GE-International Journal of Engineering Research
Vol. 3, Issue 10, Oct 2015 IF- 4.007 ISSN: (2321-1717)

Website: www.aarf.asia Email : editor@aarf.asia, editoraarf@gmail.com

DYNAMIC ANALYSIS OF VIBRATION IN LATHE TOOL POST DURING TURNING OPERATION

B. Shanmugasundaram[1] , P. Suresh Prabhu[2]

[1]Research Scholar, Mechanical Engineering, Karpagam University, India

[2]Department of Research, Karpagam University, India

ABSTRACT

Active vibration control technique is very important for increasing life of various components and structure. It results in lower fatigue, better accuracy, and low maintenance. In turning operation, chatter or vibration is a frequent problem, which affects the result of machining and in particular surface finish. Tool life is also influenced by vibration. As the vibrations cannot be eliminated completely during machining, control of the same is possible. The objective is to control the vibration in lathe tool post during turning operation using various stripper materials (Anti-vibration materials). The analysis of vibration in lathe tool post during turning operation is done using ANSYS software and the results are compared.

KEYWORDS - ACTIVE VIBRATION CONTROL, ANTI-VIBRATION MATERIALS, CUTTING TOOL VIBRATION, DAMPING SYSTEM, TOOL LIFE.

1. INTRODUCTION

Today's manufacturing industry demands higher productivity with preserved or even smaller tolerances. The demand on high productivity leads to increased material removal per unit time and higher spindle speeds, increased feed rate, and greater depth of cut. However, at certain combinations of machining parameters; process instabilities and vibrations can occur which result in decreased accuracy, poor surface finish, reduced tool life time and in the worst case spindle failure.

2. CUTTING TOOL VIBRATION

Machining is a complex process in which many variables can be deleterious to the desired results. Among them, cutting tool vibration is the most critical phenomenon which influences dimensional precision of the components machined, functional behavior of the machine tools and life of the cutting tool. In a machining operation, the cutting tool vibrations are mainly influenced by cutting parameters like cutting speed, depth of cut and tool feed rate. However during machining operation, vibration occurs and it cannot be avoided. But can be reduced to the desired extent by using various techniques. Our research deals with the reduction of vibration during turning operation using various damping materials. The various damping materials are Hamamat, Vidam, Neoprene, Chloroprene, etc.

2.1. DAMPING SYSTEM

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.

Effects of damping on performance of mechanical systems are due to reduction of intensity of undesirable resonances; acceleration decay (settling) of transient vibration excited by abrupt changes in motion parameters of mechanical components; prevention or alleviation of self-excited vibrations; prevention of impacts between vibrating parts when their amplitudes are reduced by damping; potential for reduction of heat generation, and thus for increase in efficiency due to reduced peak vibratory velocities of components having frictional or micro impacting interactions; reduction of noise generation and of harmful vibrations transmitted to human operators and more. This occurrence of vibration during machining has greater impacts on the tool and workpiece. Tool is subjected to wear, loss of life and even instant breakage. Similarly workpiece also greatly influenced by these vibrations. The effects are poor surface finish, reduced dimensional accuracy, poor quality and even resulting in a noisy workplace.

2.2. TOOL LIFE

Surface roughness is a commonly encountered problem in machined surfaces. It is defined as the finer irregularities of surface texture, which results from the inherent action of the production process. Consequently, surface roughness has a great influence on product quality, and the part functional properties such as lubricant retentively, void volume, load bearing area and frictional properties. Furthermore a good-quality machined surface significantly improves fatigue strength, corrosion resistance, and creep life.

Surface finish plays an important role in affecting friction, wear, and lubrication of contacting bodies. Furthermore, it is well known that the final geometry of surface roughness is influenced by various machining conditions such as spindle speed, feed, and depth of cut, tool flank wear, and vibration level (chatter). One of the most significant factors affecting the performance of machine tools is chatter. Chatter not only limits productivity of cutting processes but also causes poor surface finish and reduced dimensional accuracy, increases the rate of tool wear, results in a noisy workplace and reduces the life of a machine tool.

3. MODEL ANALYSIS WITH STEEL PAD

Any physical system can vibrate, the frequencies at which vibration naturally occurs, and the model shapes which the vibrating system assumes are properties of the system, and can be determined using model analysis. Model analysis is frequently utilized to abstract the model parameters of a system, including natural frequencies, mode shapes and model damping ratio.

In this model analysis, steel material is used as a strip and the vibration level is obtained in the form of amplitude and frequency for turning operation. Various factors like density, young’s modulus, poisson’s ratio, damping co-efficient and cutting forces are fed as input. Figure 1 shows the frequency Vs amplitude for steel pad.

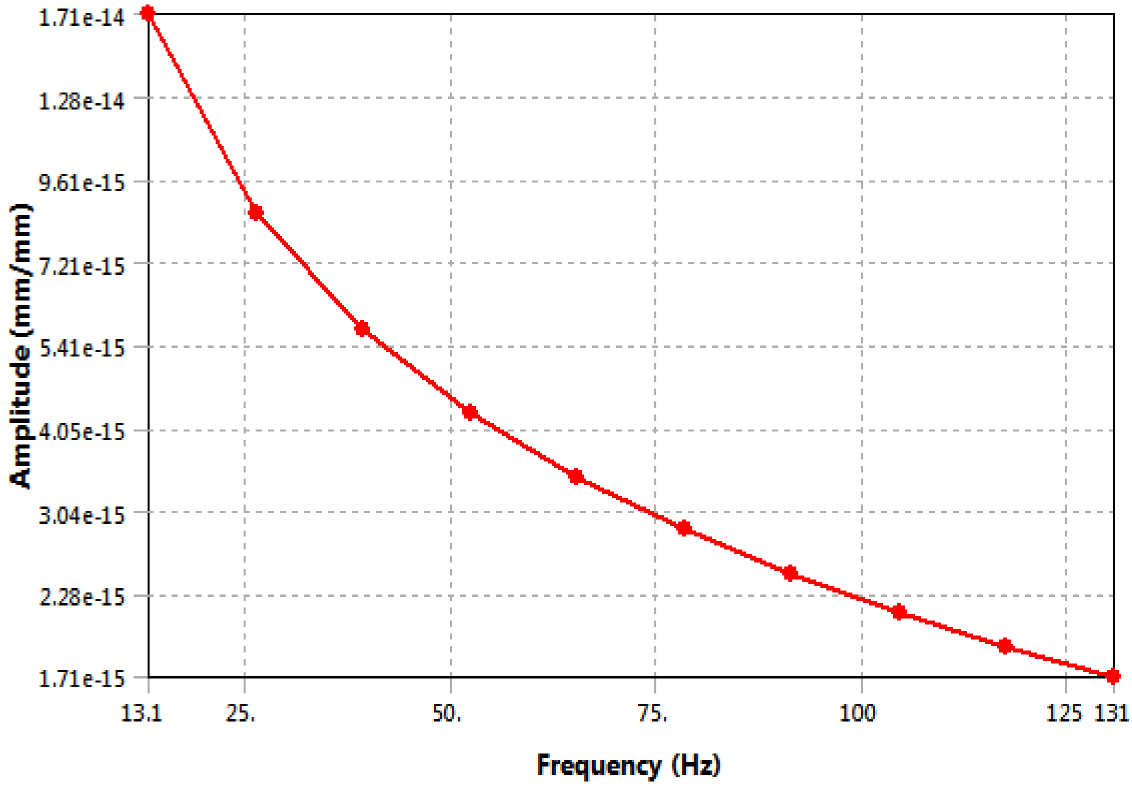

FIGURE 1: FREQUENCY Vs AMPLITUDE FOR STEEL PAD

4. MODEL ANALYSIS WITH HAMAMAT PAD

Farrat Hamamat is a very high load capacity resilient seating and damping material made from fibre reinforced Neoprene. It is compression moulded and made up of high grade Chloroprene (CR) / Neoprene rubber reinforced with microscopic Santo web fibres to increase strength and stiffness. Hamamat features are high load bearing capacity, high structural damping characteristics, excellent ozone, oil and general chemical resistance, long lifetime (in excess of 60 years).

In this model analysis, hamamat material is used as a strip and the vibration level is obtained in the form of amplitude and frequency for turning operation. Various factors like density, young's modulus, poisson's ratio, damping co-efficient and cutting forces are fed as input. Figure 2 shows the frequency Vs amplitude for hamamat pad and Figure 3 shows the frequency response for hamamat pad.

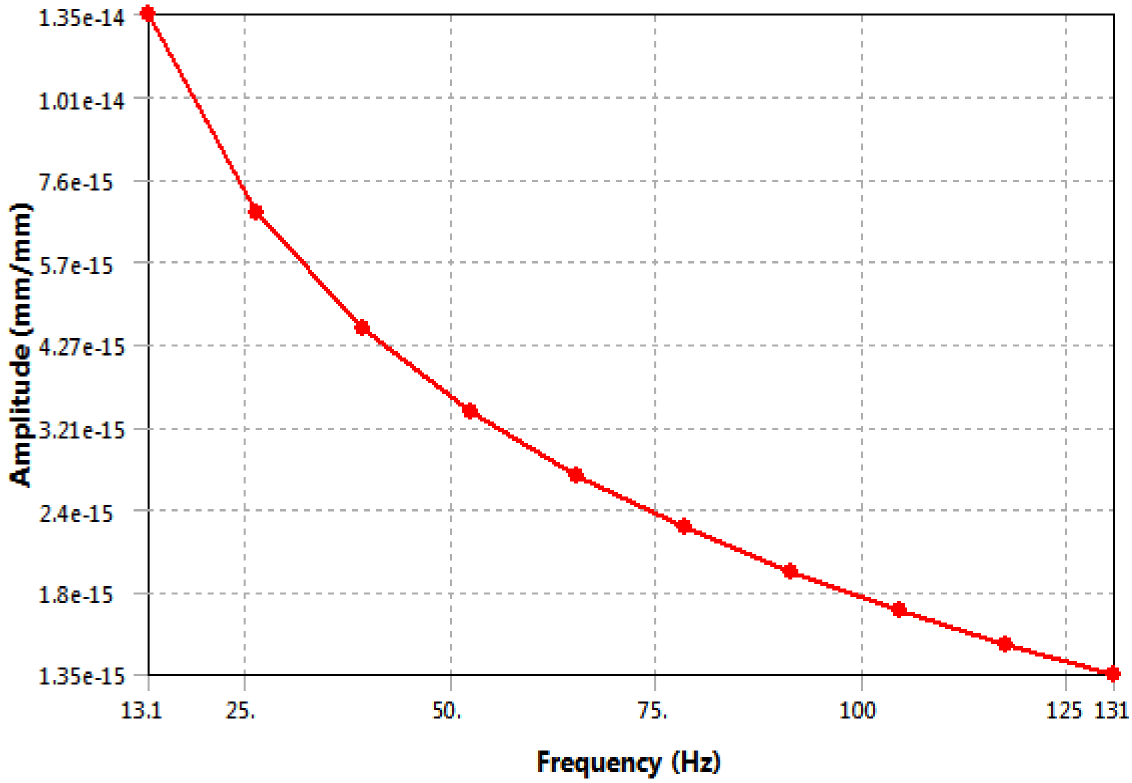

FIGURE 2: FREQUENCY Vs AMPLITUDE FOR HAMAMAT PAD

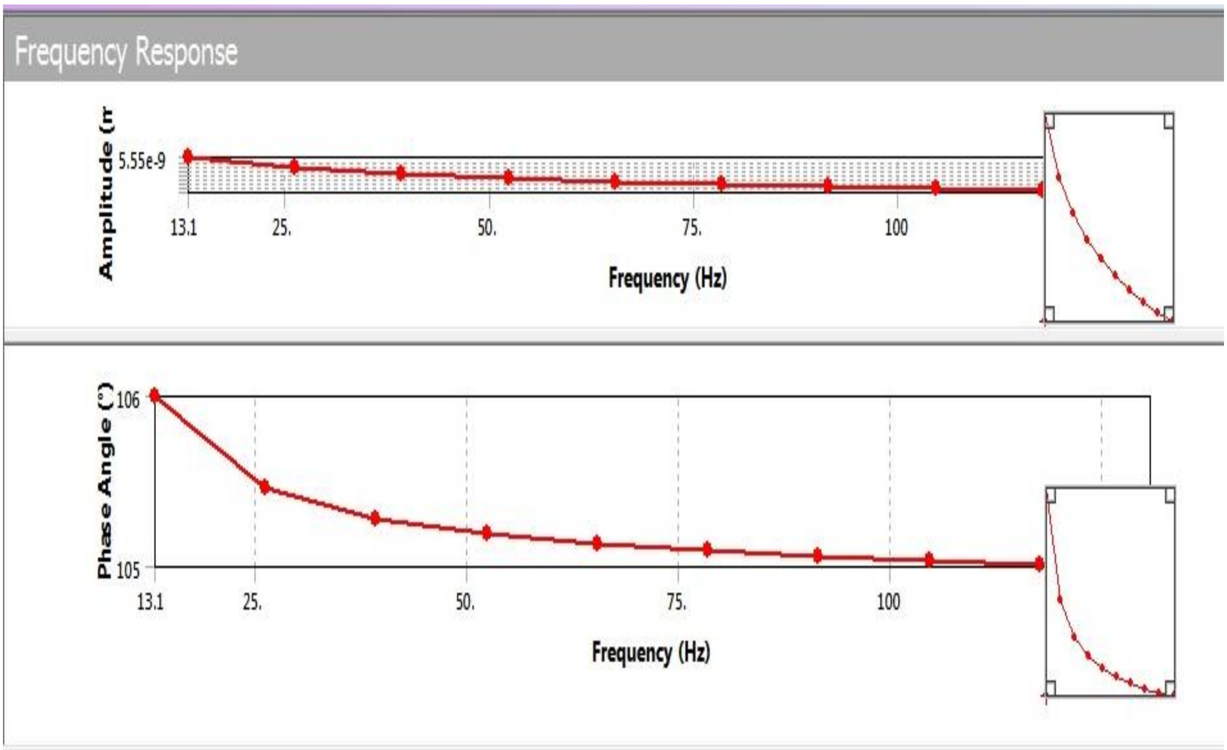

FIGURE 3: FREQUENCY RESPONSE FOR HAMAMAT PAD

CONCLUSIONS

The vibration phenomenon for two different materials has been analyzed using ANSYS software. The aim of the research is to assess the material with less vibration by keeping the cutting speed, feed rate and depth of the cut as constant for both the material. The passive damping pad is provided below the cutting tool elements. The same experiment was carried out for various materials to assess further. Figure 1 and 2 shows the comparison of vibration in tangential direction with steel pad and with hamamat damping pad respectively.

In this course of study, analysis was done on ANSYS and comparative study is done for steel strip and a damping material (Hamamat). The cutting parameters such as cutting speed, depth of cut and feed rate are kept constant. Hamamat as damping material reduces vibrations compared to the steel strip. The use of damping material will also improves surface finish, tool life and accuracy. Other damping materials are also taken into account and further analysis is to be carried out to suggest the best material.

REFERENCES

1. D. Dimla, Sensor Signals for Tool-Wear Monitoring in Metal Cutting Operations - A Review of Methods, *International Journal of Machine Tools and Manufacture, 40, 2000, 1073–1098.*
2. Claudiu F. Bisu, Philippe Darnis, Alain Gérard, and Jean-Yves K'nevez, Displacements Analysis of Self-Excited Vibrations in Turning, *International Journal of Advanced Manufacturing Technology, 2008, 126–135.*
3. M.S. Selvam, Tool Vibration and its influence on Surface Roughness in Turning, *International Journal of Manufacturing Technology, 35, 1975, 149-157.*
4. T. Alwarsamy, R. Balasubramanian, K. Raja Kumar, and B. Sankarasubramanian, Improvement of Stability by Optimal Parameters using Genetic Algorithm, *Advances in Vibration Engineering, 2(4), 2003, 388-404.*
5. Harpreet Singh, S.P. Singh, and V.P. Agarwal, Active Vibration Control of a Beam using Virtual Instrumentation Software, *International Conference on Smart Materials, Structures and Systems, India, 1999, 443–448.*
6. John L. Yang, and Joseph C. Chen, A Systematic Approach for Identifying Optimum Surface Roughness Performance in End-Milling Operations, *Journal of Industrial Technology, 17(2), 2001.*

7. J.N. Keraita, H.J. Oyango, and G.K. Misoi, Lathe Stability Charts via Acoustic Emission Monitoring, *African Journal of Science and Technology, Science and Engineering Series, 2(2), 2001, 81-93.*

8. J. Lipski, G. Litak, R. Rusinek, K. Szabelski, A. Teter, J. Warminski, and K. Zaleski, Surface Quality of a Work Material Influence on Vibrations in a Cutting Process, *Journal of Sound and Vibration, 2000.*

9. Luke Huang, Joseph C. Chen, A Multiple Regression Model to Predict In-Process Surface Roughness in Turning Operation Via Accelerometer, *Journal of Industrial Technology, 17(2), 2001.*