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Analysis of Force Affecting in Turning Operation based on MRR

Devendra Verma[1], Vishnu Rajpuriya[2]
[1]Research Scholar, GD-Rungta College of Engineering & Technology, INDIA
[2]Assistant Professor, GD-Rungta College of Engineering & Technology, INDIA

ABSTRACT

The present work performance of multi-layer coated tool in machining of hardened steel (AISI 4340 steel) under high speed turning. The influence of cutting parameters (speed, feed, and depth of cut) on cutting forces and surface finish has been analysed. Under the different cutting conditions, forces were measured using dynamometer. The results indicate that the depth of cut is the dominant factor affecting cutting force components. The depth of cut influences tangential cutting force more than radial and axial forces. The cutting speed affect stangential force more thanra dial and axial forces. Result can be predicted the parameter of cutting force to increase MRR by ANOVA method.

Keywords-- Cutting Force, MRR, turning

I. INTRODUCTION

The present work deals with the turning of hard material such as AISI 4340 steel. It is an important engineering material employed in manufacturing of components in auto and aerospace industries. Since the present trend in the manufacturing industry is high speed dry machining, it was applied to evaluate the performance of coated tools in typical manufacturing processes. Tool coatings were traditionally deposited using the CVD technique until the recent development of PVD. This method deposits thin films on the cutting tools through physical techniques, mainly sputtering and evaporation. Coatings are diffusion barriers, they prevent the interaction between chip formed during the machining and the cutting material itself. The compounds which make up the coatings used are extremely hard and so they are very abrasion resistant. Typical constituents of coating are Titanium Carbide(TiC), Titanium Nitride (TiN), Titanium Carbonitride (TiCN) and alumina (Al2O3).All these compounds have low solubility in iron and they enable inserts to cut two le at much higher rate than is or multi-layer.

II. REVIEW WORK AND OBJECTIVE

Mohanty et al The machining with titanium-nitride coated carbide tool at 0.18 mm/rev and DOC of 1.5 mm resulted in greater amount of both tangential (P_z) and axial force (P_x) than that uncoated carbide tools. Machining of Steel 3 type required lesser force compared to other two grades of cast austenitic stainless steel [1].Machining at low cutting speed and at high feed rates the chip of low curl radii was obtained with high chip thickness [2].The chip curl radius and chip thickness increases with increase in the cutting speed. At lower cutting speed the chips obtained is of yellow color, brittle color chips are obtained at higher speed [3].With increase in both cutting speed and the feed rate there occurred a transition of chip to segmented type from continuous type [4]. A separate investigation also reported that surface roughness decreased with increase in the cutting speed. At lower cutting speeds the formation of built-up edge (BUE) deteriorates the surface finish which improves gradually with increase in speed as atthe high speeds the BUE formation is retarded due to less contact time between the chip-tool interfaces [5]

Increasing the productivity and the quality of the machined parts are the main challenges of manufacturing industries, on the basis of literature review objective is listed below

- The influence of cutting parameters (speed, feed, and depth of cut) on cutting forces and surface finish has been analyzed. Under the different cutting conditions.
- 27 experiments based Full Factorial design was used to study cutting force (Fx, Fy and Fz) and Material removal Rate (MRR) of turning on hardened mild steel work-piece.
- Full Factorial function was adopted to optimize the turning process with multiple performance characteristics. The machining parameters setting of were found by using ANOVA for analysis of variance table for maximum cutting force and minimum MRR.

III. MATERIAL AND METHOD

The work piece material used for the experiments is mild steel of standard dimensions was used for machining with 45 mm diameter, 175 mm long and Its chemical composition is given in table1

Table 1 Chemical composition of AISI 4340

Component	*Composition in %*
C	*0.382*
Si	*0.228*
Mn	*0.609*
P	*0.026*
S	*0.022*
Cr	*0.995*
Ni	*1.514*
Mo	*0.226*
Fe	*95.998*

Cutting Conditions and Experimental Procedure

Since the present trend in the manufacturing industry is high speed dry machining, among the speed and feed rate combinations available on the Lathe, three levels of cutting parameters were selected. The selection of parameters of interest was based on some experiment preliminary .The following process parameters were thus selected for the present work: a) Cutting speed (A), b) Feed rate – (B), c) Depth of cut – (C), given in table 2

Table 2 Factors and their Levels

Factor	*Level 1*	*Level 2*	*Level 3*
A: Speed (rpm)	*120*	*210*	*310*
B: Feed (mm/rev)	*0.1*	*0.2*	*0.3*
C Depth 0fCut (mm)	*0.1*	*0.3*	*0.5*

Specification of the Lathe Machine & W/P Setup:

Turning experiments were carried out at four different cutting speeds which were 120, 210 and 310 m/min(*v*) and Feed rates were 0.1, 0.2, 0.3 mm/rev (*f*) and depth of cut (*d*) was kept constant at 0.1, 0.3, 0.5 mm throughout the experiments. This small depth of cut was used for finish turning. The lathe used for machining operations is Royal Machine Tool Centre Lathis shown in Figure 1 and their specification listed in table 3.

Table 3. Specification of the Lathe machine

Name	*Royal Machine Tool Centre Lath*
Manufactured by	*Industrial Instruments Bangalore*
Power of the motor	*7 KW, 5 HP*
Centre height	*175mm*
Swing over Bed	*350mm*
Accuracy	*0.1mm*
Range of spindle speed	*120-300rpm*

Fig. 1 Centre Lathe

The photographic view of the experimental setup is shown in Fig 2.

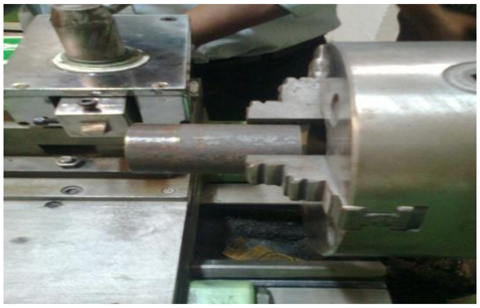

Fig.2 Work piece Setup

Measurement of Cutting Force

The forces acting on a tool are an important aspect of machining for studying the machinability conditions and lath tool dynamometer are shown in fig 3. Knowledge of the cutting forces is needed to estimate the power requirements and ensure that the machine tool elements, tool-holders, and fixtures are adequately rigid and free from vibrations. Measurements of the tool forces are helpful in optimizing the tool design. Cutting force is also one of the major criteria for determining the machinability index of any work-piece during the machining. The measurement of the cutting forces will help in:

<u>Force components measured in turning tests:</u>

F_x: axial component of force-The effect of feed force during machining is of least significant and is generally harmless.

Fig. 3 Lathe Tool dynamometer

Material Removal Rate (MRR) Measurement:

The challenge of modern machining industries is mainly focused on the achievement of high quality, in terms of work piece dimensional accuracy, high surface finish, high production rate, Chip formation, less tool wear on the cutting tools, economy of machining in terms of cost saving and increase the performance of the product with reduced environmental impact. MRR of the machined chip is an important quality measure in metal cutting, and it is important to monitor and control during the machining operation.

Chip mechanism:

Machining is practically a material removal process from a given workpiece material to get desired shape with high dimensional accuracy and surface integrity.Machining generallyinvolves gradual removal of material in form of chip are shown in Fig 4.

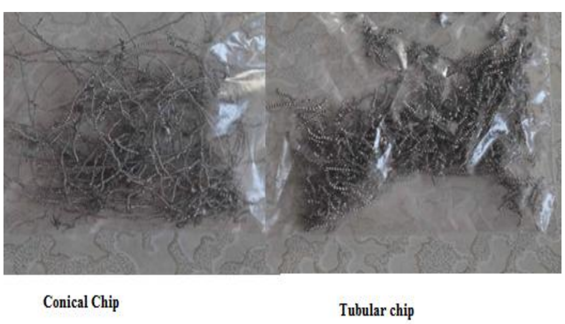

Fig 4 Chips By turning machine

IV. RESULT

The results of analysis of variance (ANOVA) for axial force F_x are shown in table 5.2 This table also shows the degrees of freedom (Df), F-values means ratio of variance and probability (P-VAL.) each factor and different interactions . A low P-value (≤0.05) indicates statistical significance for the source on the corresponding response (i.e., α = 0.05, or 95% confidence level), this indicates that the obtained models are considered to be statistically significant, which is desirable; as it demonstrates that the terms in the model have a significant effect on the response. The other important coefficient, R-Squared, which is called coefficient of determination in the resulting ANOVA tables, is defined as the ratio of the explained variation to the total variation and is a measure of the fit degree. When R-Squared approaches to unity, it indicates a good correlation between the experimental and the predicted values.

Table 5.2 -Analysis of variance table

Source	SS	Df	MS	F Value	P-Value Prob> F
Model	8297.66	6	1382.94	1.29	0.3056
A-V	2320.23	2	1160.12	1.08	0.3574
B-F	23.60	2	11.80	0.011	0.9890
C-D	5472.17	2	2736.08	2.56	0.1027
Residual	21411.38	20	1070.57		
Lack of Fit	21043.91	19	1107.57	3.01	0.4286
Pure Error	367.48	1	367.48		
Cor Total	29709.04	26			

3DSurface plots of F_x: 3d Surface plots of F_x vs. different combinations of cutting regime elements are shown in fig.5. These figures were obtained using Design Expert software according to their mathematical models.

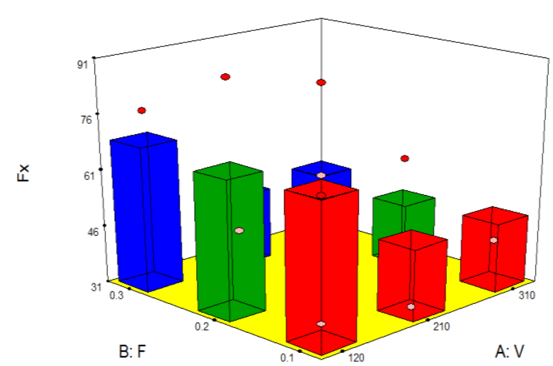

Fig. 5. 3D Solid plot of Fx effect factor V&d

V. CONCLUSION

Full Factorial Design method is found to be a successful technique to perform trend analysis of Cutting Force and MRR in metal cutting with respect to various combinations of design variables (metal cutting speed, feed rate, and depth of cut).The depth of cut influences cutting forces in a considerable way. Its contributions on F_x, are in F value 2.56.

REFERENCE

[1] Lalwani D.I., Mehta N.K., Jain P.K., Experimental Investigations of Cutting Parameters Influenceon Cutting Forces and Surface Roughness in Finish Hard Turning of MDN250 Steel, Journal of Material Processing Technology , 206(1-3) , 167-179 (2007).

[2] Aruna M, Dhanalakshmi V., Response surface methodology in finish turning INCONEL 718, International Journal of Engineering Science and Technology , 2(9) , 4292-4297, (2010)

[3] Fnides B, Yallese M A, Aouici H 2008 Hard turning of hot work steel AISI H11: Evaluation of cutting pressures, resulting force and temperature. Mechanika. Kaunas: Technologija, Nr. 3(77): 68–73

[4] Trent E M metal cutting 2nd edition Butterworth's & Co. London, UK, limited, ISBN 0-408- 34-38, (1984).

[5] A.Devilleza , F.Schneider a, S. DOminiaka, D. Duzinskia , D. Larrouquereb, "Cutting Forces and wear in dry maching of Inconel 718 with coated carbide tools" wear (2007).

[6] Bouacha K., Yallese M.A. Mabrouki T, Rigal J-F 2010 Statistical analysis of surface roughness and cutting forces using response surface methodology in hard turning of AISI 52100 bearing steel with CBN tool. Int. J. Refractory Metals and Hard Materials 28: 349–361.

[7] SupriyaSahuPerfomance Evaluation of Uncoated and Multi layer Tin coated carbide tool in Hard Turning.(2012)

[8] Bradley C., Automated Surface Roughness Measurement, International Journal of Advanced Manufacturing Technology , 16(9) , 668-674 (2000).

[9] Kumar P., Singh N. and Goel P., A multi-objective framework for design of vacuum-sealed molding process, Robotics and Computer Integrated Manufacturing , 15(5) , 413-432 (1999)

[10] Xie L.J., Schmidt J., Schmidt C. and Biesinger F., 2D FEM estimate of tool wear in turning operation, Wear , 258(10) , 1479-1450 (2005)

[11] Lin, W. S. (2008). The study of high speed fine turning of austenitic stainless steel. Journal of Achievements in Materials and Manufacturing Engineering,27(2)

[12] Akasawa, T., Sakurai, H., Nakamura, M., Tanaka, T., & Takano, K. (2003). Effects of free-cutting additives on the machinability of austenitic stainless steels. Journal of Materials Processing Technology, 143, 66-71

[13] Yesilyurt, S. (2004). Investigation of the cutting parameters depending on process sound during turning of AISI 304 austenitic stainless steel. Materials & design, 25(6), 507-513.

[14] Korkut, I., Kasap, M., Ciftci, I., &Seker, U. (2004). Determination of optimum cutting parameters during machining of AISI 304 austenitic stainless steel. Materials& Design, 25(4), 303-305

[15] Chattopadhyay, A.B. " Machining and Machine tools," Wiley India Pvt. Limited, Edition 2011

