Review of Development of vibration control for chatter suppression in Application of boring bar

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Abstract - *Boring, also called as internal turning operation is the operation of enlarging the previously drilled hole. Boring operation uses cantilevered (i.e overhang) tooling which is less rigid than the tooling used for external turning. While machining deep hole it become necessary to use a tool with large length to diameter ratio. As this overhang increases this results deflection of boring bar which results in the vibration between a tool and a work piece. Vibration degrade the work piece surface quality as well as shorten the tool life. In this dissertation work passive damper (i.e .Nylon and PTFE) is used to suppress vibrations of boring bar and to improve the surface finish of the work piece as well as to increase useful life of the boring tool or boring bar. The experiments for boring operation are carried out on lathe by using boring tool with and without passive damper. The analysis is carried out using FFT analyzer. The machining parameters like spindle speed, feed and depth of cut are varied accordingly. The results i.e RMS value and surface roughness value Ra value are compared by using boring bar with and without damper. To determine natural frequencies and mode shape Modal analysis is also carried out.*

***Key Words*: Boring bar, passive damper, static stiffness, Vibration, Deflection, RMS Value, Modal analysis, FFT Analyzer, PTFE, Nylon, Surface Roughness**

1.INTRODUCTION

The development within production engineering is accompanied by increasing quality requirements of the produced work pieces. 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) Boring is used to achieve greater accuracy of the diameter of a hole. Boring bar vibration is a common problem during internal turning operations and is a major problem for the manufacturing industry. Stability is the keyword to turn bores to the appropriate criteria such as dimension tolerances and surface finish.

Boring operation uses cantilevered (i.e overhang) tooling which is less rigid than the tooling used for external turning. While machining deep hole it become necessary to use a tool with large length to diameter ratio. As this overhang increases this results deflection of boring bar which results in the vibration between a tool and a work piece. Vibration degrade the work piece surface quality as well as shorten the tool life. There are several ways that can be established by the different methods such as Active damping system, passive damping system or semi active damping system for the stability of that boring bar. By using this damping system the vibration from boring bar minimizes or reduces.

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. Hence, it is important to limit vibrations of the machine tool structure as their presence results in poor surface finish, cutting edge damage, and irritating noise.

2. LITERATURE REVIEW

1] Lorenzo Daghini, Andreas Archenti, and Cornel Mihai Nicolescu paper explains that a novel design for boring bar with enhanced damping capability. The principle followed in the design phase was to enhance the damping capability minimizing the loss in static stiffness through implementation of composite material interfaces. The use of composite material in the design of damped tool has been demonstrated effective. Furthermore, the autoregressive moving average (ARMA) models presented in this paper take into consideration the interaction between the elastic structure of the machine tool and the cutting process to characterize the machining system in operational conditions

2] M. Senthil kumar et al. 2011 worked on particle damping technique for the control of vibrations in boring bar. He investigated the efficiency of particle damping in vibration attenuation of boring bar using damping particles like copper and lead. In this , Boring bar is drilled in which damping particles were embedded in longitudinal hole. Experimental investigations were carried out by giving an impact pulse by an impact hammer to the bar held as a cantilever beam. Damping performances of these particles having various sizes were observed and compared .Natural frequencies of the solid boring bar acting as a beam were compared with those of the drilled boring bar.

3] Zhehe Yao et al. worked on chatter suppression by parametric excitation. In this study, the effect of parametric excitation with a time delay feedback was studied using the averaging method. They validated the effect of parametric excitation on chatter suppression through the cutting experiments using Magneto-Rheological (MR) fluid-controlled boring bar. The effect of parametric excitation on the self-excited vibration system was studied regardless of the generation mechanisms of the self-excited vibration. The regenerative effect is the most common effect that generates chatter in the machining processes. Therefore, they studied the regenerative effect for the stability analysis of the cutting vibration system. Parametric excitation effects on chatter suppression were investigated by experimental validation and theoretical analysis. The cutting experiments using magneto-rheological fluid controlled boring bar showed remarkable effects on chatter suppression.

4] Henrik Akesson et al.concentrated on studying the various clamping conditions of boring tool. They worked on the effect of different clamping properties on the dynamic properties of clamped boring bars. They discussed about Euler Bernoulli modeling of clamped boring bar with emphasis on the modeling of the clamping conditions. Experimental investigation results show variation in dynamic characteristics of boring bar as per the changes in the clamping positions of boring bar. is investigated experimentally.

5] Deqing Mei et al. proposed an MR fluid-controlled chatter suppressing boring Bar. They established a dynamic model of an MR fluid-controlled boring bar based on an Euler–Bernoulli beam model. FEM analysis. was applied for designing the magnetic field and concluded that it can be used suppress the chatter by adjusting the damping and natural frequency of the system. Experimental results regarding the vibrations at the structure's tip in different spindle speeds validated the model and demonstrated chatter suppression in a boring process and reduced the chatter.

6] C.R.Kulgod, T.A.Jadhav study the effect of different fibre orientation on the damping of the boring bar, full factorial experimental analysis has been performed. For simple tool and coated tool, readings were taken under the same cutting conditions to check the performance of each tool. They observed that magnitude of amplitude goes on decreasing as spindle speed is increases. For more depth of cut the magnitude of amplitude is higher. As the feed rate of boring bar increases value of amplitude also increases. From the experimental analysis it is observed that, the boring bars which are coated with carbon fibre with different fibre orientation gives the damping effect when compared to simple boring bar.

7] M.H. Miguelez , L.Rubio, J.A.Loya , J.Fernandez-Saez focused on the behavior of boring bars with a passive dynamic vibration absorber (DVA) for chatter suppression. The boring bar was modeled as a cantilever Euler–Bernoulli beam and only its first mode of vibration was considered. The stability of the two-degree-of-freedom model was analyzed constructing the stability diagram, dependent on the bar characteristics and on the absorber parameters (mass, stiffness, damping, and position). This work is focused on the design improvement of passive dynamic absorbers (DVA) for chatter suppression in boring operations. The boring bar, being the main structure, was modeled as a Euler-Bernoulli beam, accounting only the first vibration mode. Moreover, subsequent local analysis performed in this work, allowed the establishment of simple analytical expressions for the tuning frequency improving the behavior of the system against chatter.

8]Pranali Khatake et al. introduced a vibration attenuation technique for boring bar through the implementation of passive damper. They used damping particles within the boring bar and experimental investigation was undertaken to observe the surface finish of specimen using different overhang lengths of boring bar during operation. The results proved that the chatter of the tool is suppressed at a larger amount which means the self excited vibrations of the boring tool are reduced.

9]Gaurav Saindane, Amit Jakikore, Asst. Prof. Ashish Umbarkar introduces an experimental investigation of vibration damping in boring using passive damper, to enhance the damping capability, minimizing the loss in static stiffness through implementation of passive damper (i.e. Nylon and Polyurethane). The results proved that passive vibration damper from nylon material is more effective than polyurethane.

10] Shrikant Waydande, Prof. D. A. Mahajan Prof.(Dr.) S. Y. Gajjal use Two Passive dampers (one is Aluminum & PTFE and second is PTFE Materials). PTFE .It explain that irrespective of higher values of machining process parameters such as spindle speed, feed rate depth of cut the passive damper made of composite material reduce the level of vibration by approximately 25 % as compared to PTFE.

11] A.M.Badadhe, S. Y. Bhave, L. G. Navale select the combination of optimum cutting parameters which will result in better surface finish. Machining with optimum cutting parameters will result in minimum machining time and hence increasing the productivity. Four parameters viz. spindle speed, feed, depth of cut and length to diameter (L/D) ratio of boring bar has been taken as control factors. The Analysis of Variance (ANOVA) was carried out to find the significant factors and their individual contribution in the response function i.e. surface roughness.

12]S. Devaraj, D. Shivalingappa, Channankaiah, Rajesh S Jangaler , investigates the improvement of surface quality of boring operation using fine particle impact damper.The fine particle impact damping offers a better damping method. Due to its conceptual simplicity, potential effectiveness over a wide frequency range, temperature and degradation insensitivity and cost-effectiveness, particle damping is an attractive passive damping. The fine particles embedded within small hole in a vibrating structure to dissipate the exciting energy thereby damping the vibrations.

3. PROBLEM STATEMENT

Boring operations associated with serious vibration related problems. To reduce the problem of vibration and ensure that the desired shape and tolerance are achieved, extra care must be taken with production planning and in the preparations for the ma- chining of a work-piece. A thorough investigation of the vibrations involved is therefore an important step toward solving the problem.

The diameter and length of boring bar are the most important factor has to be considering in boring operation, following the other cutting parameter such as cutting speed, feed rate and depth of cut. The wrong selection of combination cutting parameter will occurs the bad cutting condition e.g. vibration that effect the poor surface finish. Different work piece material with different property and microstructure give different effect to the cutting tool performance.

In boring operation, the performances of cutting tools are depending on a few cutting conditions and parameters. The proper selection of feed rate has direct effect to the product surface roughness. Turning process by maximizing cutting speed and depth of cut will optimize the cutting process and minimize the production cost. The tool life, machined surface integrity and cutting forces are directly dependent on cutting parameters and will determine the cutting tool performances. The study of surface roughness form will re- solve the characteristic and phenomena happening during the machining process.

It is well known that the machining parameters of the cutting system like cutting speed, cutting feed (feed rate), and depth of cut (which are known as process parameters). affect the tool life and subsequently the quality of product. Influence of the cutting feed in a wide range of cutting parameters.

1) Influence of the cutting feed under the optimal cutting temperature:-Understanding the influence of the cutting feed under the optimal cutting temperature is important in the selection of the optimal cutting system

2) Influence of the depth of cut :-When the depth of cut increases and the uncut chip thickness is kept the same, the specific contact stresses at the tool–chip interfaces. By using passive damper increase in the depth of cut should not change the tool wear rate if the machining is carried out at the optimum cutting regime.

3) Influence of Tool length :-Using long tool length may set excessive vibrations, noise that could be efficiently controlled by use of damped boring bar

4. METHODOLOGY

4.1 Experimental work:-

In this Project work a passive damper is used to investigate the performance of boring tool under vibratory conditions. The experiments for boring operation are carried out using boring tool with and without passive damper. The frequency domain analysis is carried out using FFT analyzer. The machining parameters are varied by changing spindle speed, feed rate and depth of cut.

The boring operations were carried out on a lathe machine. The work piece was mounted in a chuck. The machining parameters like feed ,speed, depth of cut etc. were selected based on the manufacturers recommendations and were changed according to the proposed conditions. Passive damper (i.e Nylon and PTFE) is introduced in between the tool insert and tool holder . The length of passive damper on boring bar and overhang length was changed. The Fast Fourier Transform (FFT) analyzer and accelerometer were used to obtain the readings. To measure the boring bar vibrations generated at the point of cutting, the accelerometers should be mounted in maximum possible close vicinity of the tool-work interface point. The deflections were measured in terms of acceleration by accelerometer. The results in the form of vibration acceleration (i.e.RMS value) and surface roughness (i.e.Ra value) are compared for conventional boring tool and boring tool fitted with passive damper and without damper

4.2 Modal analysis

It is used to determine the natural frequencies and mode shapes of the structure. The natural frequencies and mode shapes are important in the design of a structure for dynamic loading conditions. A modal analysis is a technique used to determine the vibration characteristics of structures:

1) Natural frequencies– at what frequencies the structure would tend to naturally vibrate.

2)Mode shapes–In what shape the structure would tend to vibrate at each frequency.

Modal analysis is performed on Ansys software

5. CONCLUSIONS

An innovative method is proposed to reduce the vibration of the boring bar in boring operation by using passive damper. The passive damping technique has vast potential in the reduction of deflection. Passive dampers are also relatively cheaper than other damped boring bars and has a good effect in improving surface finish in boring operation.

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