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Improvement Of Ra Value Of Boring Operation Using Passive Damper

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--ABSTRACT--
In industries, boring operation suffer vibrations due to high over hang of the tool. In this paper presents the improvement of surface finish of boring operation using passive damper. By mounting this passive damper on the standard boring bar available in the market and using the standard practice of boring operation i.e. applying routine machining parameters an experiments were conducted on reliable CNC turning center machine. The results obtained were found satisfactory and indicates that passive damper can be used for minimizing the effects of vibrations which ultimately results into enhancement of surface finish.

KEYWORDS: *Boring Bar, Passive Damper, Ra Value.*

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I. INTRODUCTION

In machining, boring is the process of enlarging a hole that has already been drilled (or cast), by means of a single-point cutting tool (or of a boring head containing several such tools), for example as in boring a cannon barrel. Boring is used to achieve greater accuracy of the diameter of a hole, and can be used to cut a tapered hole. Boring can be viewed as the internal-diameter counterpart to turning, which cuts external diameters.

[5]A schematic picture of a cutting operation using a boring bar can be seen in Fig. 1.1. The actual cutting is performed at the cutting tool mounted at the tip of the boring bar. During a cutting operation the boring bar is fed in the feed direction at a specific cutting depth and a specific rotational speed of the workpiece. The vibration of the boring bar is influenced by three parameters, feed rate, cutting depth and cutting speed. The vibrations in the boring bar are in the cutting speed and the cutting depth direction.

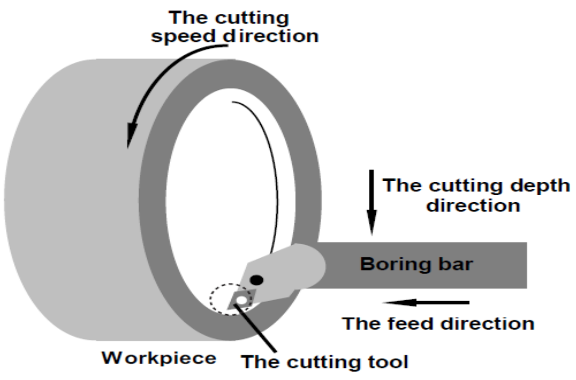


Figure 1.1: A typical boring operation[5].

A major concern in the manufacturing industry, today, is the vibrations induced by metal cutting, e.g. turning, milling and boring operations. The vibration problem associated with metal cutting has considerable influence on important factors such as productivity, production costs, etc. In particular, vibrations in internal turning operations are usually a cumbersome part of the manufacturing process. Excessive vibrations accelerate tool wear, because poor surface finish and may damage spindle bearings.

In the boring operation, vibration is a frequent problem, which affects the result of the machining, and, in particular, the surface finish. Tool life is also influenced by vibration. Severe acoustic noise in the working environment frequently occurs as a result of dynamic motion between the cutting tool and the work piece. In all cutting operations like turning, boring and milling, vibrations are induced due to the deformation of the work-piece. This implies several disadvantages, economical as well as environmental.Today the standard procedure to avoid vibration during machining is by careful planning of the cutting parameters. The methods are usually based on experience and trial and error to obtain suitable cutting data for each cutting operation involved in machining a product. Machining vibration exists throughout the cutting process. While influenced by many sources, such as machine structure, tool type, work material, etc., the composition of the machining vibration is complicated. However, at least two types of vibrations, forced vibration and self excited vibration, were identified as machining vibrations. Forced vibration is a result of certain periodical forces that exist within the machine. The source of these forces can be bad gear drives, unbalanced machine-tool components, misalignment, or motor sand pumps, etc. Self-excited vibration, which is also known as chatter, is caused by the interaction of the chip removal process and the structure of the machine tool, which results in disturbances in the cutting zone. Chatter always indicates defects on the machined surface; vibration especially self-excited vibration is associated with the machined surface roughness [9,10].

II. CUTTING FORCES IN BORING OPERATION

A large number of theoretical and experimental studies on surface roughness of machined products have been reviewed where cutting conditions (such as cutting speed, feed rate, depth of cut, tool geometry, and the material properties of both the tool and work piece) significantly influence surface finish of the machined parts. The surface roughness can be affected by built up edge formation. The analysis of tool vibration on surface roughness is also investigated by some authors.

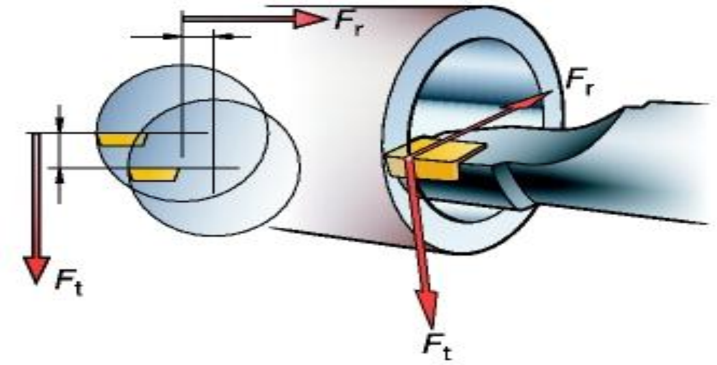


Figure 1.2: Cutting Forces in Boring Operation [6]

When the tool is in cut, the tangential (Ft) and radial (Fr) cutting forces will endeavor to deflect the tool away from the workpiece. The tangential force will try to force the tool downwards and away from the centre line, and in doing so will also reduce the tool clearance angle. When boring small diameter holes, it is particularly important that the clearance angle of the insert is sufficient in order to avoid contact between tool and wall of hole [6].

III. VIBRATION DAMPER

During machining operations, vibratory motion between the tool and workpiece can lead to reduced performance. In particular, self-excited vibration, or chatter, causes poor surface finish, tool damage, and other unwanted effects.Various passive and active techniques have been developed to improve chatter resistance. Rivin [3] provides a comprehensive overview of these and other issues related to the dynamic stiffness (the product of stiffness and damping) of tools and holders. He categorizes these techniques as:

- Reduction of cutting forces
- High damping clamping devices
- Bars with anisotropic stiffness
- Periodic variation of cutting conditions
- Enhancement of structural stiffness
- Passive vibration absorbers
- Active dampers
- Active correction systems.

The passive(impact) damper has the following features: (i) small and simple in construction; (ii) easy to mount on the main vibratory systems; and (iii) no need to adjust parameters of an impact damper to the vibratory characteristics of the main vibratory systems[1]. Furthermore, it was clarified that by applying this impact damper to a drill, chatter vibration could be suppressed effectively.Thus, in the present study, the improvement of the damping capability of boring tools and suppression of chatter vibration using the impact damper were tested. In addition, the impact damper used in this study allows a free mass to be equipped on the outside of the main vibratory system. In the vibratory system presented in Fig.1.3, the free mass exists inside the main mass [4,5]

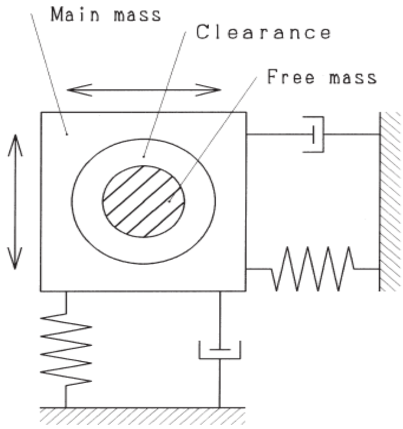


Figure 1.3: Impact Damper [4,5].

IV. EXPERIMENTAL SETUP

Number of experiments was conducted to analyze the effect of vibration on surface finish. Boring bar of 20 mm × 20 mm cross-section and 200 mm long of WIDAX make is used. The workpiece material used for study is EN9. The boring operations were carried out on CNC turning centre of ACE make.

4.1. PASSIVE DAMPERS AND BORING TOOLS

Two Boring bar of 20 mm × 20 mm cross-section and 200 mm long of WIDAX make is used.

(A) (B) (C)

Figure 4.1 (A) Boring Bar (WIDAX) with Cermets Insert, (B) Passive Damper mounted in vertical position on boring bar & (C) Passive Damper mounted in horizontal position on boring bar

Figure 4.2: Sample workpiece

4.2. Experimental Procedure

The work piece was mounted using a pneumatic chuck in CNC turning centre and the clamping pressure was set as10 bar. The machining parameters like feed, depth of cut, clamping pressure, etc. were selected based on the manufacturers recommendations and were kept constant for all the samples used. Only the cutting speed, passive damper position on boring bar and overhang length was changed. The recommended cutting speed, feed, depth of cut, etc. is shown in table 4.1. Boring was carried out for 105mm internal diameter as shown in figure 4.3.

Figure 4.3: CNC turning centre

Table 4.1: Parameters

Boring tool	BT_A	BT_B	
Overhang length *L* (mm)	40	80	120
Impact Damper position	Vertical	Horizontal	
Clearance *CL* (mm)	0.4		
Spindle rotation *N* (rpm)	80	160	240
Feed rate *S* (mm/min)	0.9		
Depth of cut *t* (mm)	0.6		

V. RESULTS

The figure 5.1 shows the experimental arrangement used to measure the surface roughness of bored parts. A Mitutoyo SJ-201P apparatus was used. The profilometer technique used in this study is common in most machine shops. For each specimen three readings were taken at approximately 120^0 angles and the average value was found out.

Figure 5.1. Surface Roughness Tester

Table 5.2 Surface Roughness or Ra values (µm)

5.2.1 Without Passive Damper:
Speed: 240 rpm, Depth of Cut: 0.6 mm and Feed: 0.09 mm/min

Sr.No.	Test No.	Overhang Length(mm)	Response (Surface finish Ra in µm)		
			1	2	3
1	3	40	2.72	2.72	2.73
2	2	80	2.33	2.47	2.69
3	5	120	2.82	2.90	2.60

5.2.2 With Passive Damper:
Boring bar overhang length: 40mm, Depth of Cut: 0.6 mm and Feed: 0.09 mm/min

Sr.No.	Speed (rpm)	Test No.	Vertical Position			Test No.	Horizontal position		
			Response (Surface finish Ra in µm)				Response (Surface finish Ra in µm)		
			1	2	3		1	2	3
1	80	7	3.16	3.30	3.28	14	3.29	3.46	3.31
2	160	4	2.70	2.61	2.65	15	2.96	2.78	2.94
3	240	6	2.37	2.39	2.51	23	2.76	2.79	2.73

5.2.3 With Passive Damper:
Boring bar overhang length: 80mm, Depth of Cut: 0.6 mm and Feed: 0.09 mm/min

Sr.No.	Speed (rpm)	Test No.	Vertical Position			Test No.	Horizontal position		
			Response (Surface finish Ra in µm)				Response (Surface finish Ra in µm)		
			1	2	3		1	2	3
1	80	1	2.61	2.40	2.50	16	3.14	3.27	3.35
2	160	8	2.56	2.37	2.31	21	2.38	2.47	2.71
3	240	9	2.61	2.40	2.50	22	1.26	1.38	1.56

5.2.4 With Passive Damper:
Boring bar overhang length: 120 mm, Depth of Cut: 0.6 mm and Feed: 0.09 mm/min

Sr.No.	Speed (rpm)	Test No.	Vertical Position			Test No.	Horizontal position		
			Response (Surface finish Ra in µm)				Response (Surface finish Ra in µm)		
			1	2	3		1	2	3
1	80	13	3.23	3.29	3.11	19	3.30	3.13	3.20
2	160	11	2.41	2.51	2.30	24	2.80	2.61	3.07
3	240	10	3.23	3.29	3.11	25	2.99	3.35	3.09

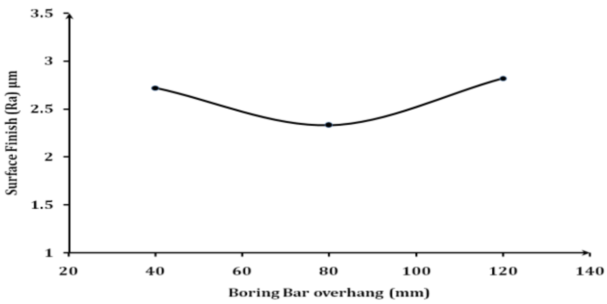
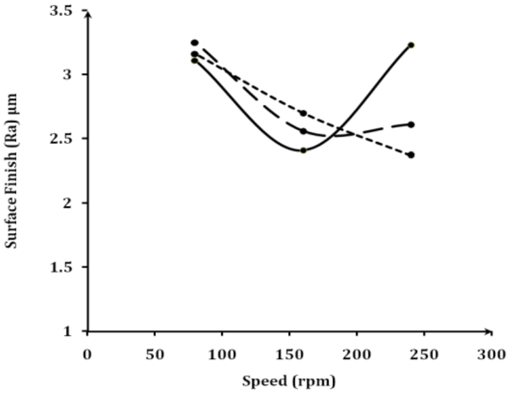
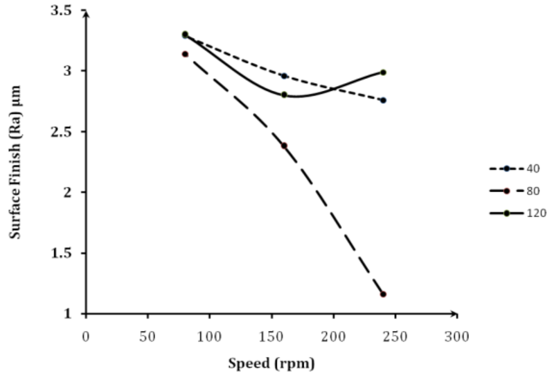


Figure 5.2 Plot for Without Passive Damper: Speed=240rpm





(A) (B)

Figure 5.3 (A)Plot for Vertical Position of Passive Damper: Boring bar overhang= 40mm, 80mm, 120mm & (B)Plot for Horizontal Position of Passive Damper: Boring bar overhang= 40mm, 80mm, 120mm

VI. CONCLUSION

From the results table and subsequent plots shown in section 5 following conclusions were made;

I. Significant improvement is observed between the results of surface finish obtained using boring bar without passive (impact) damper and boring bar with passive (impact) damper.

II. In case of passive (impact) damper mounted in vertical position – with small overhang and high speed, with large overhang and moderate speed the surfaced finish obtained is very good.

III. In case of passive (impact) damper mounted in horizontal position – with moderate overhang at all speed values the surfaced finish obtained is very good.

An innovative method is proposed to reduce tool chatter is and enhance surface finish in boring operation. The results prove the passive damping technique has vast potential in the reduction of tool chatter. Also the suppression in tool chatter by using impact damper boring bars is very significant. Boring bars with impact damping are also relatively cheaper than other damped boring bars. It is therefore concluded that impact damping has a good effect in improving surface finish in boring operation.

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