Study of Surface Roughness in CNC Milling Operation on 6061 Graded Aluminum Alloy

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***Abstract*— Surface Roughness is perhaps the main prerequisites in metal machining tasks. To accomplish improved surface quality, the proper setting of machining boundaries is significant before the cutting activity takes place. This research aims to analyze the effect of machining parameters on the surface quality of aluminium alloy in CNC milling operations with the HSS tool. The various parameters considered are Depth of cut, feed rate and spindle speed. The MINITAB-18 software and its various tools like the Taguchi method are used to analyze the data and a graph is used to describe the S/N ratio.**

Keywords—6061 graded aluminum alloy; CNC milling; Surface roughness; optimization

I. INTRODUCTION

Assembling can be characterized as a worth expansion measure by which crude material or item unique your floors yellow because of lacking material properties and poor or unpredictable size shape and finish are changed over into high utility and high-value product with proper size from dimension and wrap up conferring some useful capacity. Machining is a fundamental doing measure by which tasks of want measurement and surface completion are created by slowly eliminating the abundance material from the performed clear as chips with the assistance of cutting apparatus moved past the work surface keeping in view high productivity product quality and overall economy [1]. Fulfilment of objectives is largely dependent on improving the machinability

characteristic of the work tool combination machinability simply means is of is judged by the magnitude of the cutting forces level of the cutting temperature and life of cutting tools surface roughness chip formation improves machinability means laser cutting forces lower cutting temperatures slower tool wear or longer tool life, better surfaces finish and favorable cheap form but without sacrificing productivity [2]. Optimum selection of the values of the process parameters cutting velocity feed and depth of cut proper selection and application of environment of cutting fluid for cooling and lubrication at the cutting zone improves machinability. Examiners in the metal slicing field have endeavored to foster an investigation of the cutting interaction which gives a reasonable comprehension of the instrument in question and which empowers the expectation of the significant cutting boundaries, without the requirement for observational testing. Aluminum and its composites are today viewed as quite possibly the most functional of metals for an assortment of reasons. Its minimal expense, lightweight and current appearance are among the essential purposes behind its inescapable use [3-4]. It is famous in the development, marine and airplane enterprises due to its simplicity of creation, non-harmfulness, strength (pound for pound), and protection from the destructive environment of industry and the marine environment [5]. Few researchers are used different cutting parameters in machining operation like cutting speed, feed rate and depth of cut to optimize surface roughness while machining AL2017 T4 with an uncoated carbide tool to optimized the process parameters [6-7]. Also minimized the surface roughness during the machining of aluminium alloy block to optimized by using Taguchi method. Confirmation can be done through ANOVAR to analyze the experimental result. [8-10] The conclusion found that the speed rate and the spindle speed are the most significant parameters on surface roughness.

Due to the delicate and "tacky" nature of aluminum, explicit calculations and qualities of the end factory are needed for effective machining. Many cutting apparatus makers' offer and plants explicitly intended for aluminum machining consequently.

In this current investigation of the machining characteristics of aluminium alloy in CNC milling machine using High-speed steel (HSS) cutting tool. it will be carried out with three process parameters namely Spindle Speed, Feed Rate, Depth of Cut. Also measured the surface roughness.

II. EXPERIMENTAL DETAILS

The sample is cute with the required size from a large (aluminium 6061 graded alloy) block with the different machining operation like parting, shaping, grinding etc. A square plate (90mm×90mm) with 10mm thickness is used for milling operation by CNC Milling Machine. During the machining time, the high-speed steel tools are used with tool length approx. 100mm and shank diameter 12mm. the materials composition is given in table.1. During the machining time, the three parameters are varying like depth of cut, spindle speed and feed rate. The test levels are as follows: Depth of cut:0.18 to 0.20, Spindle Speed:1000rpm to 1800 rpm, Feed rate: 80mm/s to 100mm/s. Also, surface roughness is measured after machining the samples. A rough surface often wears out more rapidly than a smoother surface. Harsher surfaces are ordinarily more harshness analyzer outline helpless against consumption and breaks, yet they can likewise help in bond. A harshness analyzer is utilized to rapidly and precisely decide the surface or surface unpleasantness of a material. A harshness analyzer shows the deliberate unpleasantness profundity (Rz), just as the mean worth (Ra) in micrometres set up, which is shown in fig.1. Then we used the surface roughness tester to measure the centerline average of the three-work piece we used. After completion of these test on machining and roughness measurement, the data can be analyses through MINITAB analysis. Also, calculate the S/N ratio. The mean for one level has been determined as the normal of all reactions that have been acquired with that level. The mean reaction of crude information and sign to commotion proportion (S/N) of surface unpleasantness for every boundary of Level 1,2 and 3 have been determined. The mean sign to commotion proportion of the different interaction boundaries, they have been changed from to lower to a more significant level. It has been cleared that a bigger S/N proportion relates to better quality attributes. Therefore, the optimum level of process parameter in the level of highest signal to noise ratio (S/N), where $S/N = -10 * \log(\Sigma(Y2)/n))$

Fig.1 mean value (Ra) measured by in micrometres set up

Table.1 materials composition

Com Pone nt	Al	Cr	Cu	Fe	Mg	Mn	Si	Ti	Zn	Other
Wt. %	95.8-98.6	0.04-0.035	0.15-0.4	Max 0.7	0.8-1.2	Max 0.12	0.4-0.8	Max 0.15	Max 0.25	Max 0.15

III. RESULT AND DISCUSSION

The Surface roughness of the samples are revealed for various machining condition are shown in Table.2

The surface roughness value varies for different cutting condition. At the variation of spindle speed with the fixed depth of cut (0.20mm) and feed rate (80 mm/s), the Ra value obtained maximum i.e Ra values is 2.23µm on minimum spindle speed (1500 rpm). But increase the spindle speed of the said depth of cut and feed rate, the roughness value reduces drastically. Another way the depth of cut is varied with the fixed spindle speed (1800rpm) and feed rate (80 mm/s).

Table.2 Surface roughness with various machining condition.

Sl No	**Machining condition**			**Ra Value**
	Depth of cut	Spindle Speed	Feed rate	
1	0.20mm	1500rpm	80 mm/s	2.23µm
2	0.2mm	1800 rpm	80 mm/s	1.9144µm
3	0.2mm	2000rpm	80 mm/s	1.7652µm.
4	0.1mm	1800rpm	80 mm/s	2.051µm
5	0.15mm	1800rpm	80 mm/s	1.882µm
6	0.18mm	1800rpm	80 mm/s	1.913µm
7	0.20mm	1800rpm	80 mm/s	1.068µm
8	0.20mm	1800rpm	100 mm/s	1.296µm
9	0.20mm	1800rpm	120 mm/s	1.203µm

The maximum roughness (Ra) values of 2.051µm is reveals for the minimum depth of cut. Also, roughness (Ra) values are reducing with the increased depth of cut up to 0.20mm. The plot is shown in Fig.2 for surface roughness with the length in mm. Basically, these plots are indicated the average roughness values.

Table.3 MINITAB analysis with various machining condition and Surface roughness

EXP NO	Depth of CUT	SPINDLE SPEED	FEED RATE	Ra	SNRA1	MEAN1
1	0.10	2000	80	1.94031	-5.75738	1.9403
2	0.10	1800	100	1.8530	-5.751	1.8530
3	0.10	1500	120	1.6280	-4.23309	1.6280
4	0.15	1500	100	1.8980	-5.56592	1.8980
5	0.15	1800	120	1.6770	-4.49066	1.6770
6	0.15	2000	80	1.7626	-4.87366	1.7626
7	0.18	1500	120	1.0640	-0.53883	1.0640
8	0.18	1800	80	1.2960	-2.25210	1.2960
9	0.18	2000	100	1.2570	-1.98671	1.2570

After completion of these reading and data analyzed through MINITAB analysis. These data are shown in Table.3. optimize surface roughness is obtain when the depth of cut, feed rate and spindle speed are 0.10mm,100 mm/s and 1500 rpm respectively. The response for the signal to noise ratio (S/N) is shown in Table.4. From the table. 4 reveals that the smaller is better characteristic of the optimization of surface roughness

Table.4 response for signal to noise ratio (S/N)

Level	Depth of cut	Spindle speed	Feed rate
1	-5.116	-3.953	-4.294
2	-4.977	-4.033	-4.303
3	-1.593	-3.698	-3.088
Delta	3.523	0.336	1.216
Rank	1	3	2

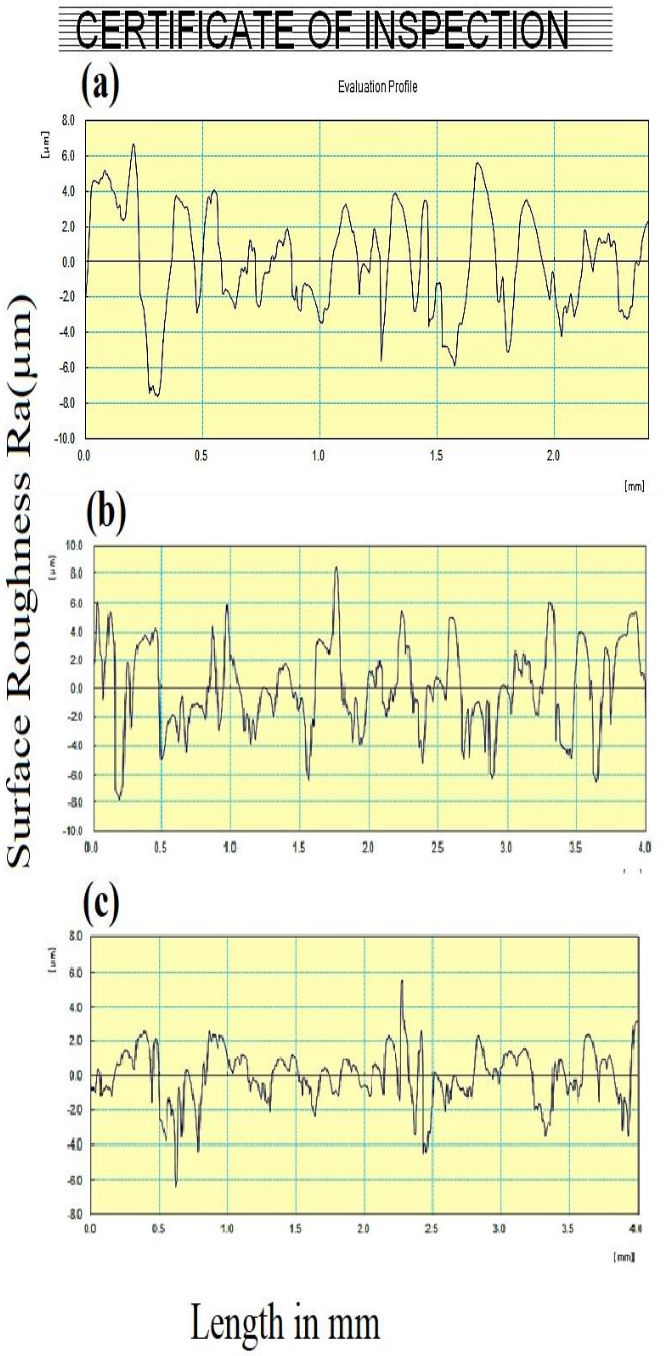

Fig.2 Surface Roughness (µm) Vs Length (mm)

IV. CONCLUSION

The experimentation uses to obtain optimum machining condition for surface roughness of aluminium 6061 alloys in CNC Milling operation. The initial stages of experimentation consist of evaluating the effect of the control factor which mainly affect the output parameters. The experimentation was carried out by varying control factors which result in factors such as spindle speed, feed rate, depth of cut. Here mini tab 18 software has been used for determining the optimum result. The following result is obtained from the research work, these are given below.

(i) There are 9 reading has been taken to get optimum result. Also, their variables are depth of cut, spindle speed and feed rate. Varying these 3 parameters 9 reading has been taken. For each reading 3 sub-reading were taken and their mean value has been determined for the final reading.

(ii) It's observed from the readings that an increase in depth of cut surface roughness value also increase when the other two variables are fixed. Likely with an increase in feed rate surface roughness value also increases when the other two variables are fixed.

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