Improvement of Surface roughness in Boring operation using Viscoelastic Material Damper.

Rohit S. Patil[1], S.M. Jadhav[2], Dr.S.Y.Gajjal[3]
[1]*PG Scholar, NBN Sinhgad school of Engineering Pune.*
[2]*Assistant professor NBN Sinhgad school of Engineering Pune.*
[3]*Professor, NBN Sinhgad school of Engineering Pune.*

***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]

L.Rubio,(2013) has done the work the optimal selection of parameter of passive vibration dynamic absorber (DVA) attached to a boring bar. In this boring bar is modeled as Eulers-bernoulli cantilever beam and stability of system analyzed in term of the bar and absorber characteristics. To obtain optimum parameter of the absorber the method for unconstrained optimization problem has used.

K.Venkata Rao,(2013) Due to tendency of hardening of the stainless steel it is difficult to machining due to vibration in boring bar. In this paper there will be study of stainless steel carried out and vibration effect of boring operation will be studied. The vibration is measured by using the lacer Doppler vibrometer and high speed FFT analyzer used to acousto-optic emission signal for specimen vibration by using neural network experimental data had improved.[11]

In this study, there are four important parameter dressing depth of cut, feed rate, Spindle speed and viscoelastic materials were selected as variable parameters. Taguchi design methodology has been applied to determine the optimum dressing parameters leading to minimum surface roughness in CNC machine on EN8 work piece. 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. Conformation experiment was conducted at the optimum level to verify the effectiveness of the Taguchi approach.

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 (R_a) 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.

III. EXPERIMENTATION 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.

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

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.

Table 1. Different Factors and levels.

Paramet-ers	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

3.1Experimentation condition

Table 4.4 lists the experimental condition to obtain the surface roughness. WIDAX made tool is used. Specimen is EN8. The spindle speed was as 1000-1200 rpm, feed rate was 0.02-0.06, depth of cut for boring process was 0.6-0.8 mm and PTFE, Rubber, and PVC are different viscoelastic material dampers was used. Coolant was continuously on during boring operation. 0.8 mm insert was used for boring.

3.2 Work piece material

In this work, EN8 steel rod of 50 mm diameter and 50 mm length has been selected as a work piece material. EN8 is a high quality carbon alloy steel which offers a medium strength material.. EN8 steel is widely used for manufacturing nut, high tensile studs, and for forging obtaining for various grades etc.

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.

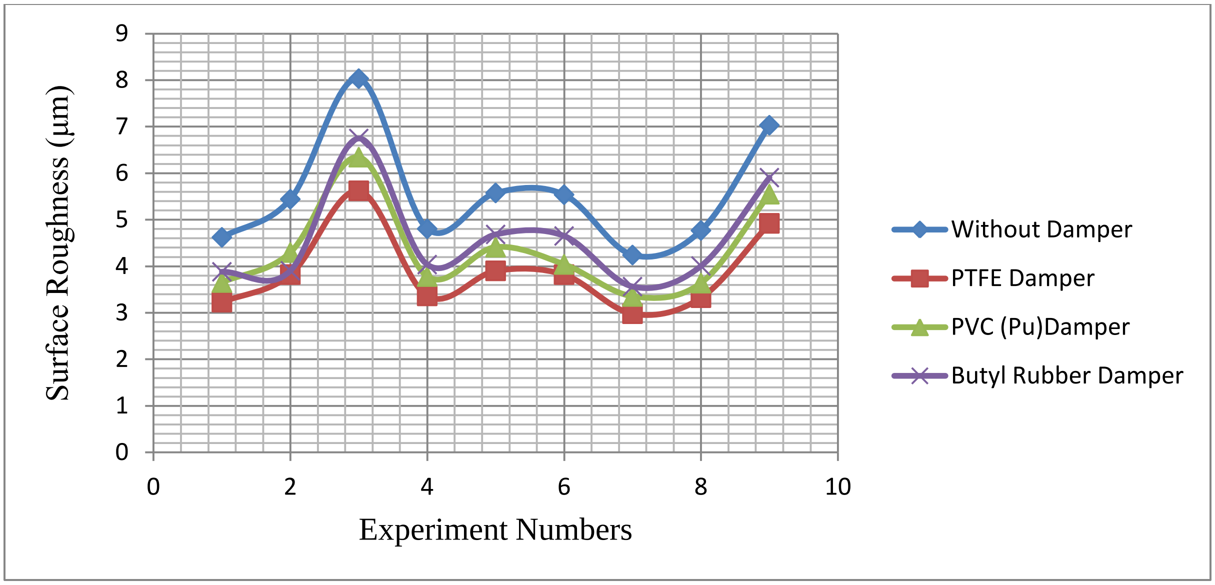
The objective of this work is to investigate the effect of the boring parameters and different viscoelastic material measured in terms of output response Surface roughness for EN8 work piece. 9 experiments were conducted for each case, means total 36 experiments are conducted using Taguchi experimental 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.

5.1 Surface Roughness Measurement

Surface roughness values are obtained from MITUTOYO Surf test SJ-210 surface roughness tester for each experiment and each condition. The obtained values are used for the Taguchi optimization process.

IV. RESULT AND DISCUSSION

Expt. No	**Input Parameter**			**Response**			
	s	f	d	Surface Roughness(µm)			
				Without passive Damper	With passive damper		
					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



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 L_9 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. 5

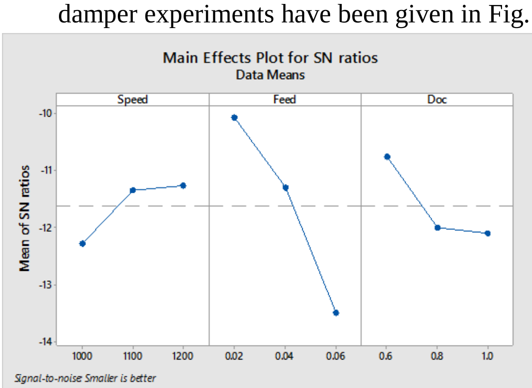


Fig.a) Main Effect Plot

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.

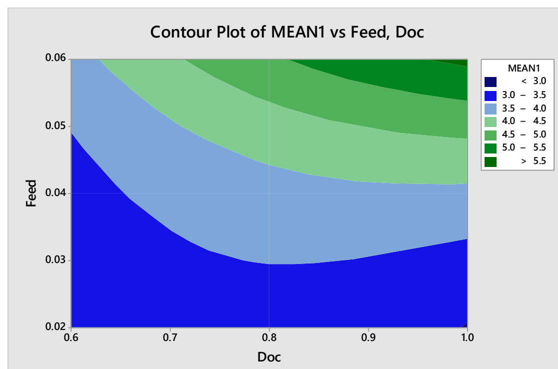


Fig b) Contour plot

b) 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 mm Depth of cut and 0.02 mm/min feed rate.

a) Analysis of Variance

The experimental results were analysis of variance (ANOVA) by using MINITAB 17 statistical software. The regression analysis of variance results for the response are shown in Table 4.

Table 4. ANOVA of Surface Roughness

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	3	4.9270	1.6423	8.18	0.023
Speed	1	0.3478	0.3478	1.73	0.245
Feed	1	3.8236	3.8236	19.05	0.007
DoC	1	0.7555	0.7555	3.76	0.110
Error	5	1.0037	0.2007		
Total	8	5.9307			

ANOVA results determine the significance of factors. This significance of the factors is calculated by using F-ratio. It contains P-value, defined as the significance rate of the process parameters on the surface roughness. From ANOVA Table 4, the feed rate is most affecting factor on Surface Roughness.

a) 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. ACKNOWLEDGMENT

First of all I would like to express my deepest gratitude and sincere thanks to my guide, Prof. S. M. Jadhav, Assistant Professor, Mechanical Department, NBN Sinhgad School of Engineering, Ambegaon, Pune his valuable time and keep interest in my project research work. His intellectual advice has helping me in every step of my research work.

I also thank thanks to our beloved Head of Department, Prof. (Dr.) S.Y. Gajjal who has contributed towards the completion of my project.

VI. 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.

REFERENCES

[1] F. Atabey, I. Lazoglu, Y. Altintas, Mechanics of Boring Process Part-1 and Part-2 Multi Insert Boring Heads, International Journal of Machine tool and Manufacturing 43, 2003, PP. 477-484.

[2] L. Andren, L. Hakansson, A. Brandt, I. Claesson, Identification of dynamic properties of boring bar vibrations in a continuous boring operation, Mechanical Systems and Signal Processing, 2004, PP. 869–901.

[3] M.H. Miguelez, L.Rubio, J.A.Loya, J.Fernandez-Saez, Improvement of chatter stability in boring operations with passive vibration absorbers, Department of Mechanical Engineering, University Carlos III of Madrid, 2010.

[4] L. Andren, L. Hakansson, A. Brandt, I. Claesson, Identification of dynamic properties of boring bar vibrations in a continuous boring operation, Blekinge Institute of Technology, 372 25 Ronneby, Sweden, 2002, PP. 372.

[5] M.Sortino, G.Totisn, F.Prosperi, Modeling the dynamic properties of conventional and high-damping boring bars; Dept. of Electrical, Management and Mechanical Engineering, University of Udine, 2012.

[6] M.Senthil kuma1, K. M. Mohanasundaram and B. Sathishkumar, A case study on vibration control in a boring bar using particle damping, Department of Mechanical Engineering, PSG College of Technology Coimbatore,2011.

[7] Mohan D. Rao, Recent applications of viscoelastic damping for noise control in automobiles and commercial airplanes; Michigan Technological University, Houghton, 2002.

[8] M. Sortino, G.Totis, F.Prosperi, Modeling the dynamic properties of conventional and high-damping boring bars, Mechanical Engineering, University of Udine, Via delle Scienze, 2012.

[9] L. Rubio , J.A.Loya , M.H.Miguélez , J.Fernández-Sáez, Optimization of passive vibration absorbers to reduce chatter in boring, 2013.

[10] M. Kaymakci, Z.M. Kilic, Y. Altintas. Unified cutting force model for turning, boring, drilling and milling operations; The University of British Columbia, Department of Mechanical Engineering,2011.

[11] K.Venkata Rao, B.S.N. Murthy, N. Mohan Rao. Cutting Tool Condition Monitoring By analyzing surface Roughness, work piece vibration and Volume of Metal removed for AISI 1040 steel in Boring, Measurement 4075-4084, 2013.

[12] Lorenzo Daghini, Andreas Archenti and Cornel Mihai Nicole, Implementation and analysis of Composite Material Damper for Turning Operation, World Academy of Science, Engineering and Techonology, 2009.