Optimization of Effect of Boring Parameters for Minimum Surface Roughness Using CNC Boring Machine

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Abstract- **Boring is also known as internal turning operation. Which is used to increases the internal diameter of the hole. Boring or internal turning operation is very critical manufacturing process. Which create surface roughness; vibration, noise, and tool wear related problems. In the boring operation of machining vibration is very critical problem. This study is focuses on the vibration damping techniques used in boring operation such as passive damping technique. The reduction of vibration in boring tool and it effect on the production and production cost. Where observed enhance the new design of boring tool with passive damper (Viscoelastic material damper) with the consideration of speed, feed, and depth of cut for different viscoelastic material dampers. Taguchi design methodology has been applied to determine the optimum boring parameters leading to minimum surface roughness using CNC Boring machine on EN8 Work piece. Experimental results were used to find the analysis of variance (ANOVA) which explains the significance of the parameters on the responses. It was predicted that boring feed rate is most dominating parameters for surface roughness in Boring operation.**

Index Terms- **CNC Boring machine, Taguchi Design, ANOVA, Optimization, Boring bar, Passive damper, Surface roughness and viscoelastic material.**

I. INTRODUCTION

Now a day in manufacturing sector boring operation is very time consuming operation. It is required to achieve the good surface finish in boring operation on lathe or CNC. That can be achieved by workers own knowledge and experience. Thus selection of proper cutting tool and proper cutting parameters is very critical and vital task. And surface roughness is indicating the quality of the machined surface

Boring bar is weakest link in the boring bar and clamping system on the CNC or lathe. It is long and slender in cross section. But the vibration in boring bar can be depends on the some working parameters such as feed rate, depth of cut, and spindle speed. Also length to diameter ratio (L/D) of boring bar causes the vibration. If (L/D) ratio is high formulate large vibration and (L/D) ratio is low formulate the small vibration in boring tool. Vibration also depends on the material of the tool, material of the work piece and geometry these three parameters are most important. [1]

In the boring operation there are different forces acting on the boring tool these are tangential force, radial force, and feed force. For the stability of that boring bar there are several ways can be established by the different methods can be carried out such as Active damping system, passive damping system or semi active damping system can be using takes place. By using this damping system the vibration from boring bar minimizes or reduces. [3]

II.PROPOSED METHODOLOGY

In this present paper, effort is made to find the effect of boring parameters on the work piece and it is measured in terms of minimum surface roughness (Ra) for EN8 drilled work piece. For this purpose, experiments boring tool was modified with dampers with different viscoelastic material at various level of boring parameters such as, depth of cut, feed rate, spindle speed, and different viscoelastic material such as PTFE, Rubber, PVC (Pu based) are used. An experimental design based in L9 orthogonal array is used to check the interactions between the factors for each case such as without damper and with damper. In the present work, experimental results were used to find the analysis of variance (ANOVA) which explains the significance of the parameters on the responses. To establish the suitable correlation between the input boring parameters and the response surface roughness a linear regression model is develop. Finally, surface roughness value compared with experimental result of without and with damper.

IIIEXPERIMENTATION DETAILS

Experiments are conducted on the CNC machine (AB BUSHINDO Stocholm) on EN8 work piece to determine the effect of boring parameters and different viscoelastic materials on Surface roughness. The viscoelastic dampers are mounted on boring bar. And results are compared with without different viscoelastic material damper tool surface roughness values. The boring tool is used for the experiment work has WIDAX S20S SCLCR 09T3. And TNMG16040MS insert was used which is having nose radius 0.8 for experiment with a water soluble coolant. Fig. 1 shows the boring operation on CNC machine. In this present work, three levels at four factors have been employed to predict the optimal values as shown in Table 1. Ranges of boring parameters have been established based on review of literature, industrial survey and by performing the pilot experiments using one factor at a time (OFAT) approach. The number of experiments to be conducted can be reduced by using orthogonal array method of Taguchi optimization technique.

Figure 1: Experimental setup for CNC Boring process with viscoelastic damper.

Table 1. Different Factors and levels.

Parameters	Unit	Symbols	Levels		
			L1	L2	L3
Spindle Speed	rpm	s	1000	1100	1200
Feed rate	mm/min	f	0.02	0.04	0.06
Depth of Cut	mm	d	0.6	0.8	1

Table 2 Chemical composition of work piece (EN8)

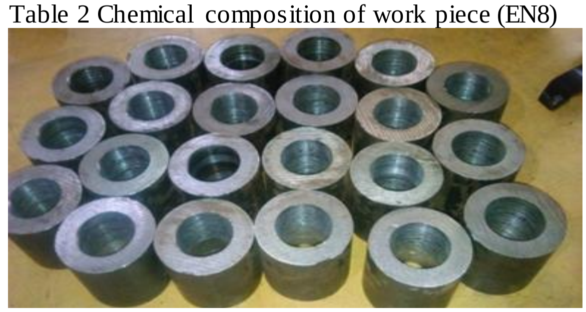


Figure 2: Work piece

The drilling operation is done on the universal central lathe machine by holding the work piece in headstock of the lathe. After the drilling operation, finishing of work piece material was carried out. After finishing, the specimens were ready for experiments. The close up view of the jobs is shown in the figure 2.

IV. RESULT AND DISCUSSION

The objective of this work is to investigate the effect of the boring parameters and different viscoelastic material measured in terms of output response Surface roughness for EN8 work piece. 9 experiments were conducted for each case, means

Ex pt. No	Input Parameter			Response			
				Surface Roughness(μm)			
				Without passive Damper	With passive damper		
	s	f	d		PTFE	PVC (Pu)	Butyl Rubber
1	1000	0.02	0.6	4.621	3.229	3.651	3.881
2	1000	0.04	0.8	5.441	3.821	4.296	3.903
3	1000	0.06	1	8.032	5.622	6.345	6.747
4	1100	0.02	0.8	4.805	3.364	3.779	4.036
5	1100	0.04	1	5.576	3.902	4.41	4.684
6	1100	0.06	0.6	5.538	3.821	4.040	4.651
7	1200	0.02	1	4.241	2.981	3.352	3.563
8	1200	0.04	0.6	4.769	3.325	3.638	4.005
9	1200	0.06	0.8	7.031	4.922	5.549	5.905

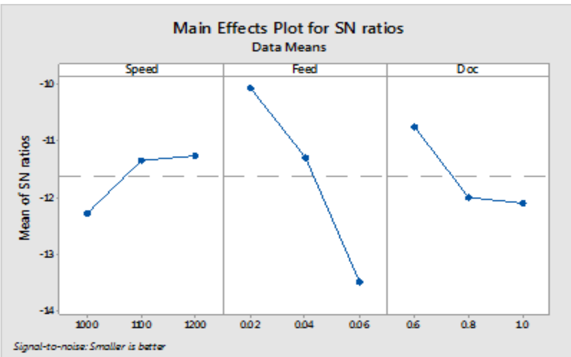
Table 3. Results of Experiments

total 36 experiments are conducted using Taguchi experimental design methodology. Experimental results for surface roughness for each damper condition are given in Table 3. In the present study all the designs, plots and analysis have been carried out using Minitab statistical software.

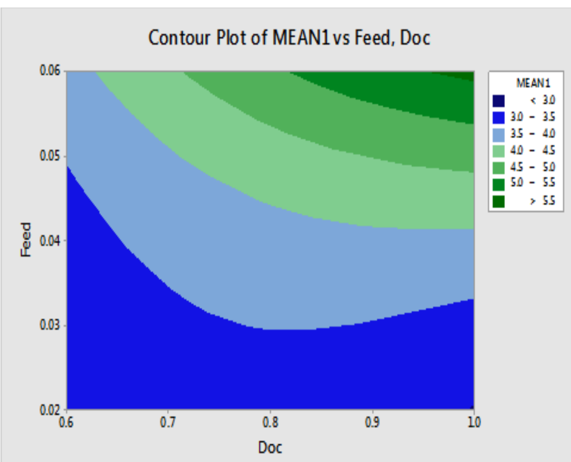
From the above graph it is clear that surface roughness for PTFE damper gives the better results as compare to without damper and with damper of PVC and Rubber. So that analysis is carried out for PTFE damper only as considering L9 orthogonal array table for PTFE material. That is given below

a)Main Effect plot for PTFE:

The main effects plots for the PTFE material damper experiments have been given in Fig.



a)Main Effect Plot for PTFE results.



b)Contour Plot of Feed vs Doc for PTFE

Fig.5 (a) shows that the surface roughness increases with decrease in the depth of cut and feed rate, and increase in spindle speed. Also, Surface roughness decreases with increase in depth of cut but further increase at some position. It is observe that, The optimal set of boring parameters obtained for surface roughness using Taguchi design of experiment methodology is boring depth of cut: 0.6 mm, boring feed rate: 0.02 mm/min, and spindle speed 1200 rpm for PTFE damper boring operation.

a) Contour Plots

Contour plots are used to explore the relationship between three variables. Generally, there are two predictors and one response variables. Contour plots are useful for establishing desirable response values and operating conditions. Minitab plots the values for the x and y factors (predictors) on the x and y axes, while contour line and colour bands represents the values for the z-factors (response).

In Fig.7 the contour plot shows that the minimum surface roughness occurs for boring operation above 0.6 Depth of cut and 0.02 mm/min feed rate.

Regression

$$Equation mean = 3.52 - 0.00241\,speed + 39.91 feed + 1.774\,DoC$$

Above equation shows that linear relationship between input parameter such as speed, feed, and depth of cut to the output as mean roughness value for PTFE damper.

V. CONCLUSION

On the basis of this investigation, the following conclusion can be drawn.

1. It was found that, for Surface Roughness (Ra), out of four dressing parameters feed rate is the most influencing factor for EN8 work material followed by depth of cut, spindle speed, and damping material respectively has relatively weak effect on surface roughness.
2. The optimal set of boring parameters obtained for surface roughness using Taguchi design of experiment methodology is depth of cut: 0.6 mm, feed rate: 0.02 mm/min, spindle speed:1100 rpm, and PTFE material for damping.
3. It is found that 30-35% reduction in surface roughness value, when passive damper is used.
4. As compare to vertical and horizontal damping, vertical damping is little bit effective.

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