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OPTIMIZATION OF CUTTING PARAMETER FOR SURFACE ROUGHNESS USING RSM METHOD FOR TURNING OF ALUMINIUM ALLOY LM13-A REVIEW

Mr. R.R.Chavan[1], Dr. A.N.Chapgaon[2]

[1]PG Student,[2]Professor, Department of Mechanical Engineering,

Ashokrao Mane Group of Institutions, Shivaji University

ABSTRACT

In this paper, study is carried out for finding the effect of turning parameter such as cutting speed (m/min), Feed rate(mm/rev) and depth of cut(mm) on surface roughness and the optimum settings of input parameters for minimizing surface roughness using Response Surface Methodology(RSM) method. The Experiment will be carried on Aluminium alloy LM13. The surface roughness is increases with the increase in the feed, decreases with increase in cutting speed also MRR increases with increase in cutting speed.

Keywords: RSM, Surface Roughness, Turning, *MRR*

I. INTRODUCTION

Turning operation is widely used in metal cutting industries. A very important problem is determining conditions that optimize the cutting parameter in order to minimize the total cost of machining operation. DOE is a systematic method of determining the relation input and output variables of process and this information is analysed for optimize the response.

Recommended Procedure for Design Of Experiment.[1]

1. Recognization of and statement of the problem
2. Choice of factor,levels and ranges
3. Selection of response variables.
4. Choice of experimental design.
5. Performining experiment
6. Statistical analysis of the data.
7. Conclusions and recommendations.

II. RESPONSE SURFACE METHODOLOGY

"RSM is the collection of statistical and mathematical techniques useful for developing, improving and optimizing process." In this techniques, input variables are called as independent variables(x1,x2,x3.....) and output of variables are called Response(y). Aim of the experiment is to optimize the response.[2]

Thus first steps in RSM is to find approximation relationship between response and independed variables. If the response is modelled by linear function of independent variables, the first order approximating function is used. which is given by the equation,

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ \ldots + \beta_k x_k + \epsilon$$

If there is curvature in the system, then a polynomial of higher degree must be used, such as

$$y = \beta_0 + \sum_{i=1}^{k} \beta_i x_i + \sum_{i=1}^{k} \beta_{ij} x_i^2 + \sum\sum_{i<j} \beta_{ij} x_i x_j + \epsilon$$

The second-order model is widely used in response surface methodology for several reasons.

1. The second-order model is very flexible. It can take on a wide variety of functional forms, so it will often work well as an approximation to the true response surface.
2. It is easy to estimate the parameters (β's) in the second-order model. The method of least squares is used. In this experiment second order model is used in Response surface methodology. [2]

III. LITERATURE REVIEW

R. Deepak Joel Johnson *et al.*[3] have been investigating the effect of cutting parameters and cutting fluid on the surface roughness by using the Taguchi Technique. In this study, an effort was made to reduce the quantity of usage of cutting fluid and to optimize the cutting parameters and fluid application parameters while turning of Oil Hardened Non shrinkable steel (OHNS) with minimal cutting fluid application using Taguchi technique. Turning with minimal cutting fluid application improved the cutting performance by giving an improved surface finish. From the Taguchi analysis and ANOVA results, it was seen that feed rate was having more influence on surface roughness.

Ranganath M S *et al*. [4] Studied the effects of speed, feed rate and depth of cut on surface roughness in CNC turning of Aluminium (KS 1275) using RSM &Taguchi methods.RSM as well as Taguchi's techniques revealed that feed is the most significant factor in minimizing surface roughness followed by speed and depth of cut. RSM technique predicted results better than the Taguchi's technique.

GrynalD'Mello *et al.* [5] have been studied the different methods such as Response Surface Methodology (RSM) and Artificial Intelligence (AI) based techniques namely Artificial Neural Network (ANN) and Adaptive Neuro-Fuzzy Inference System (ANFIS) for prediction of surface roughness.Cutting tool vibration has been measured using accelerometer mounted on the tool holder. Root Mean Square (RMS) of vibration, cutting speed and feed have been used as input parameters to develop models based on three techniques for predicting surface roughness.Experiment was carried out on mild steel. They conclude that RSM can be used as an effective tool in evaluating the influence of different dependent variables namely cutting speed, feed and cutting tool vibration on the independent variable namely surface roughness.

V.Mugendiran *et al*. [6] study was carried out to optimize surface roughness and wall thickness through incremental forming on AA5052 Aluminium alloy at room temperature by controlling the effects of forming parameters. Spindle speed, tool feed, and steps size used as input parameter. The optimal results were predicted based on Response Surface Methodology and the analysis of variance. The obtained results predict a

predominant interaction between the forming parameters which can be effectively and efficiently identified to produce minimum surface roughness and maximum wall thickness.

Ashvin J. Makadia *el al.* [7] has studied the effect of turning parameters such as feed rate, tool nose radius, cutting speed and depth of cut on the surface roughness of AISI 410 steel using response surface methodology. Response surface contours were constructed for determining the optimum conditions for a required surface roughness. Response surface methodology develop mathematical model which gives relation between input parameter and surface roughness. The surface roughness was found to increase with the increase in the feed and it decreased with increase in the tool nose radius.

C.JohnJoshua*et al*. [8] studied the effect of spindle speed and feed rate on surface roughness and material removal rate on material AA6063A using RSM method in turning operation. Cutting Speed, Feed rate and Depth of Cut are used as cutting parameters.

Jadhav J.S. *et al*.[9] studied the effect of Effect of Cutting Parameters on Cutting Force in Turning Process using Taguchi method. Experiments were conducted on a precision centre lathe and the influence of cutting parameters was studied using analysis of variance (ANOVA).Mild steel was used as working material.

Premnath A.A. *et al.* [10] has been developed the response surface model to predict surface roughness during face milling of hybrid composites. Experiment were carried out with tungsten carbide insert at various cutting speed, feed and weight fraction of alumina (Al_2O_3).Experiment were conducted on Al 6061-Aluminium alloy. They conclude that, The RSM model predict values of surface roughness quite close to measure values.

Suresh R. and Basavarajappa S. [11] studied the effect of process parameter on tool wear and surface roughness in turning of hardened AISI H13 steel (55 HRc) with PVD coated (Ti CN) ceramic tool under dry cutting condition. The Central composite design (CCD) used in this study proved to be an effective tool for modeling the tool wear and surface roughness and conclude that RSM is accurate and can be used within limits of factors investigated.

Sahib Singh *et al*.[12] Studied the machinability of aluminium metal matrix composite.(LM13/Sic/15p) during continuous turning of composite rods using carbide inserts. The effect of machining parameter e.g. cutting speed and depth of cut on the surface roughness investigated during experimentation.

H.R.Ghan *et al* [13] investigate the effect of various parameter such as cutting speed, depth of cut, feed rate on surface roughness, material removal rate and machining time in the turning and milling of the Aluminium alloy LM-26 Alloy. Also to find the optimized parameter levels of milling and turning which give optimize parameter by using taguchi design of experiment.

S.Y. Chavan *et al* [14] carried out the experiment on Al-Si7Mg(LM25) Material. Coolent enviorment, cutting speed, feed rate and depth of cut were considered as input parameter in CNC milling operation. The grey relation analysis (GRA) coupled with Taguchi method called as Grey-Taguchi method used here with L18 orthogonal array for finding optimum value of input parameter. The result of confirmation tests demonstrate that grey-Taguchi method can effectively be used to get the optimum combination of milling parameter.

Narayana B. Doddapattar *et al* [15] Studied the effect of cutting parameter such as spindle speed, feed, nose radius on surface roughness, MRR and machining time in the CNC turning of aluminium 7050. They conclude that, MRR increases with increase in spindle speed.

IV. ALUMINIUM ALLOY LM13

Experiment will be carried out on Aluminium alloy LM13 material. Aluminium Alloy LM 13 is widely used in for manufacturing of Piston in petrol and diesel engines. This alloy shows high resistance to corrosion under atmospheric condition. It has the advantage of good resistance to wear, low thermal Expansion.

V. CHEMICAL COMPOSITION OF ALUMINIUM ALLOY LM13

Sr. No.	Content	Percentage
1	Si	11.659
2	Fe	0.516
3	Cu	1.118
4	Mn	0.211
5	Mg	0.945
6	Ni	1.292
7	Zn	0.206
8	Pb	0.001
9	Ti	0.047
10	Cr	0.017
11	Al	83.869

VI. TOOL MATERIAL

Based on the tool manufacturer's catalogue for Aluminium Alloy, the Sandvik made TNMG 160408- QMH13A uncoated carbide tool Insert selected. TNMG 160408- QMH13A is uncoated carbide grade combins good abrasive wear resistance and toughness for rough to finishing turning of aluminium alloy.

VII. CONCLUSIONS

Form the literature review it is concluded that,

1. RSM method gives better result than Taguchi technique in the prediction of mathematical model of surface roughness and 3D Surfaces generated by RSM can help in visualizing the effect of parameters on surface roughness.
2. Surface roughness were found to increase with increase in feed and it decreases with increase in nose radius and cutting speed.
3. The material removal rate in turning increases with increase in cutting speed.

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