Experimental Analysis of Boring Tool's by using Viscous Oil

Prof. S. M. Jadhav [1], Mr. Nikhil. N. Nangare[2]

[1]*Professor, Department of Mechanical Engineering, NBN Sinhgad School of Engineering, Pune, Maharashtra, INDIA.*
[2]*P.G.Student, Department of Mechanical Engineering, NBN Sinhgad School of Engineering, Pune, Maharashtra, INDIA.*

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Abstract - *Boring operation is used to enlarging the drilled hole. When the hole size is small in and depth is more, then the slender boring tool. The length to the diameter ratio of the boring tool is high and there is always a possibility of boring tool deflection. As the cutting forces are exerted at the free end of the boring tool, the vibration is unsurprisingly dispensed. The vibration produces the undesirable effects in the form of poor surface finish, reduced tool life etc. To minimize the level of vibration in the operation many researchers have used different techniques. These reductions techniques are mainly are of active and passive type. From the literature survey new vibration technique are becoming more popular due to its advantages.*

In this dissertation work viscous oil is used to investigate the performance of boring tool under vibration condition. The experiment for boring operation is carried out using boring tool. The frequency domain analysis is carried out using FFT analyzer. The machining parameters are varied by changing feed rate and depth of cut. The result of vibration acceleration and surface roughness are compare for convention boring tool. Overall vibration decreases and also helps to improve the surface finish.

1. INTRODUCTION. Machines are composed of various links and their assembly which are having relative motion, so vibrations are inherent. Any motion that repeats itself after an interval of time is called vibration. Whenever system is left to vibrate after an initial disturbance, it is called as free vibration and whenever it is subjected to an external force, it is known as forced vibration. The maximum displacement of vibrating body from its equilibrium position is called the vibration amplitude. Vibration amplitude represents the severity of the problem. The time taken to complete one cycle of motion is known as the period of oscillation or time period and the number of cycles per unit time is called the frequency of oscillation. Frequency of vibration is the indication of source of problem. Many times vibrations in machining may be desirable but most of the times it is undesirable due to its adverse effect on quality parameters of job. Machining vibrations mainly depends on various. parameters such as speed, feed rate, depth of cut etc. so it is desirable to minimize or control vibrations. Thus whenever it is not possible always to act on parameter which directly causes vibrations, there are two options available i.e. one can go for vibration isolation or vibration damping

This paper focuses boring process, as boring is one of the machining processes which include enlarging the drilled hole. In the boring operation a single point or multi-point cutting tool is held with holding fixture called as boring bar. It is fitted in tool post against the rotating work piece. Boring is thus also called as internal turning. The tool holding fixture is fixed at one end and free at other end. Cutting forces exerted on tool at its free end. So, it acts as cantilever or Euler Bernoulli beam. So as the depth of hole to be bored increases, length of bar also increases resulting in lowering stiffness and thus resulting in more vibrations. Thus if rigidity of cantilevered boring bar is not sufficient; it would directly affects the dimensional accuracy, tool wear rate and surface finish. Such effect becomes prominent when the length to diameter ratio of boring bar exceeds.

1.1 Boring Operation

In Process of enlarging a hole that has already been drilled by means of a single-point cutting tool of boring. Boring is used to achieve accuracy of the diameter of hole, and can be used to cut a tapered hole. There are various types of boring. The boring bar may be supported on both ends or it may be supported at one end Line boring implies the former. Backboringthe process of reaching through an existing hole and then boring on the "back" side of the work piece Because of the limitations on tooling design imposed by the fact that the work piece is surrounds the tool in terms of decreased tool holding rigidity, increased clearance angle requirements and difficulty of inspection of the resulting surface. The reasons why boring is an area of machining practice in its own right, with its own tips, and body of expertise, despite the fact that they are in some ways identical.

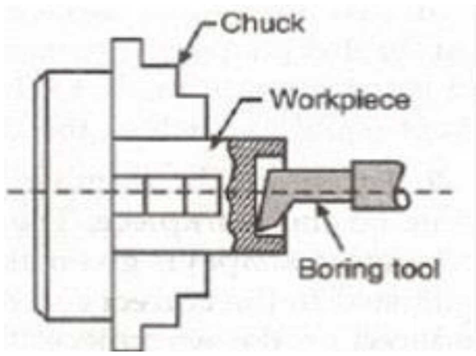

Fig. 1 Boring operation on a lathe

1.2 Vibration Basics

A motion repeats itself after an interval of time is called vibration. Mechanical systems are to vibrate if it can store energy in two different forms, in a way that energy can flow from one form to the other. Vibration is the process in which this energy exchange takes place. If a system, after an initial disturbance, is left to vibrate on its own, the ensuring vibration is known as free vibration. If a system is subjected to an external force the is known as forced vibration. A vibratory system is a dynamic system for which the variables The maximum displacement of body from its position is called the amplitude of vibration. The time taken to complete one cycle of motion is known as the period of oscillation called the frequency of oscillation.

2. PROBLEM DEFINITION

A operation is a metal cutting operation that bores deep, precise holes in the work piece and use to enlarge hole. A tool used to perform the boring operation. The boring bar is clamped at one end to a tool post or a collet and has a insert attached at the free end. The cutting tool is used to perform metal cutting in a bore or cavity of the workpiece. Since a boring bar is usually long and slender, it is tends to vibrate. Deep internal turning of a workpiece is a classic example of chatter-prone machining. Performing metal cutting under vibrating conditions will yield unsatisfactory results in terms of the surface finish of a workpiece, toollife and undesirable noise levels. In internal turning operations, the boring bar motion usually consists of force components in both the cutting speed direction and the cutting depth direction.

2.1 Objectives of work

1. To Development of passive damper to mitigate the level of vibration generated in case of beam system.

2. To find out the interrelation between the process parameters considered in the project (Speed, Feed, Depth of Cut).

3. To develop a generalized equation which can predict the level of vibration under the given set of condition.

2.2 METHODOLOGY

A boring operation is a metal cutting operation that bores deep, precise holes in the work piece and use to enlarge existing hole. A tool used to perform the boring operation is called boring tool and its characterized by great length in comparison to its diameter. The boring bar is clamed at the one end to the tool post or a collect and has an insert attached at the free end. The cutting tool is used to perform the metal cutting in bore of the work piece. Since a boring bar is usually long and slender, it is tend to vibrate. Deep internal turning of a work piece is a classic example of chatter prone machining. Performance metal cutting under vibration condition Will yield unsatisfactory result in team of the surface finish of a work piece, tool life and undesirable noise level.

3. LITERATURE REVIEW

1. Vibrations of a Beam with a Damping Tip Body.

We investigate a mathematical model for the dynamics of a beam with a tip body that experiences damping. The damping is due to granular material which partiaUy fills the tip body. We establish the existence of the unique solution to the model and analyze the model. Among other things, we establish exponential energy decay when damping is present. © 2002 Elsevier Science. Ltd. All rights reserved. In this work, we model and analyze the damped vibrations of a cantilever beam with an attached hollow-tip body that contains granular material. We establish the existence of the unique solution for the problem, and obtain estimates on the decay rate of the vibrations. In future work, we will develop ways to experimentally identify the damping coefficients contained in the model. For structures containing tip bodies, most of the existing literature [1-5] has focused on numerical or experimental analysis of vibration modes and on optimal control of the vibrations. Such work is motivated by the fact that successful manipulation of objects by robotic arms depends critically on damping any possible modes of vibration. More recently, granular materials have been considered as agents for damping vibrations of such structures [6]. Some recent experimental and parameter identification results on the behavior of a cantilever beam wrapped in a sleeve full of granular material can be found in [7,8]. The idea is that the internal frictional contact of the grains may generate a considerable amount of energy loss, which causes internal damping of the vibrations of the structure. From the mathematical point of view, probiems involving tip bodies lead to initial boundary value problems that contain acceleration terms in the boundary conditions, as well as in the equation of motion. Existence and uniqueness results for problems of this type may be found in [9,10]. However, the present problem contains more complicated boundary conditions than those treated previously.

2. Experimental analysis of vibration control in boring operation using passive damper.

Chatter is an unavoidable phenomenon during the machining process. Boring bars possess the cantilever shape and due to this, it is subjected to chatter. The undesirable effect of chatter increase in temperature which will leads to surplus tool wear. To beat these troubles, in this investigation, Nylon and Teflon damper is inserted onto the boring bar according to the overhang of the boring bar and also adequate clearance is provided in order to reduce the cutting temperature, displacement and tool wear. A conventional all-geared lathe is equipped with vibrometer, infrared thermometer and surface roughness tester, and is used to measure the displacement temperature and surface roughness of the components. The influence of input parameters such as cutting speed, depth of cut and feed rate are investigated. The response of the output parameters is recorded by the measuring the surface roughness of components, displacement and temperature of the cutting tool. The main objective of this paper is to introduce the vibration damping techniques in boring tool using passive damper. The optimum conditions to obtain better damping effects for chatter reduction is identified. The newly designed damped tool has been compared with conventional tool. It results shows it is much better than the conventional tool by means of enhance the damping competence; minimize the loss in static stiffness through execution of passive damper. The passive damping technique has vast potential in the reduction of deflection. In this research work is proposed to reduce the deflection of the boring bar in the boring operation. The results prove that the passive damping technique has vast potential in the reduction of deflection. Passive dampers are also relatively cheaper than other commercially available damper. It can therefore also be concluded that the passive damping has a good effect in improving surface finish in boring operation. Based on experimental results, the observations which were made in this research work are concluded and summarized. The Teflon passive damper equipped with the boring tool exhibited lower values of the surface roughness, vibration, feed, overhang length, cutting temperature, and tool wear. Teflon reduces 75% of vibration and 60% increased surface finish then conventional tool. Nylon reduces 65%of vibration and 50% increased surface finish then conventional tool.

3. VIBRATION SUPPRESSION OF BORING TOOL USING PARTICLE DAMPERS

The vibration suppression of boring tool using particle damping is analyzed experimentally by measuring acceleration response amplitude of boring tool for various damper configurations. Based on these results mathematical models are formulated by dimensional analysis along with regression analysis approach for boring tool with single cell and two-cell damper configurations. Initially the model is formulated for tool with single cell damper. To formulate the mathematical models for tool with two-cell damper, two approaches have been used. These models predict the effect of cutting and damper parameters on acceleration response amplitude of boring tool. The effect of particle damping on vibration response of a boring tool is analyzed experimentally. Based on the experimental results, initially a mathematical model is formulated for boring tool with single cell damper configuration using dimensional analysis approach. The model predicts accurate results as R2 is 0.91. Further, the mathematical models for twocell damper configurations are formulated by two approaches. The results obtained by both approaches are also accurate, as the percentage errors between experimental and analytical results are within the range. Based on experimental analysis, it is observed that the substantial reduction in acceleration amplitude is observed for 50 % packing ratio with single cell damper configuration. Nevertheless, two-cell damper also performs well at 25 % packing ratio. Thus, particle damping is one of the passive damping techniques used successfully to control the vibrations of machine tool structures, even though expected level of damping is comparatively small. In the next chapter, a comprehensive discussion on the results and conclusions of theoretical and experimental analysis of impact and particle dampers with its application to boring tool has been presented.

4. Experimental Analysis of Boring Tool vibrations with Passive Damping using FFT Analyzer.

Boring is one of the machining operations, which is most widely used in industry. In the case whenever depth of the hole to be bored is more compared to diameter of hole, there is need of slender boring tool. For slender boring tools the ratio of length to diameter is higher due to which while machining tool may deflect. At the time of boring, forces are exerted at free end which finally results in vibration. As vibrations are always undesirable so it has adverse effects on surface finish and tool life. So to reduce vibrations there are various techniques which can be mainly categorized as active and passive damping. In this experimentation passive damping is used to analyze behavior of boring tool under vibration. So experimentation is done with and without passive damping. FFT analyzer is used to carry out frequency domain analysis. The operating parameters such as Depth of cut in mm (0.3, 0.5 and 0.7), Spindle speed in RPM (300,500,700) and Feed Rate in mm/min (80,100,120) are varied. On the other hand, passive damper characteristics are varied by using damping particles of different sizes. The results are collected in the form of vibration acceleration and surface roughness, comparison is made among boring tool without passive damper and tool with passive damper. Analysis results show that, passive damping reduces vibration and enhances the surface finish.

5. Mechanics of boring processes

Mechanics of boring operations are presented in the paper. The distribution of chip thickness along the cutting edge is modeled as a function of tool inclination angle, nose radius, depth of cut and feed rate. The cutting mechanics of the process is modeled using both mechanistic and orthogonal to oblique cutting transformation approaches. The forces are separated into tangential and friction directions. The friction force is further projected into the radial and feed directions. The cutting forces are correlated to chip area using mechanistic cutting force coefficients which are expressed as a function of chip-tool edge contact length, chip area and cutting speed. For tools which have uniform rake face, the cutting coefficients are predicted using shear stress, shear angle and friction coefficient of the material. Both approaches are experimentally verified and the cutting forces in three Cartesian directions are predicted satisfactorily. The mechanics model presented in this paper is used in predicting the cutting forces generated by inserted boring heads with runouts and presented in Part II of the article A comprehensive model of single point boring operations has been presented. The chip geometry removed by curved boring inserts is modeled as a function of tool geometry, feedrate and radial depth of cut. Due to irregular distribution of chip load around the insert's cutting edge, the amplitudes and directions of distributed cutting forces change as a function of tool geometry and cutting conditions. As a result, the cutting forces in boring have Fig. 20. Comparison of measured and predicted tangential, radial and feed forces using orthogonal to oblique transformation method. a linear dependency with the chip area, but non-linear dependency with the feedrate and radial depth of cut. The cutting coefficients are evaluated mechanistically by conducting cutting tests at different feeds, speeds and depth of cuts with inserts having irregular rake face geometry. The cutting coefficients are estimated by correlating the chip geometry and forces using regression analysis. The cutting coefficients for inserts having smooth rake faces are modeled using orthogonal to oblique transformation method. The models are experimentally proven for single point boring bars used in industry. The models allow the process engineers to investigate the influence of insert geometry, feed, speed and radial depth of cut, boring forces, torque and power. The model is an essential foundation to study the forced and chatter vibrations in boring operations with single point boring bars and multi-insert boring heads.

4. DEVELOPMENT OF PASSIVE DAMPER

Boring is a process of producing circular internal profile on a hole made my drilling or another process. It used single point cutting tool call boring bar. In boring, the boring bar can be rotated, or the work part can be rotated. Machine tool which rotates the boring bar against a stationary work piece are called as boring machine. Boring can be accomplished on a turning machine with a stationary boring bar positioned in the tool post and rotating work piece held in the lathe chuck. The boring process can be executed on various machine tools, including general-purpose or universal machines, such as lathes or milling machines. Machining centres and machines designed to specialize in boring as a primary function, such as jig borers and boring machines or boring mills, which include vertical boring mills work piece rotates around a vertical axis while boring bar/head moves linearly; essentially a vertical lathe and horizontal boring mills.

A. Influence of Vibration on Boring Process

The Cutting system is well understood as a particular combination of the cutting speed, cutting feed and depth of cut. It is well known that the listed parameters of the cutting system affect the tool life and subsequently the quality of product. Influence of the cutting feed in a wide range of cutting parameter. The uncut chip thickness or the cutting feed has a direct influence on the quality, productivity, and efficiency of machining. It is that tool life decrees with increasing cutting feed.

B. Influence of cutting feed

Understanding the influence of the cutting feed under the optimal cutting temperature is important in the selection of the optimal cutting system because the optimal combination of the cutting speed and feed should be used in the practice of metal cutting.

C. Influence of Tool Length

Using short tool length always provide good surface roughness no matter what cutting parameters level or type of boring bar are used only slight improvement on surface roughness can be achieved by properly controlling cutting speed, feed rate or tool nose radius. Using long tool length may set excessive vibration, noise that could be efficiently controlled by use of damped boring bar.

5. DESIGN AND DEVELOPMENT OF PASSIVE DAMPER

The design and development of passive damper for cantilever type structure is presented. The utility of the passive damper is now well establish and development of one of such becomes the important task. The schematic arrangement of mechanical system with damping element is shown below

Active Control

The objective of active vibration control is to reduce the vibration of a mechanical system by automatic modification of the system's structural response. The principle of active control vibration in machining to analyze in time the signal emitted during machining, recognize instability and compensate for it. This method consists a tool design with piezoelectric actuators and force sensors with inter changeable tool head. An active control system for boring using accelerometers to tool for providing the controller both reference and error signal. The signals are processed and sent eventually to the actuators located in the tool clamp, compensates by providing dynamic forces to boring bar. The apparent advantage of the active vibration control approach is the perfect adaptability to the changes.

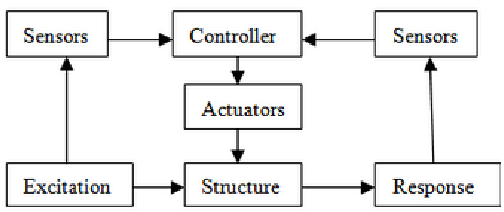

Fig. 2 Structure with Active Control System

Semi Active Control

Semi active control systems are a class of active control systems for which is the external energy requirements are smaller amounts than those of typical active control. Cannot add or remove energy to the structural system, but can control in real time parameters of the structure such as spring stiffness or coefficient of viscous damping.

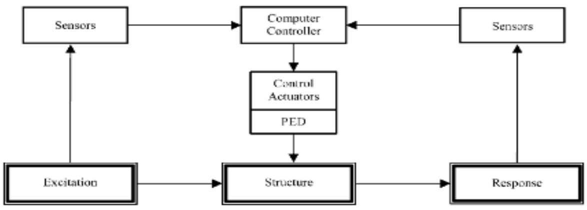

Fig.3 Structure with Semi-Active Control System

Passive Control

The principle of vibration passive control is to convert the mechanical energy into some other forms, for instance heat. A common way to achieve passive damping is by using viscoelastic materials to dissipate the energy that causes vibration. Implementing such a solution of vital importance for the design to properly locate the pre-stressed composite layers in the structure to optimally exploit the property material to give largest deformation in shear.

Comparison between Active, Semi-Active and Passive Damping Systems

The passive control System does not need complicated hardware and the end-user does not need to introduce new handling routines. Advantages of using passive damping system such as low cost, Predictable response, robustness, low complexity and ease to implementation ensures use of passive control system rather than active system in machining especially boring operations. A passive system does not require any sensing, computing or actuation mechanisms and can thus be relatively inexpensive to manufacture and implement. Passive systems developed and currently used for energy absorption.

6. DEVELOPMENT OF BORING TOOL

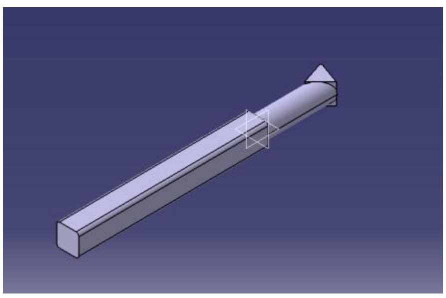

Fig.4 Boring Tool without Hole.

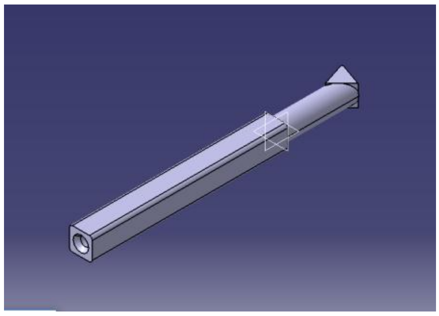

Fig.5 Boring Tool with Hole.

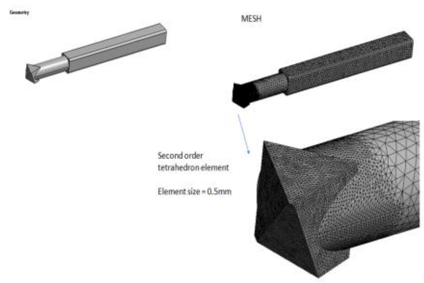

Fig.6 Geometry and Meshing.

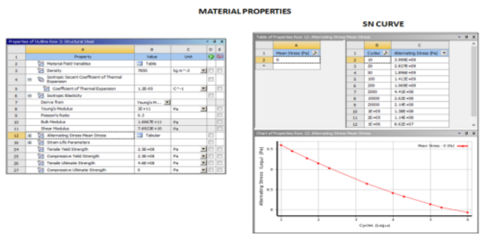

Fig.7 Material Properties.

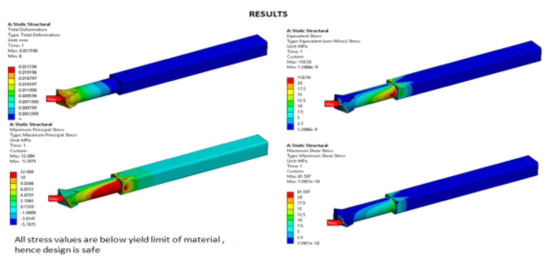

Fig.8 Result

Fig.9 Boring Tool

Fig.10 Hole at End for Oil (8mm Diameter)

Surface Testing

Fig 11 Specimen

Fig 12 Testing Result of Specimen

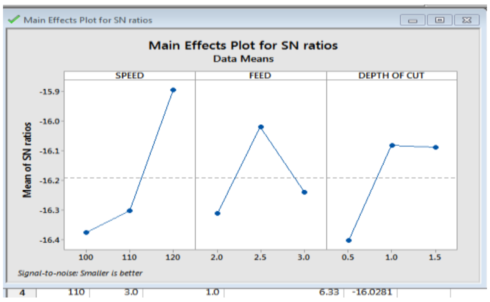

Fig 13 SN diagram of Specimen

7. CONCLUSIONS, FUTURE SCOPE and REFERENCES

CONCLUSIONS

Following conclusions were made from the results analysis carried out in the previous chapter

1. The level of vibration decreases by 40 % due to installation of passive damper on boring tool.

2. Due to reduction of boring tool vibration the surface finish enhances.

3. From the contour plots it is observed that irrespective of higher values of machining processes parameters such as spindle speed, feed rate depth of cut the passive damper reduce the level of vibration.

FUTURE SCOPE

One can carry out by Different Oil of the passive damper to see stress distribution and deformation. There is also a scope to try the different geometries and material for the passive damper to see the effectiveness of the damper.

REFERENCES

[1]. L. Rubio, J.A.Loya, M.H.Miguelez, J.Fernandez-Saez, Optimization of passive vibration absorbers to reduce chatter in boring, Mechanical Systems and Signal Processing Volume 4, Issue 4, pp-691–704, (2003).

[2]. I Saidi, A D Mohammed, E F Gad, J L Wilson, N Haritos, Optimum Design for Passive Tuned Mass Dampers Using Viscoelastic Materials, Australian Earthquake Engineering Society Conference. Volume 4, Issue 4,pp-547-562, (2007).

[3]. Mohan D. Rao, Recent applications of viscoelastic damping for noise control in automobiles and commercial airplanes, Journal of Sound and Vibration Volume 5, Issue 4 pp-457– 474 (2007)

[4]. K. Venkata Rao, B.S.N. Murthy, N. Mohan Rao, Cutting tool condition monitoring by analyzing surface roughness, work piece vibration and volume of metal removed for AISI 1040 steel in boring, Measurement Volume 3, Issue 4 pp-4075–4084, (2011).

[5]. Lonnie Houck III, Tony L. Schmitz, K. Scott Smith, A tuned holder for increased boring bar dynamic stiffness, Journal of Manufacturing Processes 13 Volume 4, Issue 3 pp-24–29, (2011).

[6]. Henrik Akesson, Tatiana Smirnova, Lars Hakansson, Ingvar Cleasson, Thomas Lago, Investigation of the Dynamic Properties of a Boring Bar Concerning Different Boundary Conditions, ICSV14 Cairns , Australia Volume 3, Issue 4 pp-9-12, (2012).

[7]. Istvan L. Ver and Leo L. Beranek, Noise and Vibration Control, Principles and applications, John Wiley and Son, Inc, second edition, Volume 5, Issue 4 pp-109-112, (2012).

[8]. Malcolm J. Crocker, Handbook Of Noise And Vibration Control, John Wiley & Sons, Inc., United States at (317) Volume 2, Issue 4 pp-572- 599,(2013).

[9]. R. Keith Mobley, Vibration Fundamentals, Boston Oxford Auckland Johannesburg Melbourne New Delhi, Volume 4, Issue 4 pp-52- 59,(2013).

[10]. Allan G. Piersol and Thomas L. Paez, Harris' Shock and Vibration Handbook, McGraw Hill Publication Sixth edition, Volume 6, Issue 4 pp-72-99,(2013).

[11]. C.M.A. Vasques, R.A.S. Moreira and J. Dias Rodrigues, Viscoelastic Damping Technologies–Part II: Experimental Identification Procedure and Validation, Journal of Advanced Research in Mechanical Engineering, Volume 3, Issue 3 pp-711-731,(2013).

[12]. K. Ramesh, T. Alwarsamy, Investigation of Modal Analysis in the Stability of Boring Tool using Double Impact Dampers Model Development, European Journal of Scientific Research ISSN 1450-216X Vol.80 Issue.2, pp.182-190, (2014).

[13]. Lorenzo Daghini, Andreas Archenti, and Cornel Mihai Nicolescu, Design, Implementation and Analysis of Composite Material Dampers for Turning Operations, World Academy of Science, Engineering and Technology 53 Volume 6, Issue 4 pp-121-131 (2014).

[14]. M. Kaymakci, Z.M. Kilic, Y. Altintas, Unified cutting force model for turning, boring, drilling and milling operations, International Journal of Machine Tools & Manufacture Volume 9, Issue 7 pp-221-236 (2014).

[15]. Viktor P. Astakhov, Effects of the cutting feed, depth of cut, and workpiece (bore) diameter on the tool wear rate, International Journal of Advance Manufacturing Technology, Volume 14, Issue 7 pp-6831-706 (2015).

[16]. T.Alwarsamy, S.Vetrivel and S. Nadarajan, Theoretical Cutting Force Prediction and Analysis of Boring Process Using Mathcad, World Applied Sciences Journal 12 (10) Volume 25, Issue 4 pp-1021-1036 (2014).