JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

# Experimental and Statistical Investigations of Surface Roughness of Steel SM45C During Machining Using Taguchi Method

**Prof. Swapnil Waybase[1], Shubham Jadhav[2], Khan Fardin[3], Jaygaonkar Shreyash[4], Dake Parshuram[5]**

Department of Mechanical Engineering, SKNCOE, SPPU, Pune

***Abstract*** – Globalization of economy, the manufacturing industries all over the world started competing with each other. Transformation of market from the seller driven to the buyer driven. The customer has occupied the centre stage. The customer started demanding better quality product at low cost and Delivery of product on time. Hence there is need to improve quality of product and increase productivity of industrial plant. In turning operation of any manufacturing industry surface roughness is one of quality determination product and MRR is related to surface roughness. This paper investigates study of parameter which are effect on surface roughness and MRR. For finding the optimal controllable process parameter Taguchi method is used. In Taguchi method we conduct L9 experiment and analyse using minitab software. By minitab software we analyse various controllable process parameter. Also find effective process parameter which is most effect on surface roughness and MRR by ANOVA analysis of variance method. Material SM45C is used in industrial for automobile drive shaft.

***Keywords – Taguchi method, Orthogonal array, Process parameter, Surface roughness, MRR, ANOVA analysis of variance.***

## I. INTRODUCTION

In machining operation various types operations are involved like turning, drilling, boring and milling. Various process parameters are effect on machining operation i.e. Spindle speed, Feed rate and DOC. Turning is most commonly used in manufacturing industry. In turning operation Spindle speed, feed rate and DOC is important process parameter. For good quality surface roughness and higher Material removal rate we find optimal process parameter by using Taguchi method. Also find effective parameter which is most effect on Surface roughness and MRR.

## II. LITERATURE REVIEW

Manish Kumar, Swapnil Singh, this author paper investigates the parameters affecting the roughness of surfaces produced in the turning process for the various materials studied by researchers. Design of experiments were conducted for the analysis of the influence of the turning parameters such as cutting speed, feed rate and depth of cut on the surface roughness. The results of the machining experiments were used to characterize the main factors affecting surface roughness by the Analysis of Variance (ANOVA) method Taguchi's parametric design is the effective tool for robust design it offers a simple and systematic qualitative optimal design to a relatively low cost.

Martoni, In the machining process there are various tools that can be used to help work in the industry. Lathe is one of the machines that can cut metal with the shape, size and quality planned. In this study, the author took the topic of "Analysis and Repair of Latitude Sledge Lathe GHB-1340G". For the process of improving latitude slashes so that the composer can be reused to make improvements in the latitude slashes. After that, the composer conducts an experiment by turning the workpiece sample. The next stage after testing the workpiece samples by making a reduction, holes, and threads obtained a good, smooth, and even turning. The machine does not experience damage or problems anymore andcan be used for a good turning process.

Miss. P. T. Jarag, Prof. P. B. Patole, Prof G. J. Pol, this author paper deals with the literature review of various factors that affect the surface roughness during turning operation. Process parameters like speed, depth of cut, feed, nose radius, etc. are studied. This study will help us in understanding, which parameters is significant parameter for Surface Roughness, Material Removal Rate, Feed Force, Tangential Force, Tool Life, etc.

Mr. S.R. Meshram, Dr C.L. Prabhune, this author Paper mainly focus on the optimizing the process parameter based on Taguchi method for minimizing the surface Roughness and maximizing the M.R.R .The experiment were carried out to turn the material IS 2062 on Lathe Machine. Three main cutting parameters were selected such as cutting velocity, feed rate and Depth of Cut and three levels were selected. MINITAB 17 is use to design orthogonal array L9 according to Taguchi Method. The signal to Noise Ratio for surface roughness and M.R.R were evaluated to determine the effect of Parameter on Quality Characteristics. Analysis of variance (ANNOVA) with the help of MINITAB 17SOFTWARE use to determine the effect of most Significant Parameters on the Quality

Characteristics such as Surface Roughness and Material Removal Rate and percentage of contribution for effecting the quality characteristics. ANNOVA is applied to identify the Ranking of Parameter which is mostly significant effect. In this investigation, itis observed that feed rate is most influencing parameter for Surface Roughness and Depth of cut is most significance Factor for MRR

Dhananjay Uttam Kadam, Suraj P. Ghorpade, Mangesh D. Indalkar, Sourabh R. Ingawale, Suyash D. Kudchadkar, For the manufacturing challenges, the Taguchi parameter optimization method is a powerful and efficient tool for quality and performance output. This thesis discusses on the parameter optimization of CNC lathe machining for surface roughness using the Taguchi method, where surface roughness generated during machining. In the parameter optimization, the parameters are cutting speed, feed, and depth of cut. After selecting parameters turning on CNC lathe is to be done and selected orthogonal array and parameters used for the optimum set of combined controlled parameters for surface roughness. Into this combination of parameters selected for minimum surface roughness value and for the optimum combination of parameters by Taguchi design. Taguchi orthogonal array L9 for three parameters cutting speed, feed rate, and depth of cut with its combination surface roughness measured, analyzed and recorded by signal to noise ratios.

Kwang-Hyeon Lee, Secong-Won, Tae-jin Yppn, Chung-Yun Kang,this author study applied laser surface melting process using CW(Continuous wave) Yb:YAG laser and cold-work die steel SM45C and investigated microstructure and hardness. Laser beam speed, power and beam interval are fixed at 70 mm/sec, 2.8 kW and 800 ㎛ respectively.

## III. EXPERIMENTAL SETUP

### A. MATERIALSM45C

SM45C, medium carbon steel, is widely used in industrial field for the production of machine parts such as crank, gear,automobile drive shaft as well as the material of cold-work die steel. [6]

Table 1 Chemical composition of SM45C

| SM45C | Chemical composition (wt.%) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | C | Mn | Si | Cr | Ni | Mo | V | W | P | S | Fe |
| | 0.41 | 0.70 | 0.25 | 0.02 | 0.03 | - | - | - | 0.03 | 0.05 | Bal. |

### B. Lathe Machine

Medium duty lathe machine is used for carried out turning operation.

Manufacturing company: VASU A.K. Machine Tools Rajkot (Gujrat)

Fig 1 Conventional Lathe Machine

### C. Turning Operation

A common method used for create specific dimensions of product is turning. In machining operation removes material from cylindrical workpiece. It is used for reduce diameter of workpiece usually to a specified or different diameters. It is performed on external surface of workpiece. In this machining operation work piece is rotating, single point cutting tool is used to remove material and Cutting tool insert parallel to the axis of workpiece material. [2]

### D. Taguchi Method

Genichi Taguchi, he was born in Japan 1924, basically an electrical engineer and worked during nineteen 1950's to improve Japan's post-World War 2 telephone communication system. And he is the father of Taguchi method, typically robust design. So, you all understand the meaning of robustness, less sensitive to the other factors, external factors, and performs to the targeted value gives the desirable performance. And this is something we call as robustness, so Taguchi emphasize on robustness of the design, and that is where he brought his concept in the domainof design of experiment.

Design of experiment – Taguchi Approach

To make the DOE easier and more attractive to research, the following technique are used:
Standardized DOE – For designing experiments, Taguchi utilized a special set of tables, called orthogonal arrays (OAs), which represent the smallest fractional factorials and are used for most common experiment designs.

Signal-to-noise (S/N) analysis – For analysis of results from multiple-sample tests, use of signal-to- noise ratios instead of the results makes the analysis of DOE results much easier. In addition, the logarithmic transformation of the results in terms of S/N ratios empowers the prediction of improvement in performance from the analysis.

E. Surface Roughness Tester

We use surface roughness tester of our college laboratory. For surface roughness testing Prof. P. P. Kharche is guide to us. Following are specification of surface roughness tester.

Manufacture: Mitutoyo

Model: SJ210

Fig 2 Surface Roughness Tester

F. Minitab Software

Minitab is a software product that helps you to analyse the data. This is designed essentially for the Six Sigma professionals. It provides a simple, effective way to input the statistical data, manipulate that data, identify trends and patterns, and then extrapolate answers to the current issues. This is most widely used software for the business of all sizes - small, medium and large. Minitab provides a quick, effective solution for the level of analysis requiredin most of the Six Sigma projects.

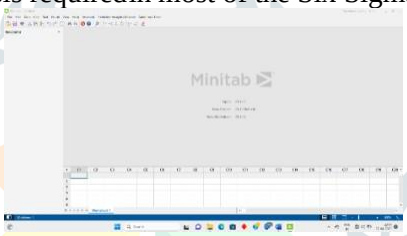


Fig 3 Minitab Software

E. Controllable Process Parameter and Orthogonal Array

Following controllable process parameter and their levels are considered for Taguchi orthogonal array. Following process parameter put in Minitab software and create orthogonal array.

TABLE I CONTROLLABLE PROCESS PARAMETER WITH THEIR LEVELS

| Sr. No. | Process Parameter | Levels | | |
|---|---|---|---|---|
| | | Level 1 | Level 3 | Level 3 |
| 1. | Spindle Speed (rpm) | 244 | 314 | 424 |
| 2. | Feed Rate (mm/rev) | 0.10 | 0.25 | 0.50 |
| 3. | Depth of Cut (mm) | 1.0 | 1.5 | 2.0 |

TABLE II ORTHOGONAL ARRAY

| Spindle Speed (rpm) | Feed Rate (mm/rev) | Depth of Cut (mm) |
|---|---|---|
| 244 | 0.10 | 1.0 |
| 244 | 0.25 | 1.5 |
| 244 | 0.50 | 2.0 |
| 314 | 0.10 | 1.0 |
| 314 | 0.25 | 1.5 |
| 314 | 0.50 | 2.0 |
| 424 | 0.10 | 1.0 |
| 424 | 0.25 | 1.5 |
| 424 | 0.50 | 2.0 |

## IV. EXPERIMENTAL RESULT AND DISCUSSION

Experiment is conducted on 9 specimens of SM45C. Following results are obtained from experiment.

TABLE III ORTHOGONAL ARRAY AND THEIR RESULTS

| Sr. No. | Controllable Parameter | | | Response Result | | S/N Ratio | |
|---|---|---|---|---|---|---|---|
| | Spindle Speed (rpm) | Feed Rate (mm/rev) | Depth of Cut (mm) | Surface Roughness Ra | Material Removal Rate ($mm^3$ /min) | Surface Roughness (Ra) | Material Removal Rate ($mm^3$ /min) |
| 1. | 244 | 0.10 | 1.0 | 2.21 | 1533.1 | -6.8878 | 63.7114 |
| 2. | 244 | 0.25 | 1.5 | 2.46 | 5749.1 | -7.8187 | 75.1920 |
| 3. | 244 | 0.50 | 2.0 | 2.71 | 15331.0 | -8.6594 | 83.7114 |
| 4. | 314 | 0.10 | 1.0 | 3.64 | 2959.4 | -11.2220 | 69.4240 |
| 5. | 314 | 0.25 | 1.5 | 3.11 | 9864.6 | -9.8552 | 79.8816 |
| 6. | 314 | 0.50 | 2.0 | 3.29 | 9864.6 | -10.3439 | 79.8816 |
| 7. | 424 | 0.10 | 1.0 | 3.27 | 5328.1 | -10.2910 | 74.5315 |
| 8. | 424 | 0.25 | 1.5 | 3.44 | 6660.2 | -10.7312 | 76.4697 |
| 9. | 424 | 0.50 | 2.0 | 3.24 | 19980.5 | -1.2109 | 86.0121 |

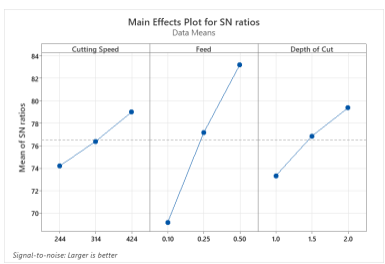


Fig 4 Graph for Material Removal Rate

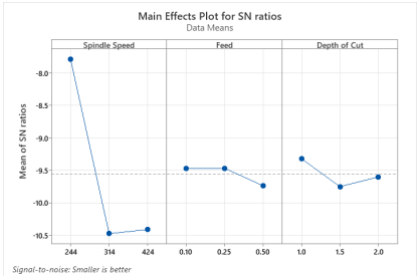


Figure 5 Graph for Surface Roughness

## V. CONCLUSION

This paper focused on study of Taguchi method application of optimization of turning parameter. Taguchi method quite and easily apply in industrial work. By Taguchi optimization method we calculate optimization parameter for turning of SM45C i.e. Spindle speed 244, Feed Rate 0.50 and Depth of Cut 1.0 is optimize parameter for surface roughness also for material removal rate Spindle speed 424, Feed rate 0.50 and Depth of Cut 2.0 is a optimize parameter. By ANOVA Analysis of variance, we find influenced parameter for Surface roughness and Material removal rate is spindle speed and Feed rate simultaneously. ANOVA is used to know the percentage contribution of control process parameters such as Spindle speed is 83.82 % on Surface Roughness and Feed Rate is 75.93 % on the material Removal Rate. Optimization cutting parameter by using this approach which will useful for the industry to optimize the machine performance and reduce wastage.

## ACKNOWLEDGMENT

I take this opportunity to thank all those who have contributed in successful completion of this research work. I would like to express my sincere thanks to my guide Prof. S. S. Waybase who have encouraged me to work on this topic and provided valuable guidance wherever required. I also extend my gratitude to Prof. T. S. Sargar (H.O.D Mechanical Department) who has provided facilities to explore the subject with more enthusiasm.

I express my immense pleasure and thankfulness to all the teachers and staff of the Department of Mechanical Engineering of Smt. Kashibai Navale College of Engineering for their co-operation and support.

## REFERENCES

[1] Manish Kumar, Swapnil Singh, Turning Process Parameter for Lathe Machine Optimization By Using Taguchi Method, International Journal of Innovative Research in Technology and Management, Volume-6, pp. 6-11, 2022

[2] Martoni, Analysis Of Damage And Improvement Of Sledge Cross On Ghb1340g Lathe Machine, Turkish Journal of Computer and Mathematics Education,

Volume12, pp. 963-972, 2021

[3] Miss. P. T. Jarag, Prof. P. B. Patole, Prof G. J. Pol, Study of Effect of Process Parameters on Quality of Workpiece in Turning Operation - A Review, International journal of advanced research in science and engineering, Volume 07, pp. 928-935, 2018

[4] Mr. S.R. Meshram, Dr C.L. Prabhune, Optimization of Lathe Machine Parameter of Turning Hardened Material IS 2062:2011 E250 Grade A for Surface Roughness and MRR, International Journal of Engineering Technology Science and Research, Volume 4, pp. 1108-1116, 2017

[5] Dhananjay Uttam Kadam, Suraj P. Ghorpade, Mangesh D. Indalkar, Sourabh R. Ingawale, Suyash D. Kudchadkar, Prof. K. K Bhosale, Prof. R. V Salunkhe, Parameter Optimization Using CNC Lathe Machining, International Journal of Advance Research, Ideas and Innovations in Technology, Volume 3, pp. 817- 822,2017

[6] Kwang-Hyeon Lee, Secong-Won, Tae-jin Yppn, Chung-Yun Kang, Microstructure and hardness of surface melting hardened zone of mold steel, SM45C using Yb:YAG Disk, Volume 34 pp, 75- 81, 2016