Surface Roughness Optimization in Vertical Milling of Aluminium Alloy by Experimental Investigation

Dibya Biswas
Students of final Year, Department of Mechanical Engineering, JIS College of Engineering, Kalyani

Bhaskar Bhowmick
Students of final Year, Department of Mechanical Engineering, JIS College of Engineering, Kalyani

Subhankar Biswas
Students of final Year, Department of Mechanical Engineering, JIS College of Engineering, Kalyani

Aritrya Roy
Students of final Year, Department of Mechanical Engineering, JIS College of Engineering, Kalyani

Gourab Barik
Students of final Year, Department of Mechanical Engineering, JIS College of Engineering, Kalyani

Joydip Roy
Students of final Year, Department of Mechanical Engineering, JIS College of Engineering, Kalyani

Utsav Ghosh
Students of final Year, Department of Mechanical Engineering, JIS College of Engineering, Kalyani

Anirban Sarkar
Assistant Professor, Department of Mechanical Engineering, JIS College of Egineering, Kalyani,

***Abstract*— Surface roughness is one of the mostly needed parameters required for metal machining operations. In order to get required surface quality in cutting operation, setting of machining parameters is vital. The objective of this research is to analyse the effects of machining parameters of vertical CNC milling machine for the Aluminium Alloy (AA-60630) T6 with response of surface roughness by employing Mitutoyo Surface roughness tester. The machining parameters of this investigation are cutting Speed, feed rate, and depth of cut. Specimens are machined in CNC milling machine and surface are tested with Mitutoyo surface roughness tester & results are tabulated to investigate. The roughness values (R_a, R_q, R_z) are compared with each other and it is found that at high speed with low feed and moderate depth of cut gives the best surface roughness result.**

Keywords*— Surface roughness, aluminium alloy, design of experiment, CNC milling

I. INTRODUCTION

Surface finish refers to the process used to vary metal's surface by adding, removing or reshaping. The purpose is to save the underlying metal against wear, corrosion etc. and rise aesthetic outlook. [1] The tool fixed in the machine is called as 'Milling machine', [2] it has simply classified in vertical CNC Milling machine (Flex-mill). The major role of machining considers the three primary factors are speed, feed and depth of cut. Computer Numerical Control –CNC machine is controlled by codes like as G and M codes. [3] The preparatory functions such as geometry of tool movements and operating state of the machine controller functions. G code and M codes are used to control the CNC milling operations. Surface roughness is a major property for quality of the product since it is deeply influencing the act of the mechanical parts. Surface roughness has reflected on the mechanical properties like fatigue strength, abrasion resistance, creep life and wear [4].

II. LITERATURE REVIEW

A number of attempts have been made in previous for investigating optimum machining condition for surface roughness. T. Sathish et al.[5] got optimal process parameters for Al-Alloy 6063 as feed rate is 400 mm/min, Depth of cut is 1 mm and Cutting speed is 1000 rpm respectively. Milon D. Selvam et al. [6] shows influences of number of passes, depth of cut, spindle speed and feed rate on machined surface roughness in face milling operation. Optimum machining parameter combination has been found through Taguchi technique and fine tuned with Genetic algorithm with 4.625 % error from the predicted value.V. Songmene et al.[7] suggested machining of aluminium alloys is relatively easy as the cutting forces involved are low and the tool life is relatively high if there is no built-up edge or material adhesion problem.

The purpose of this work is to find the optimum parameter conditions for the Aluminium Alloy (AA-60630) T6 to measure the surface roughness value by using Mitutoyo tool,which can measure surface roughness value by using R_q, R_a, R_z parameter.

Table 1. Experimental Details

Machine tool	CNC Milling machine (FLEXMILL), Make: MTAB company's Flex mill Milling machine, Main motor power: 1.1kw A C Induction motor, Table size: 480mm x 180mm, Max. load: 50kg, spindle nose taper: BT 30.
Milling conditions	Vertical Axis, Feed: 80,100,120 mm/rev, Depth of Cut: 0.7,1 and 1.2 mm, spindle speed: 1000 r.p.m.,
Environment	Wet with coolant cut water soluble oil (1:10) Flood cooling with a flow rate of 3000 ml/min

Tool Material	Carbide end mill cutter.
Workpiece material	Aluminium Alloy T 6 (AA-60630)T6 (98.2% Al,0.6 % Si, 0.35% Fe, 0.1% Cu, 0.1% Mn, 0.45 % Mg,0.1 % Zn, 0.1%Ti.)
Workpiece size	90*90*10 mm.

III. EXPERIMENTAL CONDITIONS

The experiment is carried out using CNC vertical axis milling machine as given details in Table 1. For observing surface roughness value the whole experiment divided into two parts. In first part with spindle speed of 1000 r.p.m and feed of 80 mm/rev. is taken. The depth of cut of first part of experiments is taken 0.7,1 and 1.2 mm respectively. In the second part spindle speed with 1000r.p.m and depth of cut of 1 mm is kept constant. The feed varies as 80, 100 and 120 mm/rev. respectively. Machined surfaces roughness are measured by using a Mitutoyo surface roughness tester, Japan and tabulated. Each time three surface roughness values are taken in different areas.

IV. RESULTS AND DISCUSSION

Surface roughness of average height (Ra), ten-point average (Rz) and maximum peak to minimum valley (Rq) surface roughness values are shown in Fig. 1 from first part of experiments. It is observed that surface roughness values at 1 mm depth of cut gives better surface roughness than others.

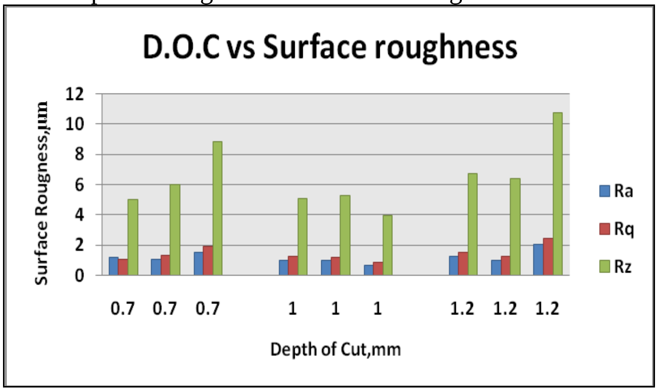

Fig. 1: Comparison of surface roughness at different depth of cut

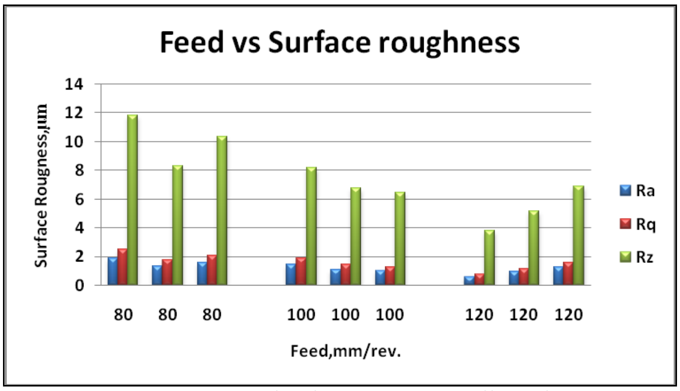

Fig. 2: Comparison of surface roughness at different feed

From second part of experiments, the surface roughness values are plotted as shown in Fig. 2.It is found that at the feed of 120 mm/rev gives better surface roughness than feed at 80 mm/ rev and 100 mm/revs. It is due to the favourable machining conditions that gives optimum results in these suitable conditions.

V. CONCLUSION

i) It is found that with 1mm depth of cut, 80 mm/rev feed and 1000 rpm of spindle speed gives optimum surface roughness compared to 0.7mm depth of cut and 1.2mm depth of cut.

ii) In another condition with 120mm/rev feed, 1mm depth of cut and 1000rpm spindle speed gives optimum surface roughness compared to 80mm/rev and 120mm/rev feed.

VI. FUTURE SCOPE

Statistical model analysis (e.g. Taguchi, ANOVA) method can be applied to analyse the surface roughness with various combinations of design variables (e.g. cutting speed, feed rate, and depth of cut).

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