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COMPARISON ANALYSIS OF FORCE AFFECTING IN TURNING OPERATION BY SPEED AND FEED ON Y AND Z AXIS

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ABSTRACT

In modern manufacturing processes, there is an ever-increasing demand for higher productivity. The continuous demand for higher productivity and product quality asks for better understanding and control of machining processes by reducing machining time with the increase of cutting force. Response are stored in tabulated form which will suggest about the force predicting parameter are apply on turning application to obtain best process parameter of turning and also comparison the force in Y and Z direction. Under the different cutting conditions, forces were measured using dynamometer. The results indicate comparison offered and speed is the dominant factor affecting cutting force components. The cutting speed effects on Y axis more than Z axial forces can be predicted by ANOVA method.

KEYWORDS— Cutting Force, MRR, turning.

INTRODUCTION

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. 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.

REVIEW WORK AND OBJECTIVE

Huang et al. [1] have evaluated tool performance in terms of tool life based on the flank wear criterion as a function of cutting conditions, that is, cutting speed, feed, and depth of cut. Luo et al [2] have investigated the relationship between hard- ness and cutting forces during turning AISI 4340 steel hardened from 29 to 57 HRC using mixed alumina tools. How- ever, when the workpiece hardness increased above 50 HRC, segmented chips were observed and the cutting force showed a sudden elevation. Rodrigues et al [3] In these studies Effect of Cutting Parameters on Surface Roughness and Cutting Force in Turning Mild Steel. In case of surface roughness, the influencing factors were found to be feed and the interaction of speed and feed. Chou et al [4]. In these studies, only one parameter of the tool geometry has been studied, whereas more than one parameter is found to be significant and they may also have interaction effect on the response parameters. Korkut et al. [5] Second degree model were found to be more significant than the first-degree model. The interaction effects of response parameters were also found to be significant.

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 analysed. Under the different cutting conditions.
- 27 experiment based Full Factorial design was used to study cutting force (Fx, Fy and Fz) 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 effective cutting force.

MATERIAL AND METHOD

The workpiece 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 0f Cut (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 Lath are 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

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 1. 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. The measurement of the cutting forces will obtain in Fy and Fz direction. The effect of feed force during machining is of least significant and is generally harmless.

Fig. 1 Lath Tool dynamometer

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 2.

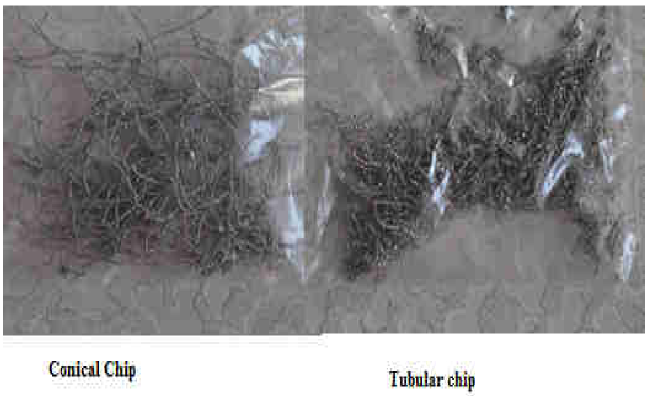

Fig 2 Chips By turning machine

RESULT

The analysis of variance of second order model is shown in table 4The "Model F-value" of 1.23 implies the model is not significant relative to the noise. There is 33.19 % chance that a "Model F-value" this large could occur due to noise.For the linear model, the p-value for lack of fit is 0.129 (>0.05) is not significant with the lack of fit and the f-statistic is 37.09 (>0.05).This implies that the model could fit and it is adequate Non-significant lack of fit is good we want the model to fit.This result shows that cutting speed has the most significant effect on the cutting force, followed by feed rate and depth of cut. The second response model is more precise than first order model, because the predicted result is much more accurate than the first response model.

Table 4 -Analysis of variance table

Source	SS	df	MS	F Value	P-Value Prob>F
Model	18965.87	6	3160.98	1.23	0.3319
A-V	14155.05	2	7077.53	2.76	0.0875
B-F	1049.48	2	524.74	0.20	0.8168
C-D	4603.68	2	2301.84	0.90	0.4236
Residual	51326.30	20	2566.32		
Lack of Fit	51253.58	19	2697.56	37.09	0.1287
Pure Error	72.72	1	72.72		
Cor Total	70292.17	26			

Normal Probability Residuals plot**-:** Normal probability plot of the studentized residuals to check for normality of residuals. Studentized residuals versus predicted values to check for constant error as shown in fig 3

COMPARISON

As we compare the ANOVA table the significant value of speed factor obtains in Y axis because it has lowest P value out of three factors similarly Z axis have their significant factor is feed. So, it is clear that the different axis is also depend on the type of input factor.

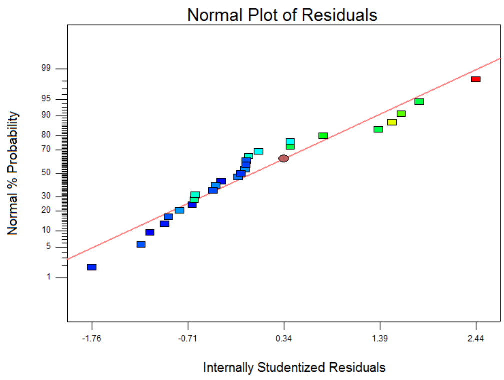

Fig. 3 Normal probability plot of Residuals

3d Surface plots of Fy: 3d Surface plots of Fy vs. different combinations of cutting regime elements are shown in fig. 4. These figures were obtained using Design Expert software according to their mathematical models.

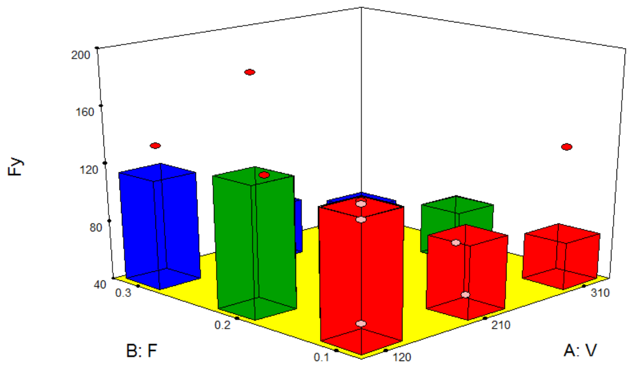

Fig. 4 3D Solid plot of Fy effect factor V&F

The analysis of variance of response Fz model is shown in table 5. The Model F-value of 7.31 implies the model is significant. There is only 0.03% chance that a "Model F-Value" this large could occur due to noise.Values of "Prob > F" less than 0.0500 indicate model terms are significant. In this case B, C are significant model terms.The "Lack of Fit F-value" of 0.95 implies the Lack of Fit is not significant relative to the pure error. There is a 68.32% chance that a "Lack of Fit F-value" this large could occur due to noise. Non-significant lack of fit is good we want the model to fit.

The "Pred R-Squared" of 0.4268 is in reasonable agreement with the "Adj R-Squared" of 0.5930."Adeq Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. Your ratio of 10.307 indicates an adequate signal. This model can be used to navigate the design. It can be noted that the feed is the dominant factor affecting tangential cutting force Fz The second fac- tor influencing Fz is depth of cut For cutting speed, its effect is less significant.

Table 5 Analysis of variance table Fz

Source	SS	Df	MS	F Value	P-Value Prob>F
Model	41236.60	6	6872.75	7.31	0.0003
A-V	5865.48	2	2932.74	3.12	0.0661
B-F	22843.95	2	11421.97	12.15	0.0004
C-D	14598.92	2	7299.46	7.77	0.0032
Residual	18796.79	20	939.84		
Lack of Fit	17806.22	19	937.17	0.95	0.6832
Pure Error	990.57	1	990.57		
Cor Total	60033.29	26			

Normal Probability Residuals plot-: Normal probability plot of the studentized residuals to check for normality of residuals. Studentized residuals versus predicted values to check for constant error as shown in fig 5

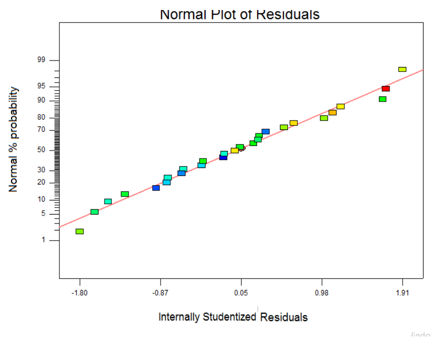

Fig.5 Normal probability plot of Residuals

3D Surface plots for Fz

Fig 6 show 3D surface plots for Fz. These figures were obtained by response surface methodology for different combinations of cutting regime elements according to their mathematical models

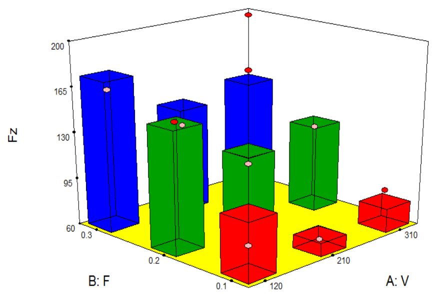

Fig. 6 3D surface plots for Fz effect factor V&F

CONCLUSION

Full Factorial Design method is found to be a successful technique to perform trend analysis of Cutting Force in metal cutting with respect to various combinations of design variables (metal cutting speed, feed rate, and depth of cut). The speed and feed influences cutting forces in a Y and Z axis respectively. Feed is the most significant factor due to its lowest P value that is 0.0004 in Z axis.

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