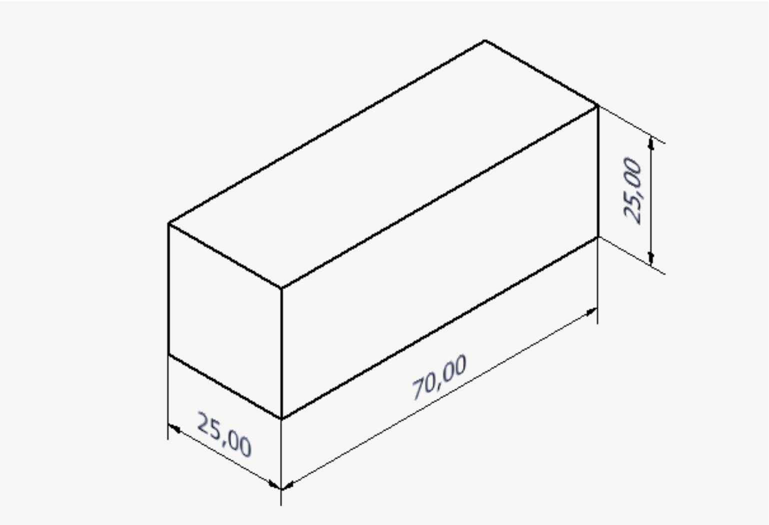

Figure 1 : Specimens

The variables carried out in this study are dependent variables and independent variables. The dependent variable is the variable that is affected. The dependent variable in this study is the level of surface roughness. The independent variable is the variable that affects. The independent variables in this study were cutting speed, feeding motion and cutting thickness. The independent variables varied are used, namely:

a. Cutting Speed: 44m / minute, 60m / minute and 76m / minute.
   Feeding: 0.2 mm / step, 0.4 mm / step and 0.6 mm / step.
b. Depth of Cut: 1 mm, 1.5 mm and 2 mm.

Data that has been obtained from the results of roughness testing on specimens were analyzed to determine the level of quality of the roughness of the test object.

Calculate average roughness per specimen (ΣRa_s)

$$\Sigma Ra_s = \frac{T1 + T2 + T3 + \ldots\ldots\ldots\ldots Tn}{n} \quad \ldots\ldots (1)$$

3. RESULT AND DISCUSSION

The research was started from the preparation of materials, cutting of materials, distribution of test specimens, planning of cutting parameters, construction of sealing, testing of surface roughness and analyzing the effect of cutting speed, feeding, and depth of cut on the level of surface roughness using SPSS version 16.0. This table shows the results of surface roughness test data analysis:

Table 1 : Average Roughness Test Results

Testing	Cutting Speed (m/min)	Feeding (mm/step)	Depth of Cut (mm)	∑Ra
1			1	7,52
2		0,2	1,5	5,66
3			2	5,41
4			1	7,65
5	44	0,4	1,5	5,99
6			2	5,06
7			1	10,8
8		0,6	1,5	10,41
9			2	14,01
10			1	5,76
11		0,2	1,5	5,24
12			2	5,37
13			1	5,25
14	60	0,4	1,5	5,02
15			2	4,99
16			1	11,34
17		0,6	1,5	12,92
18			2	11,7
19			1	4,76
20		0,2	1,5	5,33
21			2	4,83
22			1	4,47
23	76	0,4	1,5	4
24			2	4,82
25			1	10,32
26		0,6	1,5	9,79
27			2	9,08

The results of the roughness measurements of the specimens carried out using a measuring instrument Surface Tester Mitutoyo SJ 201, the specimen roughness values were obtained in µm units. Each specimen was tested three times at different test points. The number of specimens was 27 specimens and one specimen made 3 test points so many tests were 27 times the test and the taking point as comparison 3 times to 27x3 = 81 points, therefore it can be seen in the graph below:

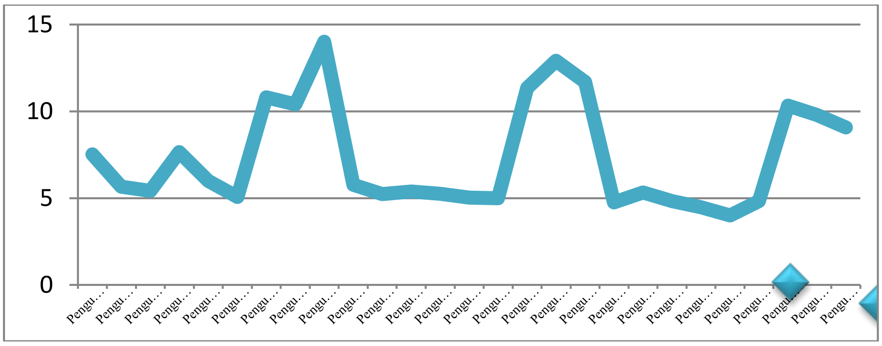

Fig. 2. Graph of comparison of roughness averages

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Tests carried out, the highest average value of roughness obtained is the 9th test with the highest roughness price found with the value Ra = 14.01 µm. While the lowest average roughness value obtained is the 23rd test with the lowest roughness with Ra = 4.00µm. The researcher explained the results of data processing using the SPSS version 16.0 application so that the significant level of data used regression analysis. The purpose of regression analysis is to determine the effect of a variable on other variables in the regression analysis.

3.1 Regression variable Cutting Speed (X1) with the level of surface roughness (Y)

The results of the data in table 2, obtained the value of Sig. F 0.240 ($p < 0.05$), it can be concluded that the hypothesis is accepted, meaning that the Cutting Speed variable has a significant effect on the level of steel surface roughness of ST 37 in the shaping process.

Table 2. Regression of variables X_1 and Y

ANOVA[b]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	12.684	1	12.684	1.449	.240[a]
	Residual	218.877	25	8.755		
	Total	231.561	26			

a. Predictors: (Constant), *Cutting Speed*

b. Dependent Variable: Roughness Average

3.2 Regression variable Feeding (X_2) with the level of surface roughness (Y)

The results of the data in table 3, obtained the value of Sig. F 0,000 ($p < 0.05$), it can be concluded that the hypothesis is addressed, meaning that the Feeding variable has a significant effect on the level of steel surface roughness of ST 37 in the shaping process.

Table 3 : Regression of variables X_2 and Y

ANOVA[b]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	141.064	1	141.064	38.969	.000[a]
	Residual	90.497	25	3.620		
	Total	231.561	26			

a. Predictors: (Constant), *Feeding*

b. Dependent Variable: Roughness Average

3.3 Regression variable Depth of Cut (X3) with the level of surface roughness (Y)

The results of data from table 4, obtained the value of Sig. F 0.845 ($p < 0.05$), it can be concluded that the hypothesis is addressed, meaning that the Depth of Cut variable has a significant effect on the level of steel surface roughness of ST 37 in the shaping process.

Table 4 : Regresi variabel X_3 dan Y

ANOVA[b]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	.361	1	.361	.039	.845[a]
	Residual	231.200	25	9.248		
	Total	231.561	26			

a. Predictors: (Constant), *Depth of Cut*

b. Dependent Variable: Roughness Average

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3.4 Regression variable Cutting Speed (X_1), Feeding (X_2) and Depth of Cut (X_3) with the level of surface roughness (Y).

The results of Table 5 data, obtained the value of Sig. F 0,000 ($p < 0.05$), it can be concluded that the hypothesis is addressed, meaning that the variables cutting speed, feeding, depth of cut have a significant effect on the level of roughness of the steel ST 37 in the shaping process.

Table 5 : Regression of variables X_1, X_2, X_3 dan Y

ANOVA[b]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	154.109	3	51.370	15.255	.000[a]
	Residual	77.452	23	3.367		
	Total	231.561	26			

a. Predictors: (Constant), *Cutting Speed*, *Feeding* dan *Depth of Cut*

b. Dependent Variable: Roughness Average

Through this regression equation, it can be explained that if the cutting speed, feeding and depth of cut scores are created at 5,285. If the value of cutting speed is increased by one scale, then the level of steel surface roughness will increase by -0.052 and if the feeding factor is increased by one scale, then the level of steel surface roughness will increase by 13.997 and if the depth of factor is increased by one scale, the level of steel surface roughness will be increased by - 0.283, so the scale became 5.285 - 0.052 + 13.997 - 0.283 = 18.942. The results of the regression analysis in table 1 so that the multiple regression equation used is $Y = a - b_1.X_1 + b_{2.}\ X_2 - b_{3.}\ X_3 = 5{,}285 - 0{,}052\ X_1 + 13{,}997X_2 - 0{,}283X_3$. From the description above it can be concluded that cutting speed, feeding, the depth of cut has a positive and significant effect and can produce the ST 37 steel surface thickness in the shaping process. Thus it can be interpreted that the influence of ST 37 steel surface roughness level of 66.6% is determined by cutting speed, feeding, depth of cut and the remaining 33.4% is determined by other variations.

4. CONCLUSION

Working on the shaping process, there are several factors that affect the surface roughness of steelwork using a shaping machine, including cutting speed, feeding, depth of cut, feed rate, engine condition, workpiece material, cut blade shape, cooling, and operator. Based on testing and research conducted on the effects of cutting speed, feeding, depth of cut, it can be concluded that the lowest level of average roughness value was obtained in the 23rd test with an average value of Ra = 4.00μm using cutting speed 76 m/minutes, feeding 0.4 mm / step, and 1.5 mm depth of cut. The highest level of average roughness is obtained in the 9th test with an average value of Ra = 14.01μm using cutting speed 44 m / minute, feeding 0.6 mm / step, and depth of cut of 2 mm. This research is if the data is using the SPSS 16.0 application, the researcher tests the normality and the results of the four variables are stated as normal distribution data. The homogeneity test on the four variables has the same or homogeneous variant. Test regression variable cutting speed, feeding, depth of cut, has a significant effect on roughness with the value of Sig. F 0,000 ($p < 0.05$), it can be concluded that the hypothesis of the four variables is accepted. The surface roughness equation ($Y = 5{,}285 - 0{,}052\ X_1 + 13{,}997X_2 - 0{,}283X_3$) Variable free cutting speed, feeding, depth of cut, has an influence of 66.6% on the dependent variable, namely the level of surface roughness.

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NOMENCLATURE

ΣRas	= Average roughness per specimen (μm)
T	= Testing point (μm)
N	= Many testing points.
ST 37	= Stainless Steel 37
X_1	= Cutting Speed (m/menit)
X_2	= Feeding (mm/langkah)
X_3	= Depth of Cut (mm)
Y	= Tingkat Kekasaran (μm)

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