ANALYSIS OF SURFACE ROUGHNESS ON MACHINING OF AL-5CU ALLOY IN CNC LATHE MACHINE

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Abstract

In this study, an experimental approach is presented for the measurement of the surface roughness of the machined surface produced by simple turning operation in a computer numerically controlled (CNC) Lathe. The parameters used in the experiment were reduced to three cutting parameters, cutting speed, depth of cut, feed rate. Other parameters such as tool nose radius, workpiece length, workpiece diameter, and workpiece material was taken as constant. The effect of the process parameters namely, cutting speed, depth of cut, feed rate, upon the response like surface roughness of the finished surface was analyzed by using 3D profilometer, during this investigation. Experiments were carried out by keeping cutting speed, depth of cut, as constant and feed rate as variable.

Index Terms: *Al-5Cu alloy, surface roughness, cutting speed, depth of cut, feed rate.*

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1. INTRODUCTION

The service life of any workpiece depends on its properties of the surface, because this is with the direct contact of atmosphere, so the performance of any surface may get affected because of the physical and chemical change in the surface [1]. There is a high demand of components of aluminium alloys of better finishing in the aerospace industries in order to increase their performance by avoiding presence of some stress concentrators in the surface, such as micro cracks, scratches, or striations produced during machining [2]. The productivity of any machine tool and any machined component is determined by the quality of the surface produced by that machine. Hence for the good functional behavior of any mechanical components achieving good surface quality is of great importance [3]. Thus surface roughness is used as an indicator of quality of any product. It influences properties like wear resistance, fatigue strength, coefficient of friction, corrosion resistance, lubrication, wear rate of the machined parts [4]. In today's manufacturing industries quality is one of the significant factors, the only component to influence the customer to a level of satisfaction. In every industrial sector surface quality is detected by the surface roughness of the component [5].

Surface quality is a very essential requirement for many machined products. Any metal cutting processes are not only to shape machine components but also to produce a good dimensional accuracy, good geometric shape and fine surface. Now a days there are an increasing demand of most quality products. Because of the increasing demand for quality products, manufacturing engineers are facing with the difficulties of increasing productivity without compromising quality. Notably, precision machine components require accurate processes. High precision machine tools and cutting tools are being manufactured for this purpose which can be used at high speeds. These machine tools can be sensitively controlled by a computer. In the same way, the machining quality must be controlled. Surface roughness cannot be controlled as accurately as geometrical form and dimensional quality as it fluctuates according to many factors such as machine tool structural parameters, cutting tool geometry, workpiece and cutting tool materials, environment, etc. In other words, surface quality is affected by the machining process, e.g. by changes in the conditions of either the workpiece, tool or machine tool. Surface roughness changes over a wide range in response to these parameters [6]. The characteristics of any machined surfaces have significant effect on the ability of the material to withstand several conditions like stresses, temperatures, friction, and corrosion [7]. The demand for high quality products with good surface finish increasing day by day because of newer applications in various fields like automobile, die and mold manufacturing and thus manufacturers are required to increase productivity by improving surface quality to remain competitive in the market [8]. Surface topography of any machined surface is characterized by many parameters, among them surface roughness is the most important parameter. To evaluate the surface integrity of any machined components, because it directly controls the surface functions, such as friction, wear, lubricant retention and load carrying capacity. It improves the fatigue strength, corrosion resistance and creep life, which are prerequisite in the case of aerospace components [9].

2. EXPERIMENTAL DETAILS

Aluminum 320 gm and 5% Copper (16 gm) were melted in muffle furnace at a temperature of 950°C and hold for 20 minutes in the furnace to have uniform distribution of Cu in Al melt. It makes the Al-Cu alloy called Duralium. The molten metal was then poured in the metallic mold of length 50 mm, and diameter of 18 mm. The machinability of the material was checked in CNC Lathe machine. The material was cut using Power Hacksaw, to make the specimen for the CNC Lathe machine. In CNC Lathe simple turning operation was performed. There are many parameters which affect surface roughness. In this experimental study, the structural parameters namely, cutting speed, depth of cut, feed rate was taken into consideration.

In most of the production processes turning is the primary operation in the industry. The turning operation produces components which have critical features which needs specific surface finish. Inadequate knowledge of the complexity and factors affecting the surface finish in turning operation, an improper decision will cause high production cost and low machining quality. Thus the proper selection of cutting tools and process parameters is the most vital task. The experimental conditions and results are shown in Table 1 and Table 2 respectively.

Table -1: Details of experiment

Sl No.	Material	Cutting Tool	Input Parameters	Response Parameters
1	Al-5Cu alloy	High Speed Steel	Cutting Speed	Surface Roughness of the machined surface
2			Depth of Cut	
3			Feed	

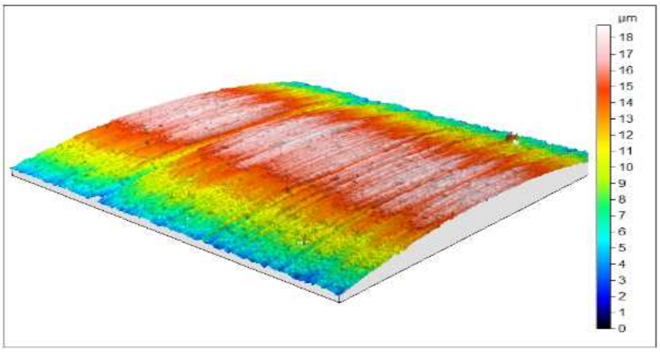

Fig -1: Surface Profile of the rough surface found in 3D profilometer

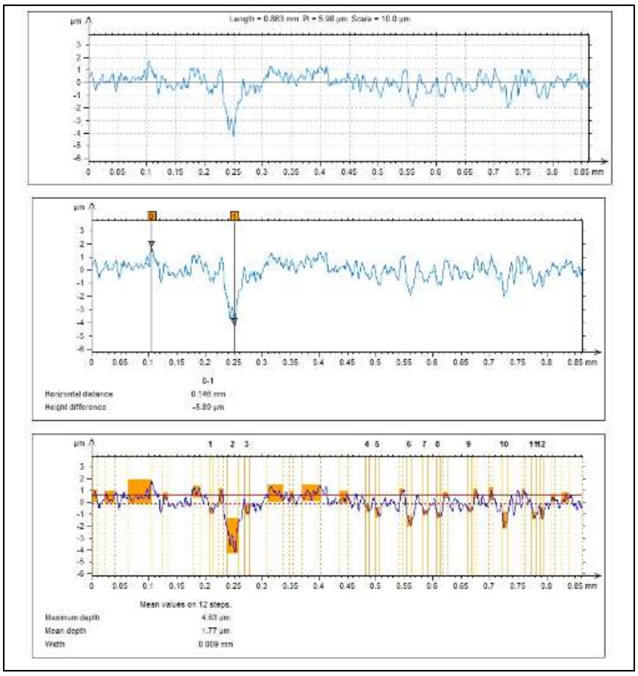

Fig -2: Measurement of different surface roughness Parameters in 3D profilometer

Table -2: Results of the experiment

Specimen No.	Input Parameters			Response Parameters			
				Surface Roughness			
	Cutting Speed (m/min)	Depth of Cut (mm)	Feed (mm/min)	Ra (µm)	Rz (µm)	Rmr (µm)	Sa (µm)
1	25.14	0.2	6.5	0.547	4.05	17.3	3.27
2	25.14	0.2	7.0	0.608	3.71	21.0	3.31
3	25.14	0.2	7.5	0.656	4.28	11.0	2.93
4	25.14	0.2	8.0	0.575	3.86	16.1	3.22
5	25.14	0.2	8.5	0.482	3.01	29.5	3.14
6	25.14	0.2	9.0	0.698	4.08	11.1	3.08
7	25.14	0.2	9.5	0.632	3.29	17.3	3.20
8	25.14	0.2	10.0	0.756	3.70	7.42	3.26
9	25.14	0.2	10.5	0.691	4.07	14.8	3.21

3. EXPERIMENTAL RESULTS & DISCUSSIONS

Initially specimen was prepared and experiments were carried out in CNC Lathe machine. To visualize the influence of feed rate over surface roughness parameters (RA), (Rz), (Rmr), (SA), four different line graph plot is shown in Chart 1, 2, 3, and 4 respectively. It is evident from the Chart 1, that as feed rate is increasing RA seems to be increasing, and at a value of 10 mm/min feed rate, RA is maximum, from Chart 2, we can see that Rz parameter is continuously increasing and decreasing as feed is increasing, at a value of 7.5 mm/min feed Rz reaches a peak value, from Chart 3, it is clear that when feed rate is increasing, Rmr is rapidly increasing and decreasing, at a value of 8.5 mm/min feed rate Rmr is maximum, and from Chart 4, it can be said that as feed is increasing, SA parameter is also increasing and at value of feed rate 7 mm/min, SA is maximum

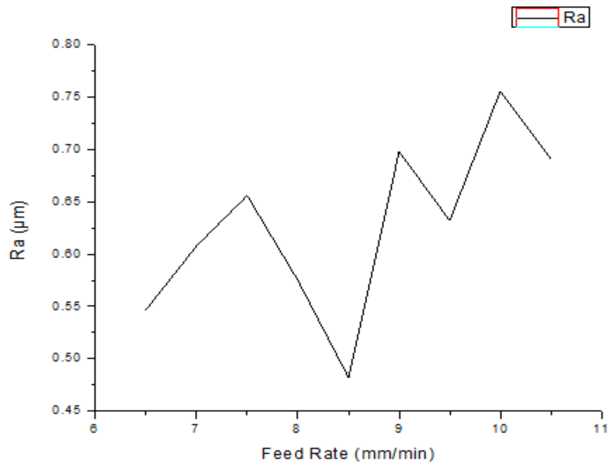

Chart -1: Effect of feed rate on surface roughness (Ra) while depths of cut and cutting speeds are constant

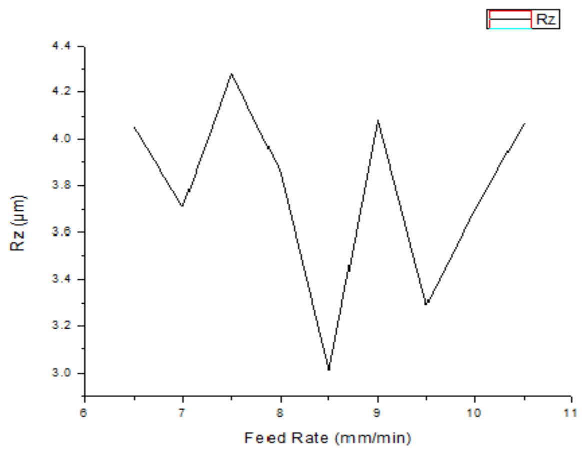

Chart -2: Effect of feed rate on surface roughness (Rz) while depths of cut and cutting speeds are constant

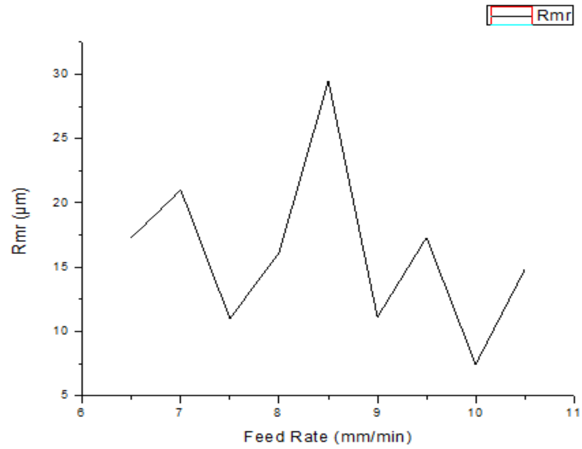

Chart -3: Effect of feed rate on surface roughness (Rmr) while depth of cut and cutting speeds is constant

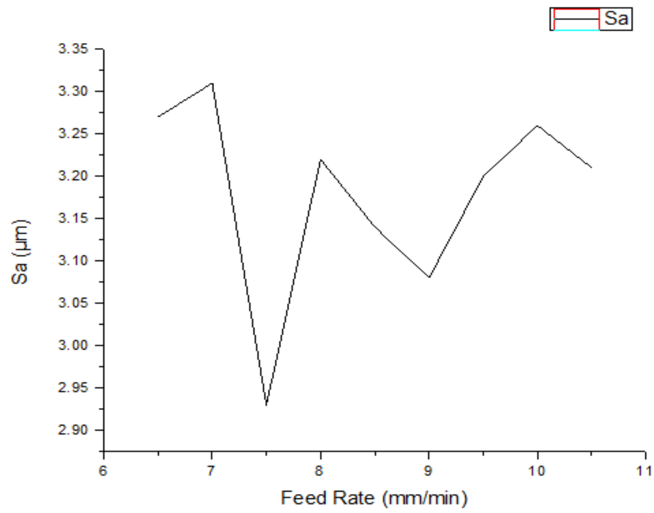

Chart -4: Effect of feed rate on surface roughness (Sa) while depth of cut and cutting speeds are constant

CONCLUSIONS

An experimental study has been done for finding the surface roughness of the machined surface. The conclusion may be drawn, the feed rate is a dominant parameter and the surface roughness increases rapidly with the increase in feed rate. From the above charts 1 to 4, it is clear that the surface roughness parameters Ra, Rz, Rmr, Sa increases gradually as feed rate increases and after reaching certain value it also decreases and then again it starts increasing and at some particular value of feed rate it reaches the maximum peak value. So we can draw a conclusion that feed rate makes dramatic changes in the surface finish of the machined surface.

ACKNOWLEDGEMENTS

The authors would like to acknowledge HOD Production Engineering Department, the entire supporting staffs of Production Engineering Department of National Institute of Technology, Agartala, for their valuable suggestions and help during the entire experimental work. Financial support given by AICTE to one of the author is also gratefully acknowledged.

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BIOGRAPHIES

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