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Optimization of Surface Roughness For Turning Operation in Lathe Using Taguchi Method

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ABSTRACT : In this project the cutting of MS material using lathe by Taguchi methodology. Taguchi method is used to formulate the experimental layout. A Taguchi L9 design of experiment (DOE) will be applied and the analysis of variance (ANOVA) will be carried out to determine the effect of process parameters on process performance. To analyse the effect of each parameter on the machining characteristics and to predict the optimal choice for each parameter such as SPEED, FEED, DEPTH OF CUT. It will be found that these parameters have a significant influence on machining characteristics such as surface roughness and metal removal rate test is conducted to validate the test result.

KEYWORDS: turning process, surface roughness, Taguchi method, ANOVA, regression analysis.

I.INTRODUCTION

This project is to investigate the Lathe Machine optimum cutting speed for the three chosen parameters. Impact of cutting parameters that affect surface roughness suggest us that among cutting parameters (cutting speed, feed rate, and depth of cut), cutting speed has the biggest impact on the surface roughness. Cutting speed is defined as the speed at which the work progresses with respect to the tool. Feed rate is defined as the distance the tool travels during one revolution of the part. The primary factor in choosing feed and speed is the material to be cut. However, one should also consider material of the tool, rigidity of the work piece, size and condition of the lathe, and depth of cut. In high-volume production (cycle time), reliability (tool life), and product quality (surface finish). In addition, production parameters become critical in high-volume production since they directly impact the overall order fulfillment. Mild steel.

In turning, surface roughness which requires attention both from industry as well as research & development point of view. In modern industry, one of the trends is to manufacture low cost, high quality products in short time. Automated and flexible manufacturing systems are employed for that purpose. On the other hand another production rate and cost. So, there is a need for a tool that allows the evaluation of the surface roughness and material removal rate before the machining of the part and which, at the same time, can easily be used in the production-floor environment contributing to the minimization of required time and cost and the production of desired surface quality.

II. MATERIALS AND METHODS

Material

ArcelorMittal offers a wide range of mild steels. Depending on the formability requirements the appropriate sheet steel grade may be selected. Steel grades range from commercial steel (CS), which have the reasonable formability to grades like extra deep drawing steel plus (EDD PLUS) which offers superior formability. All of these grades are low carbon grades. Some of the highly formable steels contain ultra-low levels of carbon and are fully stabilized with micro

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alloying elements like titanium and/or niobium. These steels are also commonly known as interstitial free steels, i.e. these steels have no free interstitially available carbon or nitrogen.

Mechanical Properties of Mild Steel

Fatigue Strength Coefficient (MPa)	1067
Fatigue Ductility Coefficient	0.384
Fatigue Strength Exponent	-0.145
Fatigue Ductility Exponent	-0.531
Cyclic Strength Coefficient (MPa)	885
Cyclic Strain Hardening Exponent	0.198

Table.1. Mechanical properties of Mild steel

Experimental procedure

The scope and objectives of the present work have already been mentioned in the forgoing chapter. Accordingly the present study has been done through the following plan of experiment.

- Checking and preparing the Centre Lathe ready for performing the machining operation.
- Cutting MS bars by power saw and performing initial turning operation in Lathe to get desired dimension of the work pieces.
- Calculating weight of each specimen by the high precision digital balance meter before machining.
- Performing straight turning operation on specimens in various cutting environments involving various combinations of process control parameters like: spindle speed, feed and depth of cut.
- Calculating weight of each machined plate again by the digital balance meter.
- Measuring surface roughness and surface profile with the help of a portable stylus type profile meter, Taly surf (Taylor Hobson, Surtronic3+, UKg) Measuring cutting tool flank wear in tool makers microscope.

Taguchi Method

Taguchi Method was proposed by Genichi Taguchi, a Japanese quality management consultant. The method explores the concept of quadratic quality loss function and uses a statistical measure of performance called signal to noise (S/N) ratio. It is the ratio of the mean (Signal) to the standard deviation (Noise). The ratio depends on the quality characteristics of the product/process to be optimized (Peace, 1993). The optimal setting is the parameter combination which has the highest S/N ratio. Based on the signal to noise (S/N) analysis, the signal to noise (S/N) ratio for each level of process parameters are computed. Larger S/N ratio corresponds to better performance characteristics, regardless of their category of performance. It means that the level of process parameters with the highest S/N ratio corresponds to the optimum level of process parameters.

Taguchi method is usually used in an analysis that uses a lot of factor low than two will use the factorial design. When the total factors have been more than two, the number of experiment also will increase, and then the solution will be used Taguchi method. The flow of process when analysis by using Taguchi method. Taguchi Methods is a system of cost driven quality engineering that emphasizes the effective application of engineering strategies rather than advanced statistical technique. It includes both upstream and shop floor quality engineering. Upstream methods efficiently use small scale experiments to reduce variability and find cost effective, robust designs for large scale production and the market place. Shop floor techniques provide cost based, real time methods for monitoring and maintaining quality in production. Taguchi Methods allow a company to rapidly and accurately acquire technical information to design and produce low cost, highly reliable products and processes. Its most advanced

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Applications allow engineers to develop flexible technology for the design and production of families of high quality products, greatly reducing research, development and delivery time.

In general, the further upstream a quality method is applied, the greater leverage it produces on the improvement, and it reduces the cost and time. Most typical applications on Taguchi Methods thus far have centered around two main areas:

1. Improving an existing product
2. Improving a process for a specific product

Tremendous additional benefits can be derived from improving the robustness of generic technology in (R&D) so that it is applicable to a family of present and future products and processes. This application called Robust Technology Development is currently being practiced by only a few leading companies worldwide. Farther downstream, Taguchi method for what he terms on line quality control can achieve a more cost effective process control. Taguchi Method requires a new way of thinking about product development. These methods differ from others in that the method for dealing with quality problems center on the design stage of product development and express quality and cost improvement in monetary terms.

The DOE with Taguchi approach is divided into three main phase

1. Planning phase
2. Conducting phase
3. Analysis phase

Planning Phase

The planning phase is the most important phase for experiment to provide the expected information. Sometimes the information from the experiment is in positive or negative sense. Positive information is an indication of which factor and which level lead to improve or process performance. Negative information is an indication of which factor don't lead to improvement. In the planning phase the factors and levels are selected therefore the planning phase is the most important phase of the experiment. Also the correct selection of factors and levels is non statistical in nature and is dependent upon product and process expertise.

Analysis Phase

The analysis phase is when the positive or negative information concerning the selected factors and levels is generated based on the previous two phase. In summary, this project attempts to optimize the cutting parameters using Taguchi technique for the wire electrical discharge machining of titanium material with the objective of obtaining a better surface finish. Analysis of variance for s/n ratio (software) .The analysis of variance are used to identify the most significant process parameter for affecting the Surface Finish by using MINITAB 15

Select the Level for the Factors

Parameter	Units	Level 1	Level 2	Level 3
Speed	(N) (RPM)	400	650	900
FEED	(mm/rev)	5.2	6.2	7.2
DOC	(d) (mm)	0.5	1.0	1.5

Table 2 Level for the Factors

Select the Appropriate Orthogonal Array

Experiment No	Level 1	Level 2	Level 3
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3
6	2	3	1
7	3	1	2
8	3	2	3
9	3	3	1

Table 3 Appropriate Orthogonal Array

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Assign the Factors to the Orthogonal Array

Experiment No	Speed(rpm)	Feed(mm/rev)	DOC(d) (mm)
1	400	5.2	0.5
2	400	6.2	1.0
3	400	7.2	1.5
4	650	5.2	1.0
5	650	6.2	1.5
6	650	7.2	0.5
7	900	5.2	1.5
8	900	6.2	0.5
9	900	7.2	1.0

Table 4 Assigns the Factors to the Orthogonal Array

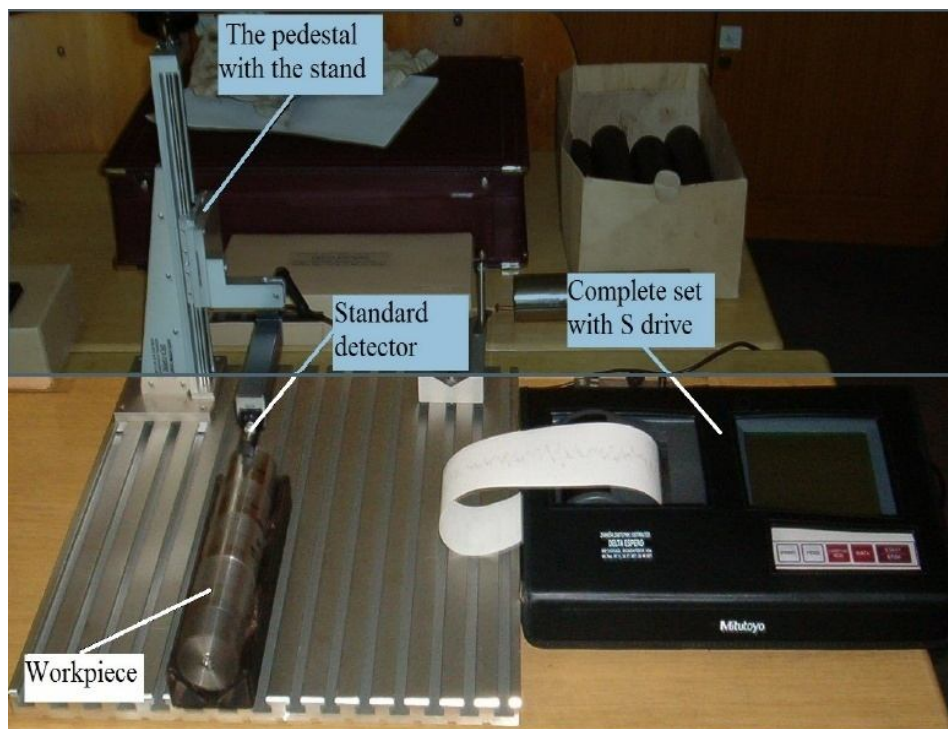


Fig.1. Surf Test SJ-400 Surface Roughness Testing Machine

III RESULT& DISCUSSION

The below table shown L9 orthogonal array for surface roughness cut length 2mm, with a diameter of shaft 30mm. the result show mean Ra value and S/N Ratio for Mild steel.

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L9 Orthogonal Array for Surface Roughness

S.NO	SPEED(RPM)	FEED(mm/rev)	DOC(mm)	RA(m)	S/N RATIO
1	400	5.2	0.5	3.980	-11.9977
2	400	6.2	1.0	5.380	-14.6156
3	400	7.2	1.5	7.271	-17.2319
4	650	5.2	1.0	6.976	-16.8721
5	650	6.2	1.5	6.728	-16.5577
6	650	7.2	0.5	4.290	-12.6491
7	900	5.2	1.5	4.400	-12.8691
8	900	6.2	0.5	1.150	-12.3610
9	900	7.2	1.0	4.020	-12.0845

Table.4.L9 Orthogonal Array for Surface Roughness

Main effect of Plot (Data Mean) for S/N ratio (software)

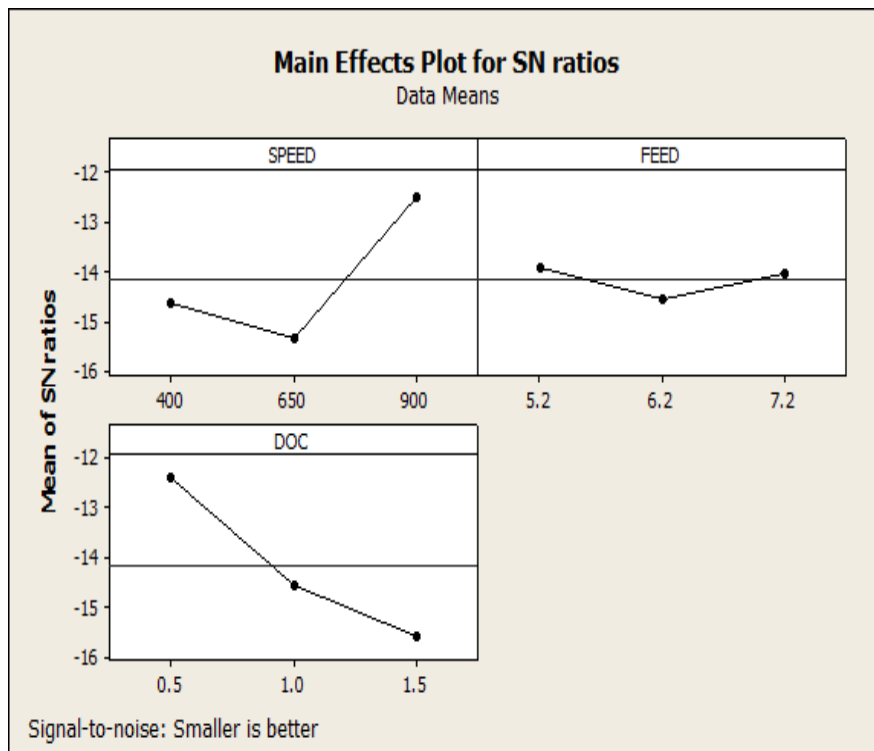


Fig.3.Main effect of plot (Data mean) for S/N Ratio (software)

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Main Effect Plot for Means (Software)

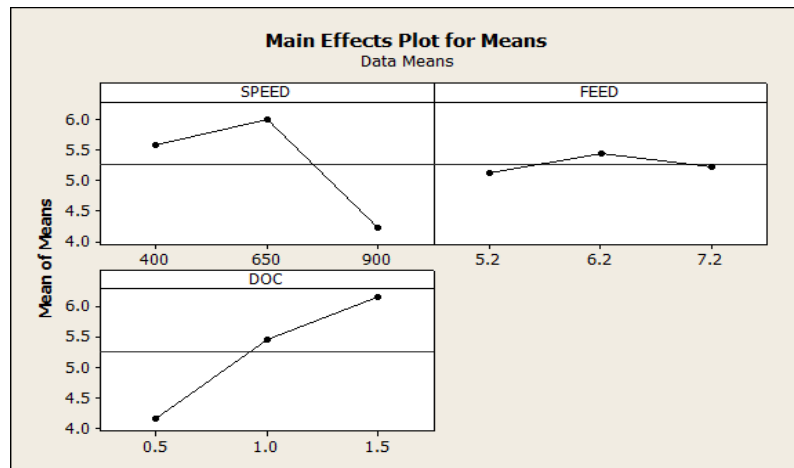


Fig.4.Main effect plot for means (Software)

MEAN EFFECT OF SPEED, FEED, DOC TABULATION

LEVEL	SPEED	FEED	DEPTH OF CUT
L1	-14.161	-13.907	-13.540
L2	-15.257	-14.045	-12.653
L3	-12.438	-13.999	-15.497

Table.5.Mean Effect Of Speed, Feed, Doc Tabulation

Analysis of Variance for S/N Ratio (Software)

SOURCE	DOF	SEQ SS	ADJ SS	ADJ MS	F
A	2	2849.362	2949.362	1424.681	164.3
B	2	2896.203	2896.203	1448.101	167.0
C	2	2510.627	2510.627	1255.313	144.7
Residual error		0.351		0.315	
Total		8256.541		8256.541	

Table 6 Analysis of Variance for S/N Ratio (Software)

IV CONCLUSION

On the basis of experimental result, calculated S/N ratio, analysis of variance the following conclusions for machining of mild steel. speed is the most significant parameter for surface roughness for mild steel material. For better surface finish the parametric combinations is speed 900 Rpm, Feed 5.2(mm/rev) DOC 0.5 (mm) for machining of material. Based on minimum number of experiments conducted to arrive at the optimum cutting parameters, Taguchi's method seems to be an efficient methodology to find the optimum cutting parameter.

From the above results the lathe machine operators avoid the trial and error method. Using the optimal cutting parameters for machining of Mild steel material it gives better surface finish. Reduce machining cost, setting time, material wastage etc.

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