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Research Article

Optimization of Machining Parameter for Turning of EN 16 Steel

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Abstract

This paper presents the optimization of CNC turning parameters for EN 16 steel bar. Parameters for EN 16 steel bar using tungsten carbide tool. The turning parameters are RPM, feed rate and depth of cut. Based on grey relational grade value, optimum levels of parameters have been identified by using response Table and response graph and the significant contributions of controlling parameters are estimated using analysis of variances (ANOVA).

Keywords: *CNC turning, EN 16 steel, surface roughness and ANOVA*

Introduction

EN 16 is low alloy and high tensile steel and finds its typical applications in manufacturing of automobile Commonly used for general engineering applications EN16 steel is suitable for applications such as high tensile shafts, bolts and nuts, gears, pinions spindles and the like.. Properties of EN16 steel, like low specific heat, good resistance to shock, resistance to wear and excellent ductility. In machining, turning is a most widely used process in which a single point cutting tool removes material from surface of a rotating cylindrical workpiece .Surface roughness (SR) It is important to choose the best machining parameters for achieving optimum performance characteristics for machining process. The desired machining parameters are usually selected with the help of referred handbooks, past experience and various trails. However, the selected machining parameters may not be optimal or near optimal machining parameters metal matrix composites. Also applied analysis of variance (ANOVA) to study the performance characteristics of machining process parameters such as RPM, feed and Depth of cut with consideration of multiple responses, i.e., surface finish, tool wear and tool life.. The present study aims to achieve an optimum combination of machining process parameters considering responses namely surface roughness.

Literature

John *et al*. (2001) demonstrated a systematic procedure of using Taguchi parameter design to optimize surface roughness performance with a particular combination of cutting parameters in an end milling operation. Kopac *et al*. (2002) described the machining parameters influence and levels that provide sufficient robustness of the machining process towards the achievement of the desired surface roughness for cold pre-formed steel work-pieces in fine turning. Ihsan Korkut *et al*. (2004) carried turning tests to determine optimum machining parameters for machining of austenitic stainless steel. Ciftci (2006) investigated the machining characteristics of austenitic stainless steels (AISI 304 and AISI 316) using coated carbide tools. Zhang *et al*. (2007) have used Taguchi method for surface finish optimization in end milling of Aluminum blocks. G. Akhyar *et al*. (2008) optimized cutting parameters in turning Ti-6%Al-4%V extra low interstitial with coated and uncoated cemented carbide tools under dry cutting condition. Anirban Bhattacharya *et al*. (2009) estimated the effect of cutting parameters on surface finish and power consumption during high speed machining of AISI 1045 steel. Saeed Zare Chavoshi& Mehdi Tajdari (2009) developed a surface roughness model in hard turning operation of AISI 4140 using CBN cutting tool.Adeel H. Suhail *et al.* (2010) conducted experimental study to optimize the cutting parameters using two performance measures, work piece surface temperature and surface roughness. D. Philip Selvaraj and P. Chandramohan (2010) concentrated with the dry turning of AISI 304 Austenitic Stainless Steel.Nikolaos *et al*. (2010) developed a surface roughness model for turning of femoral heads from AISI 316L stainless steel. T.G Ansalam Raj and V.N Narayanan Namboothiri (2010) formed an improved genetic algorithm for the prediction of surface finish in dry turning of SS 420 materials. M. Kaladhar *et al*. (2011) constructed a multi-characteristics response optimization model based on Taguchi and utility concept. They optimized process parameters, such as speed, feed, depth of cut, and nose radius on multiple performance characteristics, namely, surface roughness and material removal rate during turning of AISI 202 austenitic stainless steel using a CVD coated cemented carbide tool.

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Material and Method

Work piece material

The experimental investigation presented here was carried out on a Jyoti CNC lathe with 13.5/9 kW power rating. The work piece material used for present work was EN-16

Figure-1 Diagram of Specimen

Experimental Procedure

The machining parameters was carried out on jyoti computer numerical control (CNC) Turning machine shown in figure. 1 This machine is manufactured by the jyoti CNC Automation ltd. The machine parameters was done on the turning machine model TMC 200. Specification of this machine are power generated by spindle motor are 13.5/9 kw and maximum spindle speed is 4000rpm maximum bar capacity is 52 mm . The weight of the machine are 3900 kg. The work material selected for the study was EN16 steel bars of diameter 30 mm and length 62 mm. The selection of the EN16 steel was made taking into account its use in almost all industrial applications for approximately 50% of the world's steel production and consumption. The chemical composition of the workpiece material and its physical and mechanical properties are given in Table-1 and Table-2. The cutting tool selected for machining was tungsten carbide tool. The responses considered in this study were surface roughness .Surface roughness can generally be described as the geometric features of the surface. The surface roughness was evaluated using a Mitutoyo Surf test 211 with the cut-off length set as 2.5 mm. Each trail was repeated for three times and the average roughness values were obtained.

Table-1 Chemical composition of EN16 steel

Element	% Composition
C	0.35
Si	0.25
Mn	1.50
Mo	0.30
S	0.02
P	0.02

Table-2 Physical and mechanical properties of EN16 steel

Property	Value
Tensile stress (MN/m^2)	695
Yield stress (MN/m^2)	605
Young's modulus (GN/m^2)	210
Density (kg/m^3)	7833
% Elongation	16

Figure-2 CNC turning center

To perform the experimental design, a total of three parameters namely RPM, feed rate and depth of cut were chosen for the controlling factor, and each parameter is designed to have two levels .The selected interactions were between RPM and feed rate , between RPM and depth of cut and between feed rate and depth of cut . To select an appropriate orthogonal array for the experiments, the total degrees of freedom (DOF) need to be computed. With three parameters each at two levels and three second-order interactions the total degree of freedom required is 7, since a two level parameter has 1 DOF and residual error has 4 DOF.

Table-3 Process parameters and their levels

Factors	Process parameters	Units	Level 1	Level 2
A	RPM	-	2100	2600
B	Feed rate	mm/rev	0.10	0.15
C	Depth of cut	Mm	0.2	0.4

Table- 4 Experimental plan with response (s)

Exp. No.	**Process parameters**			**Responses**
	RPM	**FEED**	**DOC**	**Surface roughness, SR** (μm)
1	2100	0.15	0.4	0.95
2	2100	0.15	0.6	0.84
3	2100	0.2	0.4	1.13
4	2100	0.2	0.6	0.935
5	2600	0.15	0.4	0.537
6	2600	0.15	0.6	0.714
7	2600	0.2	0.4	1.152
8	2600	0.2	0.6	1.11

Result & Discussion

In the computerized Numeric control (CNC) Process Experiment was conducted to assess the effect of RPM , feed rate and depth of cut on the surface finish and machine power consumption. The main effect plot for the three different surface parameters lower RPM that is 2600, Feed 0.15, and Depth of Cut 0.6 is the best For The Optimization for the material. Figure 2 shows the main effect plot for work-piece RPM , feed rate and depth of cut. The results show that with the increase in spindle speed there is a decrease in surface roughness value up-to 2600 RPM. A RPM of 2100 produces the highest roughness and 2600 RPM shows the lowest one, i.e. the best surface finish. In the figure the optimum value for feed was 0.15 mm/rev. and for depth of cut was 0.6 mm.

Table-2 ANOVA result for workpiece surface roughness R_a [95% confidence level

Parameters	DF	Seq SS	Adj SS	Adj MS	F	p	%Contribution
RPM	1	0.014620	0.014620	0.014620	0.55	0.498	4.42
Feed	1	0.206724	0.206724	0.206724	7.52	0.049	62.63
Depth of cut	1	0.003612	0.003612	0.003612	0.14	0.730	1.09
Residual error	4	0.105708	0.105708	0.026427			
Total	7	0.330666					

Analysis of variance (ANOVA)

The experimental results were analyzed using analysis of variance (ANOVA) for identifying the significant factors affecting the performance measures. The results of ANOVA for the surface roughness of R_a are shown in Tables 2 . This analysis was carried out for a significance level of R_a = 0.05 (confidence level of 95%). The last columns of the tables show the percent contribution of significant source to the total variation indicating the degree of influence on the result. In Tables 2, the ANOVA result shows that the F value for the factor Feed is larger than that of the other two cutting parameters, i.e., the largest contribution to the workpiece surface finish is due to the Feed . Feed is (the most significant factor) contributed 62.63% for R_a. The percent contribution of the second most significant factor RPM was found to be only 4.42% and Depth of cut contribution was least with 1.09%.

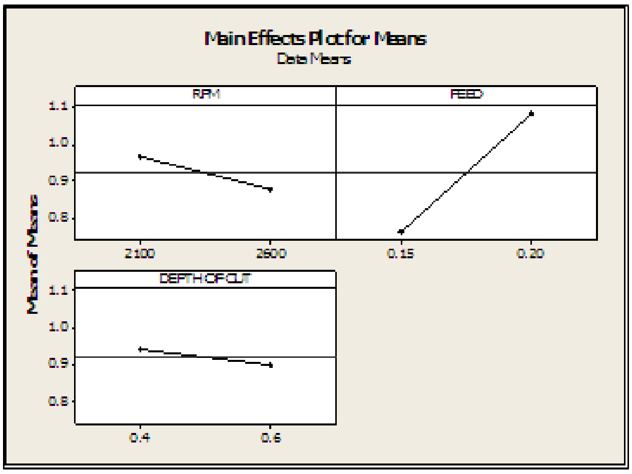

Figure-3 The response graph shows the Main effect plot for Mean

Table- 5 Response Table for mean

Level	RPM	feed	Depth of cut
1	0.9638	0.7602	0.9423
2	0.8782	1.0818	0.8998
DELTA	0.0855	0.3215	0.0425
RANK	2	1	3

Conclusion

The effect of cutting parameters on surface roughness of EN-16 was examined. Accordingly, the following drawn conclusions can be drawn: It was concluded that interesting to note that RPM and depth of cut an approximate decreasing trend. The feed has the variable effect on surface roughness.

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