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A Review on use of Damping Materials to Reduce Vibrations during Turning in Lathe Machine

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ABSTRACT

Vibration in metal cutting is familiar to every machine tool operator. This phenomenon is recognized in operations such as internal turning, threading, grooving, milling, boring and drilling, to which there are several reasons why this problem occurs. Some are related to the machine tool itself, to the clamping of the tool, the length and diameter of the tool holder and the cutting data to be used. More of this will be discussed later. There will be several different actions to consider when solving this problem. Reducing the process parameters is one such consideration, however, this could have a negative effect on productivity. Our focus, therefore, will be easy hands on recommendations for productive solutions and easy to use products. This strategy will be emphasized throughout this guide, which will also contain useful information relating to the tool holder e.g. clamping methods, extensions and the types of inserts that can be used. The aim, with this paper on hand, is to study the role packing materials below the tool shank in reducing vibrations produced during turning process. The paper studies and reviews various techniques proposed for vibration reduction and further proposes a methodology to carry out an experiment in this regard.

Keywords: *Machine, Vibration, Monitoring, Damping material etc*

INTRODUCTION:

A lathe machine is the mechanical device in which work piece is rotated against a suitable cutting tool for producing cylindrical forms.

Within the metal cutting processes, the turning process is one of the most fundamental metal removal operations used in the manufacturing industry. The quality of surface roughness is an important requirement of many work pieces in machining operations. Surface roughness, which is used to determine and evaluate the quality of a product, is one of the major quality attributes of a turned product.

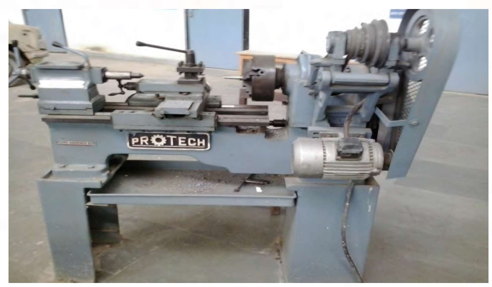

Fig-1 Centre Lathe

Surface finish is the method of measuring the quality of a product and is an important parameter in machining process. It is one of the prime requirements of customers for machined parts. Productivity is also necessary to fulfill the customers demand. For this purpose quality of a product and productivity should be high. In addition to the surface finish quality is also an important characteristic in turning operation and high MRR is always desirable [2]. Even in the occurrence of chatter or vibrations of the machine tool, defects in the structure of the work material, wear of tool, or irregularities of chip formation contribute to the surface damage in practice during machining [1].

Although under certain conditions the surface finish is predictable from a knowledge of the feed, nose radius, the depth of cut and cutting speed have the most decisive influence. The deeper the cut and heavier feed may cause deflections in the tool and the work piece giving rise to wavy pattern and chatter marks. Cutting speed which coincides with a natural frequency of the machine tool will create excessive motion between the machine tool elements and naturally will be reflected in a poorer surface finish. Even if all the mechanical conditions are properly taken care of, the metal cutting process itself will contribute a number of unbalancing factors.

As a result of intense development work of the cutting edge, the capability of the cutting tools has been increased considerably. Under certain conditions vibrations of the structural system may occur, and as with all types of machinery, these vibrations may be divided into three basic types:

Free or transient vibrations: resulting from impulses transferred to the structure through its foundation, from rapid reversals of reciprocating masses, such as machining tables, or from the initial engagement of cutting tools. The structure is deflected and oscillates in its natural modes of vibration until the damping present in the structure causes the motion to die away.

Forced vibrations: resulting from periodic forces within the system, such as unbalanced rotating masses or the intermittent engagement of multitooth cutters (milling), or transmitted through the foundations from nearby machinery. The machine tool will oscillate at the forcing frequency, and if this frequency corresponds to one of the natural frequencies of the structure, the machine will resonate in the corresponding natural mode of vibration.

Self-excited vibrations: usually resulting from a dynamic instability of the cutting process. This phenomenon is commonly referred to as machine tool chatter (chatter vibra-tions) and, typically, if large tool-work engagements are attempted, oscillations suddenly buildup in the structure, effectively limiting metal removal rates. The structure again oscillates in one of its natural modes of vibration.

The free and forced vibrations are generally controllable but Chatter vibrations are less easily controlled and metal removal rates are frequently limited because the operator must stop the machine to improve the machining conditions.

In turning operation, tool vibration is a common problem and it affects the performance of a machine, tool life and surface finish of the work material. The standard procedure adopted to avoid vibration during machining is by careful planning of the cutting parameters and damping of cutting tool. There have been many investigations on vibration prediction and control in turning.

2) NECESSITY:

It is much more important to limit vibrations during machining operation in machine tool because

1. Vibrations in machine tool results in poor surface finish, cutting edge damage, and irritating noise.

2. It also results in dimensional accuracy.

3. It also hampers productivity.

3) PROBLEM STATEMENT:

The dynamic motion between work piece and cutting tool during turning operation produce vibrations at the interface of tool and work piece which result in unacceptable surface finish and dimensional errors. The present paper is to review the use of vibration damping material during turning operation and propose a methodology to carry out experimentation in this regard.

4) MATERIALS FOR VIBRATION DAMPING:

Damping is the capacity of a mechanical system to reduce the intensity of a vibratory process. The damping capacity can be due to interactions with outside systems or due to internal performance- related interactions. The damping effect for a vibratory process is achieved by transforming (dissipating) mechanical energy of the vibratory motion into other types of energy, most frequently heat, which can be evacuated from the system. D.D.L.Chung [3] i) Metals: Metals like shape memory alloys (SMA), ferromagnetic alloys and other alloys. Shape memory effect refers to the ability of material to transform to a highly twinned phase known as martensite. Beyond certain stress martensite starts to form from austenite and results into elongation which provides damping. Ferromagnetic alloys provide damping through magneto mechanical mechanism. Other alloys provide damping through their micro structural design.

ii) Polymers: Polymer has a viscoelastic behavior and hence provides a good damping to vibrations with less cost. Rubber is well known for its damping ability. However it suffers from its low stiffness, which results in low value of loss of modulus. Other polymers like neoprene, polytetrafluoroethylene (PTFE), polyurethane, polypropylene, polyamide etc.

iii) Ceramics: As ceramics has high stiffness value, it acts like a damping material to some extent. Most widely used ceramic is the concrete. For improving its damping property, admixture like latex is added into the concrete.

Passive damping is now the major means of suppressing unwanted vibrations.

5) LITERATURE REVIEW:

Wenhai Fu, D.D.L. Chung [4] studied vibration reduction ability of thermoplastics Polymethylmethacrylate (PMMA), Polytetrafluoroethylene (PTFE), Polyamide – 66 (PA-66), acetal and a thermoset epoxy by dynamic flexural testing at $\leq$1.0 Hz. Vibration reduction can be attained by increasing the damping capacity (which is expressed by the loss tangent, tan δ) 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 vibration reduction. Among thermoplastics (PMMA, PTFE, PA-66 and acetal) and a thermoset (epoxy), PMMA exhibits the highest value of the loss modulus, while PTFE exhibits the highest value of the loss tangent. Neoprene rubber is exceptionally low in loss modulus, although it is exceptionally high in the loss tangent. Epoxy and acetal exhibit the lowest values of the loss tangent.

Dr.Pratesh Jayaswal, et al. [5] in this paper they carried out experiment on center lathe machine measured vibration using vibrometer. They measure vibration in axial and tangential direction at tool post and Bearing, vibration signal collected through vibrometer data acquisition system they were varied parameter at four level and plotted graph between r.m.s value verses feed rate at different spindle speed and at depth of cut finally they were conclude that the parameter which is highly affect the vibration is cutting speed then depth of cut and then feed rate. The optimal condition for working on centre lathe machine is cutting speed of 230-350 rpm, feed rate of 0.1-0.2 mm/rev and depth of cut up to 1 mm so it is not advisable to work on high cutting speed, feed rate and more depth of cut because it directly affect the tool life it also shows that vibrations at bearing and in tangential direction are highly occurred comparatively at tool post and in axial direction.

K.G.Nikam, et al.[6] conducted experiments using L9 orthogonal array in a SPEED LX 200 MAJOR CNC lathe machine. Turning process was carried out on the EN 8 steel. The optimum cutting condition was determined surface roughness were evaluated by the analysis of variance (ANOVA). The results obtained were Highest surface finish (lowest Ra) is obtained at a cutting speed of 200 m/min, feed rate of 0.2 mm/revolutions and a depth of cut of 0.5mm.Best surface roughness is obtained from CNMG 120412 FC insert than other two type of insert. The results of ANOVA for surface roughness show that feed rate is most significant parameter which affects the surface finish than other cutting parameters. The cutting speed and depth of cut are least significant parameters. Best surface roughness at high cutting speed (i.e. 250 m/min) is obtained from CNMG 120412 FC insert. S. S. Abuthakeer, et al. [7] has worked on the cutting tool vibrations and control of cutting tool vibration using a damping pad made up of neoprene. Experiments were conducted in CNC lathe, were the tool holder is supported with and without damping pad. The cutting tool vibration signals were collected through a data acquisition system supported by Lab VIEW software. To increase the buoyancy and reliability of the experiment a full factorial experimental design was used. The experimental studies and data analysis have been performed to validate the proposed validate proposed damping system. The online tests show that the proposed system reduced the vibrations of cutting tool to a greater extend. The vibration analysis was done without any damping pad under actual machining conditions. K. Adarsh Kumar, et al. [8] studied the effect of machining parameters speed, feed, depth of cut, on surface roughness for face turning operation using EN-8. Regression Analyses (RA) technique is used to study the effect of these parameters and their interaction on surface roughness. An empirical equation is formed by using Regression Analyses (RA) in Mini-Tab software to predict the surface roughness. The surface roughness model produced during this research work may be used in enhancing the surface quality of a product as cutting parameters are optimized and can give better surface finish. In this paper observed the results the influence of cutting speed and feed rate and depth of cut on surface roughness, the test was performed and it was seen that the effect of feed rate is greater than the effect of cutting speed. The feed has the variable effect on surface roughness. The relationship between feed rate and surface roughness is proportional, increasing the feed rate, increases the surface roughness. On surface roughness, the effect of feed rate is more considerable than cutting speed.

6) CONCLUSION:

Losing productivity in favour of keeping the process running is not beneficial. Productivity is the number one important issue in being competitive. The use of a vibration free Tool while retaining or in many cases improve productivity can be achieved through use of appropriate clamping methods by applying methods to reduce vibration, we can use various damping materials like polymers like neoprene, polytetrafluoroethylene(PTFE), polyurethane, polypropylene, polyamide etc. So research work will be on to perform turning tests on EN8k material by variation of suitable machining parameters namely Speed, feed, depth of cut and measurement of process output parameters and vibration parameters with and without PTFE and Nylon 66 respectively packing liners for Carbide Insert Cutting Tool.

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