Volume : 2 | Issue : 4 | April 2013 • ISSN No 2277 - 8160

Research Paper | Engineering

Parametric Investigation of Turning Process on Mild Steel AISI 1018 Material

J. M. Gadhiya — L. D. College of Engineering Mechanical Department, Navrangpura, Ahmedabad-15

P. J. Patel — L. D. College of Engineering Mechanical Department, Navrangpura, Ahmedabad-15

ABSTRACT

Turning is widely used machining process in today's industrial requirement. In the present research, the effect of CNC lathe machine processing parameters such as speed, feed and depth of cut effect on measured response such as surface roughness. The experiment was designed according to full factorial with three different level of each input parameter. For result interpretation, analysis of variance (ANOVA) was conducted and optimum parameter is selected on the basis of the signal to noise ratio, which confirms the experimental result. The result indicated that cutting speed and Feed play important role in surface roughness.

KEYWORDS : Turning, Mild steel, Full factorial design, Analysis of variance.

1 Introduction:

In manufacturing, the process of removing unwanted segment of metal work piece in the form of chips is known as machining. Machining is one of the five groups of manufacturing processes which includes casting, forming, powder metallurgy and joining. Turning is a machining process in which a cutting tool, typically a non-rotary tool bit, describes a helical tool path by moving more or less linearly while the workpiece rotates. The tool's axes of movement may be literally a straight line, or they may be along some set of curves or angles, but they are essentially linear.

Turning can be either on the outside of the cylinder to produce tubular components to various geometries. Although now quite rare, early lathes could even be used to produce complex geometric figures, even the platonic solids; although since the advent of CNC it has become unusual to use non-computerized tool path control for this purpose. Computerized numeric controlled (CNC) machine could able to increase its productivity or profit for the manufacturing industry because of its ability to finish a job in minimum possible time and also achieves greater savings in money. [1]

2. Literature review:

Surface roughness is an effective parameter representing the quality of machined surface. Kopac J. et al. [2] analyzed the influences of workpiece material and the machining parameters on surface roughness. They show the experimental results which machining parameters can to be used at for different combinations of cutting tool and workpiece material for the achievement of the desired roughness of the machined surface. Yang W. H. et al. [3] used the Taguchi method for determining optimum cutting parameters. They machined S45C steel work piece with carbide cutting tools. The cutting parameters chosen were cutting speed, feed rate and depth of cut. They show that tool life and surface roughness can be improved significantly for turning operations. The confirmation experiments were conducted to verify the optimal cutting parameters. Kopac J. et al. [4] conducted an experiments to analyze the influence of workpiece material properties, cutting parameters, and TiN (PVD) hard coating on the surface roughness of fine-turned workpieces. The analysis of influence of each control factor on surface roughness has been performed with signal-to-noise response method. They concluded the optimized values of machining parameter from the S/N table to achieve the fine-surface roughness. The feed and the depth of cut also affect the surface roughness of the machined part. Benardos P. G. et al. [5] aims at the various methodologies and practices that were employed for the prediction of surface roughness. They were classified in different approaches based on machining theory, experimental investigation, designed experiments and artificial intelligence (AI). It was also be noted that factors such as the cutting tool's deflection or the thermal conditions could be introduced for a more realistic depiction of surface roughness creation. Bouzid W. [6] conducted the experiments with four types of inserts in which three chemical vapor deposition coated inserts and one ceramic tool. The method uses empirical models for tool life, roughness and cutting forces. The obtained results indicate that the described method was capable of selecting the appropriate conditions. Kirby E. D. et al. [7] used a fuzzy-nets modeling technique for predict the surface roughness for a turning operation. It was observed that the sensor and modeling methods selected had a good potential both for prediction and adaptive control for surface roughness in turning operations. Tjeng C. et al. [8] investigated the optimization of CNC turning operation parameters for SKD11 (JIS) using the Grey relational analysis method. Nine experimental runs based on an orthogonal array of Taguchi method were performed. The depth of cut was identified to be the most influence on the roughness average and the cutting speed was the most influential factor to the roughness maximum and the roundness. Asilturk I. et al. [9] studied the effect of cutting parameter on surface roughness by conducting the experiments using the L9 orthogonal array in CNC turning machine. Variance analysis was applied to S/N ratios to discover interactions between cutting parameters relating to Ra and Rz. According to the ANOVA analysis, the feed rate has an effect on Ra and Rz at a reliability level of 95%. Any difference was not observed for the cutting speed and the depth of cut at the reliability level of 95%.

3 Experimental Setup

3.1 Experimental Set-Up and material

STC-200 CNC, lathe machine is used for experiment work. The insert of tungsten carbide is used for the machining experiment. The length of the work piece was 270 mm and 68 diameter and 10 mm slot of the bar for experiment and surface measurement. Surface roughness measured using portable profile meter of Mitutoyo, Model: SJ 201P. In table 1 shows the mechanical properties of materials.

Mechanical properties on Mild Steel (AISI 1018)			
Yield strength, Mpa	Tensile strength, Mpa	Elongation %	HBW
370	440	15	126

3.2 Control parameters and Range Selection

The experiment is conducted by varying three parameters and their values are given in the table 3.Due to present of high magnesium content require high surface hardness to cut so, low cutting speed and feed were selected for Mild steel AISI 1018.

Symbol	Factor	Unit	Mild steel (AISI 1018)
A	Speed	RPM	250,500,750
B	Feed	mm/min	0.05,0.1,0.15
C	Depth of cut	mm	0.4,0.7,1.0

TABLE: 2 PROCESS PARAMETERS AND THEIR LEVELS

4 Results and Discussion

4.1 Analysis of Variance (ANOVA):

The purpose of ANOVA experimentation is to reduce and control the variation of a process; subsequently, decisions can be made concerning which parameters affect the performance of the process. ANOVA is the statistical method used to interpret experimental data to make the necessary decisions. Through ANOVA, the parameters can be categorized into significant and insignificant machining parameters. Here in

this analysis 95% confidence level is used. ANOVA analysis carried out in Minitab software and the results are shown here. The table 4 shows the p-value known as probability value is less than 0.06 (alpha value), which signifies that all the parameters are significant.

4.2 Signal to noise ratio (S/N Ratio):

According to Taguchi method, the S/N ratio is the ratio of signal to noise where signal represents the desirable value (i.e., the mean for the output characteristics), and noise represents the undesirable value (i.e., the square deviation for the output characteristics). Therefore, the S/N ratio is the ratio of mean to square deviation. It is denoted by 'η' with a unit of dB. Depending on the criterion for the quality characteristic to be optimized, different S/N ratios can be chosen: smaller-the-better, larger-the-better, and nominal-the-best. Regardless of the category of the performance characteristic, the larger algebraic value of S/N ratio corresponds to the better performance characteristic, and hence the optimal level of the parameter is the level with the highest S/N. For surface roughness smallest is the better.

$$S/N = \eta = -10 log\left(\frac{1}{n}\sum_{i=1}^{n} y_i^2\right)$$

Where, Yi is the i-th observed value of the response, and n is the number of observations in a trial.

4.3 Result discussion for mild steel:

Sr. No.	A. Speed, RPM	B. Feed, mm/min	C. Depth of Cut, mm	Surface Roughness (Ra), µm	S/N Ratio for Ra
1.	250	0.05	0.7	3.285	-10.3316
2.	250	0.10	0.7	1.580	-3.9713
3.	250	0.15	0.7	2.124	-6.5417
4.	500	0.05	0.7	2.421	-7.6799
5.	500	0.10	0.7	1.286	-2.1871
6.	500	0.15	0.7	1.707	-4.6464
7.	750	0.05	0.7	1.956	-5.8289
8.	750	0.10	0.7	1.002	-0.0174
9.	750	0.15	0.7	1.188	-1.4963
10.	250	0.05	0.4	3.132	-9.9155
11.	250	0.10	0.4	2.217	-6.9140
12.	250	0.15	0.4	2.264	-7.0988
13.	500	0.05	0.4	2.664	-8.5107
14.	500	0.10	0.4	1.239	-1.8614
15.	500	0.15	0.4	1.309	-2.3388
16.	750	0.05	0.4	1.537	-3.7354
17.	750	0.10	0.4	1.080	-0.6685
18.	750	0.15	0.4	1.157	-1.2642
19.	250	0.05	1.0	2.479	-7.8844
20.	250	0.10	1.0	1.561	-3.8681
21.	250	0.15	1.0	2.006	-6.0466
22.	500	0.05	1.0	1.322	-2.4268
23.	500	0.10	1.0	1.114	-0.9377
24.	500	0.15	1.0	1.518	-3.6235
25.	750	0.05	1.0	1.413	-3.0049
26.	750	0.10	1.0	1.378	-2.7829
27.	750	0.15	1.0	0.964	0.3185

TABLE: 3 SURFACE ROUGHNESS AND S/N RATIO

From table 4, it is seen that R2 value is 82.68% which indicates the model used for the analysis is appropriate. The difference between the R2 (adjusted) and R2 (predicted) is also very low which is desirable. Value of p is also less than 0.06 which indicates that all parameter are significant for surface roughness.

Source	DF	Seq SS	Adj SS	Adj MS	F	P
A. Speed	2	4.65	4.66	2.33	24.9	0
B. Feed	2	3.66	3.66	1.84	19.6	0
C. Depth of cut	2	0.59	0.59	0.3	3.1	0.06
Error	20	1.87	1.87	0.09		
Total	26	10.78				
S = 0.30553 R-Sq = 82.68% R-Sq(adj) = 77.48%						

TABLE: 4 ANOVA ANALYSIS FOR MILD STEEL

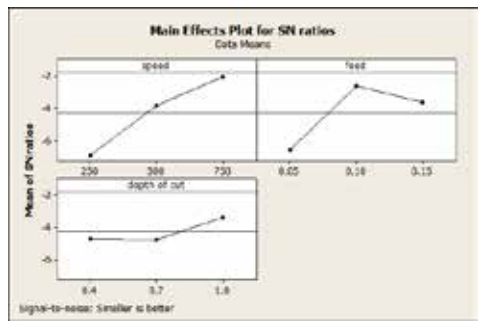

FIGURE: 1 MAIN EFFECT PLOT FOR S/N RATION FOR MILD STEEL

From figure 1, we can directly find out the optimum parameter where get small surface roughness. As seen the optimum value for conducted experiment result with parameter level speed (A3), feed (B3) and depth of cut (C3), which gives 0.964 µm.

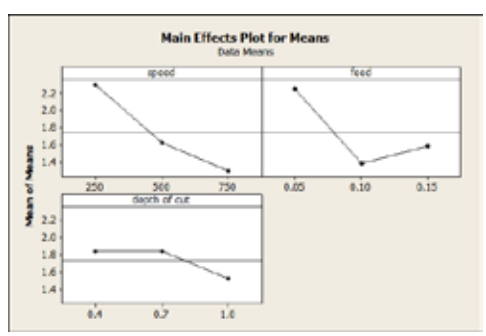

FIGURE: 2 MAIN EFFECT PLOT FOR MEANS FOR MILD STEEL

5 Conclusions

From conducted experiment of Turning cutting on Mild steel, varying Speed, feed and depth of cut gives following conclusion.

1. Cutting speed and feed have high contribution on surface roughness for Mild steel.
2. Depth of cut had less effect for surface roughness.
3. The S/N ratio suggests the optimum parameter setting for selected operating rage of experiment.

REFERENCES

[1] "Turning," [Online]. Available: http://en.wikipedia.org/wiki/Turning. | [2] J. Kopac and M. Bahor, "Interaction of the technological history of a workpiece material and the machining parameters on the desired quality of the surface roughness of a product," Journal of Materials Processing Technology, pp. 381-387, 1992-93. | [3] W. Yang and Y. Tarng, "Design optimization of cutting parameters for turning operations based on the Taguchi method," Journal of Materials Processing Technology, pp. 122-129, 1998. | [4] J. Kopac, M. Bahor and M. Sokovic, "Optimal machining parameters for achieving the desired surface roughness in fine turning of cold pre-formed steel workpieces," International Journal of Machine Tools & Manufacture, pp. 707-716, 2002. | [5] P. G. Benardos and G. C. Vosniakos, "Predicting surface roughness in machining: a review," International Journal of Machine Tools and Manufacture, pp. 833-844, 2003. | [6] W. Bouzid, "Cutting parameter optimization to minimize production time in high speed turning," Journal of Materials Processing Technology, pp. 388-395, 2005. | [7] E. D. Kirby and J. C. Chen, "Development of a fuzzy-nets-based surface roughness prediction system in turning operations," Computers & Industrial Engineering, pp. 30-42, 2007. | [8] C.-J. Tzeng, Y.-H. Lin, Y.-K. Yang and M.-C. Jeng, "Optimization of turning operations with multiple performance characteristics using the Taguchi method and Grey relational analysis," journal of materials processing technology, pp. 2753-2759, 2009. | [9] I. Asiltürk and H. Akkus, "Determining the effect of cutting parameters on surface roughness in hard turning using the Taguchi method," Measurement, pp. 1697-1704, 2011.