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Experimental Investigation of Vibration Damping in Boring Operation using Passive Damper

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Abstract

This paper introduces an experimental investigation of vibration damping in boring using passive damper. The principle followed in this paper was to enhance the damping capability, minimizing the loss in static stiffness through implementation of passive damper. The newly designed tool has been compared to a conventional tool. The evaluation criteria were the dynamic characteristics, frequency and damping ratio, of the machining system.

Keywords: *Boring bar, passive damper, static stiffness, deflection.*

1. Introduction

Vibrations are undesirable for structures, due to the need for structural stability, position control, durability (particularly durability against fatigue), performance, and noise reduction. Vibrations are of concern to large structures such as aircraft, as well as small structures such as electronics. Vibration reduction can be attained by increasing the damping capacity and/or increasing the stiffness (which is expressed by the storage modulus). The loss modulus is the product of these two quantities and thus can be considered a figure of merit for the vibration reduction ability. Damping of a structure can be attained by passive or active methods. Passive methods make use of the inherent ability of certain materials (whether structural or non-structural materials) to absorb the vibration energy (for example, through mechanical deformation), thereby providing passive energy dissipation. Active methods make use of sensors and actuators to attain vibration sensing and activation to suppress the vibration in real time. The attenuation of machine tool vibration is a field of research that has been the concern of many engineers over the past few decades.

The driving force behind the ongoing research can be related to the fact that the level of vibration at the tool tip, limits the tool life as well as tolerances and the surface finish obtained by the machining process. Traditionally, the rate of material removal is reduced to obtain the required tolerances and surface finish The reduction in rate of material removal reduces the efficiency of the machine, since the component manufacturing time is increased and lower production is obtained from the machine over a period of time The objective of the vibration attenuation is to improve the dynamic stiffness of the machine tool structure, to increase the rate of material removal and thereby prolonging the life of the tool tip Acoustic noise emission during the machining process results from the relative motion between the tool tip and work piece. High levels of acoustic noise can cause discomfort in the working environment. The problem is related to the dynamic stiffness of the machine tool structure. By improving the dynamic stiffness of the structure, the level of noise emission from the machining process can be reduced.

2. Experimental Procedure

Number of experiments was conducted to analyze the effect of vibration on deflection of boring bar. Boring bar of 16 mm × 16 mm cross-section and 200 mm long of WIDAX make is used. The work piece material used for study is EN9. The boring operations were carried out on a lathe machine. The work piece was mounted using a four jaw chuck. The machining parameters like feed (0.02mm/rev, 0.04mm/rev), depth of cut (1mm, 2mm), etc. were selected based on the manufacturers recommendations and were changed according to the proposed conditions. Also the cutting speed, length of passive damper on boring bar and overhang length was changed. The recommended parameters are shown in Table 1. Boring was carried out for 51mm internal diameter. Passive dampers of Nylon and Polyurethane were used. The Fast Fourier Transform(FFT) Analyzer and accelerometer were used to obtain the readings. The deflections were measured in terms of acceleration by accelerometer.

3. Tables and Figures

Abbreviations used in the following tables are given below: C-Condition, S-Speed, F-Feed, D-Depth of Cut, O-Overhang of the boring bar, M-Material used for Damping, P-Percentage of Overhang Damped, L-Length of Passive Damper.

Table 1: Testing Conditions

C	S (rpm)	F(mm/rev)	D(mm)	O(mm)	M	P	L (mm)
1	100	0.02	1	100	Nylon	3	30
2	100	0.02	1	120	PU	6	72
3	100	0.04	2	100	Nylon	6	60
4	100	0.04	2	120	PU	3	36
5	120	0.02	2	100	PU	3	30
6	120	0.02	2	120	Nylon	6	72
7	120	0.04	1	100	PU	6	60
8	120	0.04	1	120	Nylon	3	36

Fig. 1 Boring bars

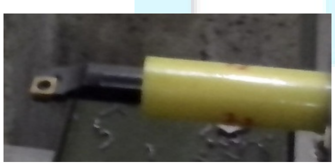

Fig. 2 Boring bar with passive damper

Fig. 3 Workpieces

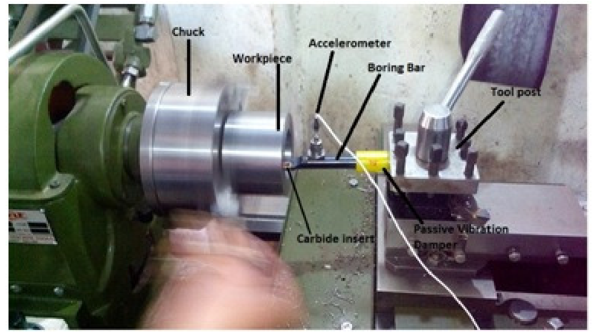

Fig.4 Installation of boring bar with passive damper and accelerometer on lathe machine

Table 2: Results

C	Without Damper (μm/s²)	With damper of Polyurethane (μm/s²)	With damper of Nylon (μm/s²)
1	28	22	25
2	50	40	30
3	40	50	30
4	25	28	40
5	24	25	23
6	40	30	20
7	25	22	18
8	48	35	20

4. Conclusions

An innovative method is proposed to reduce the deflection of the boring bar in boring operation. The results prove the passive damping technique has vast potential in the reduction of deflection. Passive dampers are also relatively cheaper than other damped boring bars. It can therefore also be concluded that passive damping has a good effect in improving surface finish in boring operation.

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