Comparative Analysis of Fixed Round Speed and Fixed Cut Speed on the Surface Roughness of ST 37 Steel Level Turning on PU 2A NC Machines

Defindo Efendi, Yufrizal A and Arwizet K
Jurusan Teknik Mesin, Fakultas Teknik, Universitas Negeri Padang, Indonesia

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ABSTRACT

Parameters of rotation speed and cutting speed affect surface roughness in the turning process. The purpose of this study was to determine the ratio of the level of surface roughness resulting from the parameters of fixed rotation speed and fixed the cutting speed. The method of this research is experimental research, by performing a multilevel turning process on ST 37 steel specimens in the NC PU 2A EMCOTURN 120 machine. The number of specimens was 6 specimens, each with a multilevel specimen of 3 levels, each level being tested for 3 surface quality points using the "Mitutoyo SJ-201P Surface Tester". The results of the study were analyzed using descriptive statistics by taking the average value of the two parameters. Based on the analysis of the data from the results of the research conducted, the surface roughness produced using a fixed cutting speed (G96) is better than the fixed rotation speed (G97). Fixed cutting speed is more stable when cutting in multilevel turning.

Corresponding Author:

Defindo Efendi,
Jurusan Teknik Mesin, Fakultas Teknik, Universitas Negeri Padang
Jln. Prof. Dr. Hamka Air Tawar, Padang (25131), Sumatera Barat, Indonesia
Email: findochelsea@gmail.com

1. INTRODUCTION

In line with the progress of science and technology that is increasingly rapid, the development of the industrial world in Indonesia continues to increase, especially in manufacturing is the production process. One type of tool used for production equipment is lathe [1]. These technological advances have been applied to production equipment, namely the use of computer systems on lathes called NC / CNC. NC / CNC machines are machines that are controlled using computers with numerical languages [2]. CNC is a machine tool that in operation uses a computer that is able to read code instructions N and G (Goode) in managing the work of the machine tool system [3]. NC machines are more precise, more precise, more flexible, and more productive than conventional machines [4]. Operation of CNC machines is more sophisticated than conventional machines [5]. The CNC machine operating system uses a set of command codes called programs. The program is a sequence of commands that are arranged in detail each block per block to provide input for CNC machines about what to do [6]. In the program, the tool travel process is arranged along with the tuning parameters. There are three main parameters in each lathe process that can be adjusted, namely rotation speed, feeding movement, and depth of cut [1]. In conventional machines, the rotational speed is a reference in the lathe process and the cutting speed only adjusts to the diameter of the workpiece performed.

The rotational speed is the number of the main spindles turns that can rotate in one minute [7]. The rotational speed is very influential on the results of turning. The use of rotation speed that is not in accordance with the provisions of turning can cause the surface results on the workpiece to be bad, it can even lead to wear on cutting tools so that it can shorten the life of the cutting tool. In conventional machines can only set the rotation speed as a reference in turning which is called a fixed rotation speed (G97). Cutting speed is the ability to cut tools to cut workpieces that produce total measured in units of length/time (feet/minute or m / minute) [7] [8]. Cutting speed is preferred in the turning process where the cutting speed is determined by the diameter of the workpiece [8]. The price of cutting speed in NC PU 2A machines can be set as a reference in turning which is called a fixed cutting speed (G96) [9]. The fixed cutting speed in

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question is the price of the cutting speed to be a reference and does not change or remains at the set price from the start when doing turning with a different diameter. So, in this case, the rotation speed changes according to the diameter of the object being turned. Both of these parameters affect the quality of the workpiece produced.

Quality is a matter that becomes a reference in determining an acceptable product or not [10]. Surface quality is an important thing to note. Every workpiece that is done has a level of surface quality that must be fulfilled [5]. Good quality can be seen from its surface roughness. The higher the surface roughness, the lower the product value, while the lower the surface roughness value, the higher the product value.

The most widely used metal is stee because it has a resilient, strong or hard, and easily shaped [11]. According to its carbon concentration, steel is classified into low, medium and high carbon steel [12]. Low carbon steel contains less than 0.3% carbon, medium carbon steel contains 0.3% - 0.6% carbon, and high carbon steel contains carbon 0.6% - 1.5% [13]. Low carbon steel is a material that is very widely used in various purposes because it is more economical, efficient, and easily available in the market compared to other metals [14] [15]. One of the low carbon steel is ST 37 steel which contains carbon element 0.30% and tensile strength (ST) 37 kg / mm² [16]. This study aims to determine the comparison of surface roughness of ST 37 steel material produced using fixed rotation speed parameters and fixed cutting speed in multilevel turning process on PU 2A NC machines.

2. MATERIAL AND METHOD

The research method used is a type of experimental research. The experimental research method is a research method used to look for the effect of certain treatments on others in controlled conditions [17]. Experiments here are carried out with a multilevel turning process by comparing the use of fixed rotation speed and fixed the cutting speed to the surface roughness of the specimen.

The variable determined is the speed of feeding (feeding) which is 50 mm / minute using the G94 code and the thickness of feed (depth of cut) is 0.3 mm for a single feed so that in one feeding the specimen diameter is reduced by 0.6 mm. While the variables controlled are rotation speed and cutting speed. In the G97 parameter the rotational speed used for specimen 1 = 568 rpm, specimen 2 = 612 rpm, and specimen 3 = 663 rpm, while in the G96 parameter the cutting speed used for specimens 4.5, and 6 is 50meters/minute. The surface roughness of the specimen is measured by a test length of 0.8 x 5 mm (4 mm) per one test point.

The specimen material used in this study was Baja ST 37. The object of the research studied was the quality of the specimen surface. The tool used to conduct the experiment was the NC PU 2A EMCOTURN 120 Machine. A tool for measuring the surface roughness of specimens, the Mitutoyo SJ-201P Surface Tester. The number of specimens is 6 specimens, 3 specimens (S1, S2, and S3) use fixed rotation speed parameters and 3 more specimens (S4, S5, and S6) use fixed cutting speed parameters. Each specimen has the same size with different parameters. Each specimen was carried out in 3 tiers of turning, each level was tested for 3 surface roughness. In one specimen tested 9 points of surface roughness.

Fig. 1: Mitutoyo SJ-201P Surface Tester

Fig. 2: Test specimens

The implementation method starts from (1) material measurement; (2) cutting material; (3) formation of test specimens; (4) experimental process; and finally done (5) testing the level of surface roughness. The surface roughness test results on the specimens were analyzed using descriptive analysis techniques, namely looking for the average price of the specimen surface roughness. Data analysis techniques are as follows:

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a. Calculate the average surface roughness of the turning level (ΣRa_p)

$$\Sigma Ra_P = \frac{T1 + T2 + \ldots\ldots Tn}{nT} \tag{1}$$

b. Calculate the average surface roughness per specimen (ΣRa_s)

$$\Sigma Ra_S = \frac{\Sigma Rap1 + \Sigma Rap2 + \ldots\ldots \Sigma Rapn}{np} \tag{2}$$

After obtaining the price of surface roughness of each test point, then the average surface roughness is calculated at one level of turning. From the three turning levels calculated the average surface roughness in one specimen. Then a comparison is made and enter the class surface roughness table. The price of surface roughness each has a roughness class, N1 to N12.

Table 1. Average Roughness Class (Ra) [18].

ROUGHNESS CLASS	Velue Ra (μm)	Tolerance N $^{+50\%}_{-25\%}$
N1	0.025	0.02 – 0.04
N2	0.05	0.04 – 0.08
N3	0.0	0.08 – 0.15
N4	0.2	0.15 – 0.30
N5	0.4	0.30 – 0.60
N6	0.8	0.60 – 1.20
N7	1.6	1.20 – 2.40
N8	3.2	2.40 – 4.80
N9	6.3	4.80 – 9.60
N10	12.5	9.60 – 18.75
N11	25.0	18.75 – 37.5
N12	50.0	37.5 – 75.0

3. RESULT AND DISCUSSION

Based on the results of testing that has been done, it is obtained that the surface roughness of each test point is analyzed and entered into the test data table. The following is a table of results of the analysis of surface roughness test data using fixed rotation speed and fixed the cutting speed.

Table 2: Surface Roughness Testing Data

Sample		Diameter (mm)	Speed of rotation (rpm)		Cutting Speed (m/mnt)		Roughness Level (μm)			Average Surface Roughness ΣRa_p (μm)	Roughness Class
			Permanent	Changed	BChanged	Permanent	T1	T2	T3		
S1	A	30	568	-	53,5	-	3,08	3,14	3,03	3,0833	
	B	28		-	50,0		2,63	2,52	3,07	2,7400	
	C	26		-	46,5		2,44	1,91	2,23	2,1933	
					ΣRa_S					**2,6722**	**N8**
S2	A	30	612	-	57,7	-	2,37	2,57	2,42	2,4533	
	B	26		-	50,0		1,89	2,16	2,04	2,0300	
	C	22		-	42,3		1,82	2,09	2,01	1,9733	
					ΣRa_S					**2,1522**	**N7**
S3	A	30	663	-	62,5	-	2,38	2,27	2,14	2,2633	
	B	24		-	50,0		2,28	2,08	2,01	2,1233	
	C	18		-	37,5		2,41	2,96	3,19	2,8533	
					ΣRa_S					**2,4133**	**N8**
S4	A	30	-	530	-	50	2,26	2,53	2,28	2,3567	
	B	28		568	-		2,19	2,37	2,32	2,2933	
	C	26		612	-		1,65	1,96	1,79	1,8000	
					ΣRa_S					**2,1500**	**N7**
S5	A	30	-	530	-	50	2,27	2,30	2,28	2,2833	
	B	26		612	-		2,11	2,15	1,85	2,0367	
	C	22		723	-		1,87	1,85	1,53	1,7500	
					ΣRa_S					**2,0233**	**N7**
S6	A	30	-	530	-	50	2,88	2,91	2,92	2,9033	
	B	24		663	-		2,34	2,15	2,20	2,2300	
	C	18		884	-		1,52	1,69	1,86	1,6900	
					ΣRa_S					**2,2744**	**N7**

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Based on the test results data that has been analyzed, the average surface roughness in each specimen is inserted into the graph. Comparison of the average surface roughness of the two parameters can be seen from the following graph.

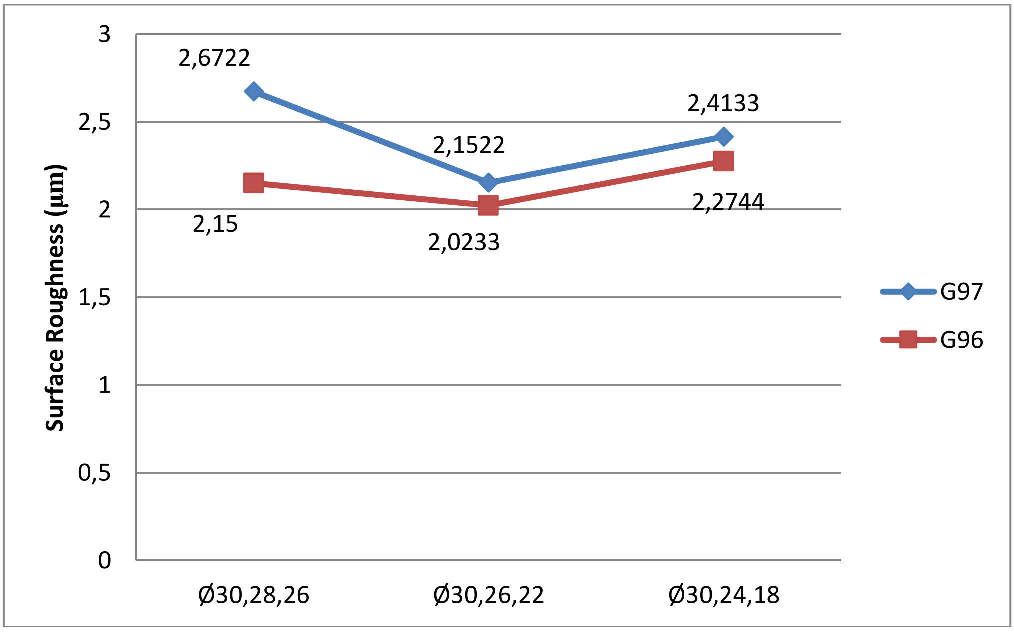

Fig. 3. Graph of Comparison of Surface Roughness of G97 and G96

The graph above explains the average surface roughness price using a fixed cut speed parameter (G96) lower than using a fixed rotation speed parameter (G97). The average price of surface roughness of the cutting speed parameter is always below the fixed rotation speed. The average surface roughness uses a fixed cutting speed of 2.4125 µm in the N7 class, while the average surface roughness uses a fixed rotation speed of 2.1492 µm in the N8 class. This shows that the use of fixed cutting speed is better to get good product quality.

The use of fixed cutting speed parameters is more stable in cutting because every change in workpiece diameter, the price of the rotation speed always adjusts the diameter of the cutting. The smaller the diameter of the workpiece, the higher the speed of rotation, the greater the diameter of the workpiece, the lower the speed of the rotation speed. In this case, the price of the cutting speed is always constant so that the ability of the cutting tool in cutting objects is not too heavy and not too light, but is at a number that has been set according to the cutting speed table. The result is lower surface roughness and can extend the life of cutting tools. Whereas when using a fixed rotation speed, the ability of the cutting tool to cut the workpiece is unstable. The smaller the diameter of the workpiece, the higher the cutting speed and the larger the diameter of the workpiece the lower the cutting speed. The high price of cutting speed causes the cutting done to be light, while the price of the cutting speed is low, the cutting will be heavy. If the cutting done is too heavy, it will have an impact on the surface roughness produced to be higher, besides that the life of the cutting tool becomes shorter.

4. CONCLUSION

To achieve the objective of the research is to know the ratio of surface roughness produced between fixed rotation speeds and fixed cutting speeds, carried out by the experimental research method, namely multilevel turning process on ST 37 steel specimens in the NC PU 2A EMCOTURN 120 machine. Mitutoyo SJ-201P Surface Tester, obtained the price of surface roughness using a fixed cutting speed (G96) better than a fixed rotation speed (G97). Fixed cutting speed is more stable when cutting in multilevel turning because the ability to cut tools is always constant. Therefore, the multilevel turning process should use a fixed cutting speed parameter to get a low surface roughness price.

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NOMENCLATURE

G97 = Fixed Rotational Speed (rpm)
G96 = Fixed Cut Speed (m/men)
ΣRa_P = Average Level Roughness of Turning (μm)
ΣRa_s = Average Perspective Roughness (μm)
S = Specimens
T = Surface Roughness at the Testing Point (μm)
nT = Many Testing Points
np = Many levels of turning
A,B,C = Turning rate

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