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THE USE OF PASSIVE DAMPING TECHNIQUES IN CNC MACHINE TOOLS EFFECTIVELY IMPROVES THE ROUGHNESS FACTOR IN BORING MACHINING OPERATIONS.

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ABSTRACT
Hole machining operations in industry are exposed to vibration due to the high overhang of the tool. This article describes the use of passive dampers to improve performance in boring operations. Experiments have been conducted on improving this poor performance of the current boring model on the market and developing a reliable CNC lathe machine by using the standard practice for boring work (for example, the use of traditional machining is not good). The results obtained are satisfactory and show that passive dampers can be used to reduce the effects of vibrations and ultimately improve the surface quality.
KEYWORDS: Boring Operation, Passive Damper, Surface Roughness.

I. INTRODUCTION
Boring in machining is the process of enlarging a drilled (or cast) hole using a single-point cutting tool (or a boring head that is many things like a tool), such as boring guns. Drilling is used to obtain more accurate diameters and can be used to cut tapered holes. The hole can be thought of as the inner diameter of the diameter that intersects the outer line. The actual cutting process is done with cutting tools mounted at the ends of the hole. During the cutting process, the boring bar is fed in the feed direction with a certain cutting depth and a certain rotation speed of the workpiece. The vibration of boring is affected by three parameters: feed rate, depth of cut and cutting speed. The vibration of the drill depends on the direction of cutting speed and depth of cut.
Figure 1.1: A typical boring operation 5.
The biggest problem in manufacturing today is vibration caused by metal cutting operations such as shearing. Turning, milling and boring operations. Vibration issues associated with machining have a significant impact on important products such as productivity and production costs. Excessive vibration causes tool wear due to poor surface finish and can damage the spindle bearing. Vibration in hole machining is a problem that affects the machining results, especially the finished product. Equipment life is also affected by vibration. Noise often occurs in the workplace due to the movement of cutting tools and workpieces. Vibrations occur due to the deformation of the workpiece in all cutting operations such as turning, drilling and milling. This shows some negative aspects of work and the environment. The standard procedure for preventing vibration during machining today is the careful planning of cuts. This process generally relies on experience and trial and error to obtain appropriate cutting information for each cut involved in the production of the product. Machining vibration is present throughout the cutting process. Machining vibration in machine tools, equipment, work equipment, etc. It is affected by many places such as and its features are complex. However, at least two types of vibrations are defined as machining vibrations, namely forced vibrations and self-excited vibrations. The coercive force is the result of a certain dynamic force in the machine. The source of this oil may be bad gear, unbalanced, bad mechanical equipment or sand pumps. This causes an impact on the cutting area. Chatter always indicates a flaw in the functioning of the machine;

II. CUTTING FORCES IN BORING OPERATION
Many researches and tests have been analyzed to determine the material used by the equipment (such as cutting speed, feed rate, depth of cut, tool geometry, tool and workpiece material). affects surface

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roughness. Surface roughness may be affected by the occurrence of edge formation. Some authors have also investigated the effect of tool vibration on roughness.
Figure 1.2: Cutting Forces in Boring Operation [6]
The tangential (Ft) and radial (Fr) cutting force relative to the cutting tool works to move the tool away from the workpiece. Tangential forces will attempt to force the tool downward and away from center, reducing tool tension in doing so. When drilling a small diameter hole, it is especially important that the insert clearance angle is large enough to prevent contact between the tool and the hole wall. [6]

III. VIBRATION DAMPER
During machining operations, vibration movements between the tool and the workpiece can cause performance degradation. Especially their own happy vibrations or chatter can cause negative aspects of the environment, damages and other negative effects. Rivin [3] provides a comprehensive overview of these and other issues related to the stiffness (hardness and damping properties) of tools and equipment. He categorized these techniques as follows:
• Reduced cutting forces
• Improved clamping materials
• Materials with anisotropic stiffness
• Timely changes in the cutting condition
• Improve rigid structures
• Passive Dampers
• Active Dampers
• Active Correction Systems.
The impact or pulse dampers have the following characteristics: (i) small and simple structure; Vibration characteristics of the main vibration [1]. It has also been shown that speech can be effectively impacted by using an impact dampener for the drill bit. In addition, the shock absorber used in this study allows the free mass to be equipped externally to the main vibration system. In the vibration system shown in Figure 1.3, the free mass consists of large particles. [4,5]
Figure 1.3: Impact Damper [4,5].

IV. EXPERIMENTAL SETUP
Extensive testing has been conducted to verify the effect of vibration on the finished surface. A WIDAX boring bar with a cross section of 20 mm × 20 mm and a length of 200 mm is used. The equipment used in the study is EN9. The boring work is carried out on a CNC turning center manufactured by ACE.
4.1. PASSIVE DAMPERS AND BORING TOOLS
Two boring tools with a cross section of 20 mm × 20 mm and a length of 200 mm produced by WIDAX are 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 workpiece is mounted on the CNC turning center using a pneumatic chuck with the clamping pressure set at 10 bar. Feed, depth of cut, clamping pressure etc. Processing parameters such as are selected according to the manufacturer's recommendations and are kept constant for each model used. Only the deceleration, the passive damper position of the boring bar and the overhang length were changed. Recommended cutting speed, feed, depth of cut, etc. As shown in Table 4.1. Figure 4.3 shows a hole with a diameter of 105 mm.
Figure 4.3: CNC Turning

Machine 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
Figure 5.1 shows the test rig used to measure the roughness of the drilled surface. Use Mitutoyo SJ-201P unit. The profilometer used in this study is available in many stores. For each sample, take three readings from approximately 1200 angles and find the average.

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 Response (Surface finish Ra in µm)			Test No.	Horizontal position 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 Response (Surface finish Ra in µm)			Test No.	Horizontal position 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

The following conclusions are drawn from the results and images presented in Chapter 5; (reactive) dampeners and boring bars with passive (reactive) dampeners significant improvements have been observed. If the passive (pulse) damper is installed in a vertical position, the surface quality is very good for small overhangs and high speeds, large overhangs and medium speeds. If the passive (shock) damper is mounted in a horizontal position and has an average protrusion at all speed values, the surface quality is very good. A new method was proposed to reduce tool chatter during drilling work and improve the finished area. The results show that the use of damping technology can reduce device noise. In addition, the durability of the communication device in which shock-damped boring bars are used is also very important. Damping effect boring lines are also cheaper than other damped boring lines. Therefore, it has been determined that the damping effect is beneficial in improving the surface quality in hole machining operations.

REFERENCES

[1] Rajender Singh, Introduction to Basic Manufacturing Processes and Workshop Technology, New Age Publication, 2006
[2] Ronald Walsh and Denis Cormier, McGraw Hill Machining and Metalworking Handbook, 3 rd Edition, McGraw Hill Publication, 2006
[3] Rivin E., Tooling structure: interface between cutting edge and machine tool, Annals of the CIRP 2000; 49(2):591–634.
[4] S. Ema and E Maru, Damping characteristics of an impact damper and its application, Int. J. Math. Tools Manufact. Vol. 36, No. 3. pp. 293-306, 1996.
[5] L. Andren and L. Hakansson, Active Vibration Control of Boring Bar Vibrations, Blekinge Institute of Technology, Sweden, August, 2004.
[6] Sandvik coroment, How to reduce vibration in metal cutting.
[7] Satoshi Ema, Etsuo Marui, Suppression of chatter vibration of boring tools using impact dampers, International Journal of Machine Tools & Manufacture 40 (2000) 1141–1156.
[8] M. Senthilkumar, K. M. Mohanasundaram and B. Sathishkumar, A case study on vibration control in a boring bar using particle damping, International Journal of Engineering, Science and Technology Vol. 3, No. 8, 2011, pp. 177-184.
[9] M.R. Duncan, C.R. Wassgren, C.M. Krousgrill, The damping performance of a single particle impact damper, Journal of Sound and Vibration 286 (2005) 123–144.
[10] Steven E. Olson, An analytical particle damping model, Journal of Sound and Vibration 264 (2003)
1155–1166.
[11] B. Moetakef-Imani, N.Z.Yussefian, Dynamic simulation of boring process, International Journal of Machine Tools & Manufacture 49 (2009) 1096–1103.
[12] B. Sathishkumar, K. M. Mohana Sundaram, and M. Senthil Kumar, Experimental Studies on Impact of Particle Damping on Surface Roughness of Machined Components in Boring Operation, European Journal of Scientific Research ISSN 1450-216X Vol.71 No.3 (2012), pp. 327-337.
[13] S. Chatterjee, On the principle of impulse damper: A concept derived from impact damper, Journal of Sound and Vibration 312 (2008) 584–605.
[14] R. D. Friend and V. K. Kinra, Particle Impact Damping, Journal of Sound and Vibration (2000) 233(1), 93}118.
[15] K. Ramesh, T. Alwarsamy, Investigation of Modal Analysis in the Stability of Boring Tool using Double Impact Dampers Model Development, ISSN 1450-216X Vol.80 No.2 (2012), pp.182-190.
[16] L. Andren, L. Hakansson, A. Brandt, I. Claesson, Identification of motion of cutting tool vibration in a continuous boring operation-correlation to structural properties, Mechanical Systems and Signal Processing 18 (2004) 903–927.