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Lathe machine tool vibration minimization by using lapping layer of carbon fiber material

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ABSTRACT - Boring is a commonly used operation to enlarge the existing holes of machine structures. When boring tool is slender and long, it is subjected to excessive static deflections or self-excited chatter vibrations which are detrimental to the accuracy and surface finish of the hole. It also causes accelerated wear and chipping of the tool. Internal turning frequently requires a long and slender boring tool in order to machine inside a cavity, and the vibrations generally become highly correlated with one of the fundamental bending modes of the boring tool. Different methods can be applied to reduce the vibrations, the implementation of the most efficient and stable methods require in-depth knowledge concerning the dynamic properties of the tooling system. Furthermore, the interface between the boring tool and the clamping house has a significant influence on the dynamic properties of the clamped boring tool. This report focuses on the behavior of a boring tool that arises under different overhang lengths which are commonly used in the manufacturing industry.

Keywords – Lathe Machine, Carbon, fiber.

I. INTRODUCTION

In a boring operation, the boring tool is subjected to dynamic excitation, due to the material deformation process during a cutting operation. This will introduce a time varying deflection of the boring tool. If the frequency of the excitation coincides withone of the natural frequencies of the boring tool, a condition of resonance is encountered. Under such circumstances the vibrations are at a maximum, thus the calculation of the natural frequencies is of major importance in the study of vibrations.

Bending vibration is major type of vibration in the boring tool caused by the forces from the cutting process. The force is applied at the cutting tool and the force originates from the chip deformation process during a cutting operation. Most realistic structural systems are characterized by the ability to support transverse shear as well as having internal stiffness.

II. PROBLEM STATEMENT

During deep boring process, usually when l/d (overhang length/boring tool diameter) ratio is higher, the excessive vibrations are induced at tip of boring tool which hampers the surface finish consequently quality of the products. Moreover it reduces life of cutting tool. Hence, vibration of boring tool is reduced by means of applying carbon fibre composite layers as a passive damper with different orientations of fibre.

III. OBJECTIVES

1. To develop anew technique to reduction of vibration in boring operation.

2. To study the analytic behavior of boring tool under different cutting conditions.

3. To analyses the effect of carbon fiber lapping with different angle of layer and optimize vibration.

4. To analyses the vibration response of laminated tool by experimental result.

IV. FUTURE SCOPE

In this study, a finite element analysis of boring tool with and without the damper, with different layer configuration will be carried out. The experimental set-up will be designed to study the effect of various cutting parameters on the boring tool. It is proposed that the configurations of the polymer based composite should be selected such that it gives maximum damping effect. The results obtained by finite element analysis will be validated with experimental analysis.

V. METHODOLOGY

The stiffness and damping of the boring tool should be increased in order to reduce the vibration. In this project, to achieve the maximum damping effect, the boring tool is laminated with carbon fibre with different fibre orientations. Four different boring tools were laminated

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with carbon fibre with 0 orientations. To assess the effect of carbon fibre on the acceleration amplitude, experimentation is carried out with different cutting parameters.

5.1 Construction of the Damped Boring Tool

The carbide tip steel boring tool of diameter 16 mm is used for the boring of mild steel work piece of 100 mm diameter. Because of dynamic stiffness and natural frequency of high-speed steel, boring with high slenderness ratio is very difficult as it induces vibrations in boring operation. It is difficult to perform a boring operation at low feed rate, low speed and high depth of cut due to poor properties of the boring tool.

Steel has less stiffness as compared to the composite material. Hence to improve longitudinal and bending stiffness, lamination of carbon fiber with different 0 orientation was done on the shank of the Boring Tool.

Adhesive used for lamination of a carbon fiber is the epoxy resin. Epoxy resin is not only act as an adhesive but also it improves the stiffness of the structure.

Fig.5.1 Photograph Standard and Laminated Boring Tool

5.2 FEA Analysis

Tool Length 96mm without lamination

Fig. 5.2 shows finite element model of without lamination.

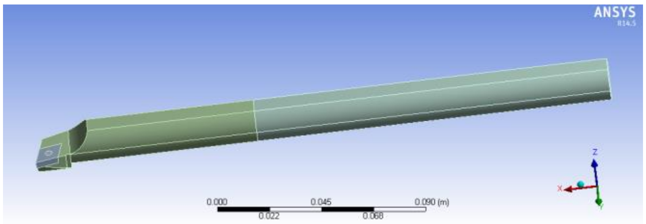

Fig. 5.3 3D geometry of 96mm tool withoutlamination Meshing model

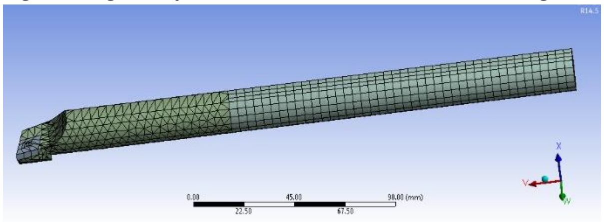

Fig 5.4 Meshing model of 96mm tool without laminationFixed support

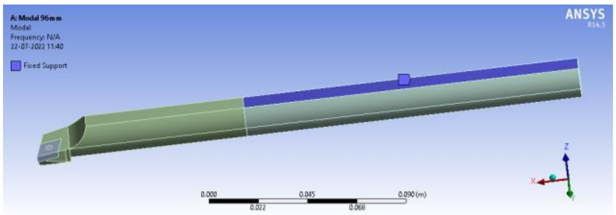

Fig 5.5 Fixed support applied to 96mm tool without lamination

5.3 Modal Result of 96mm tool without lamination

Tabular Data

	Mode	Frequency [Hz]
1	1.	1404.6
2	2.	1473.5
3	3.	7369.1
4	4.	7647.7
5	5.	9200.6
6	6.	13543

Table 5.1 Frequency of all mode shape at 96mm tool without lamination

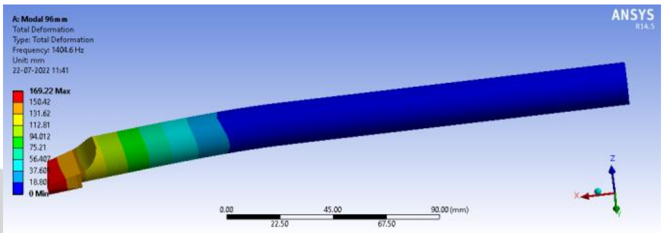

Fig5. 6 Mode shape 1 deformation of 96mm tool without lamination

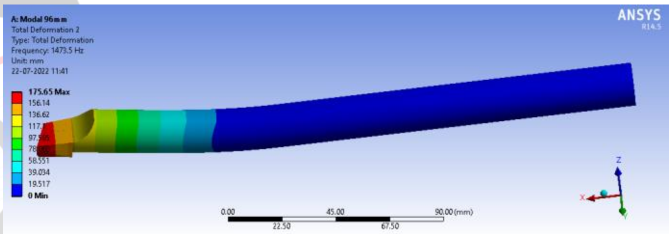

Fig 5.7 Mode shape 2 deformation of 96mm tool without lamination

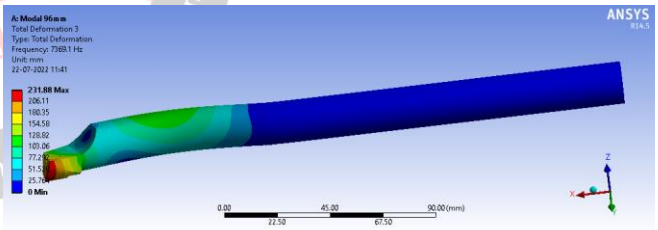

Fig 5.8 Mode shape 3 deformation of 96mm tool without lamination

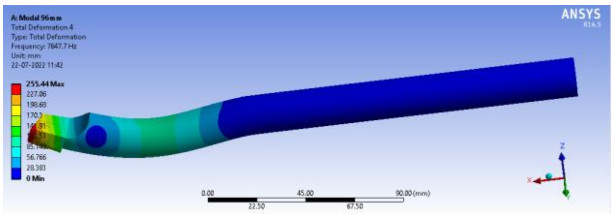

Fig 5.9 Mode shape 4 deformation of 96mm tool without lamination

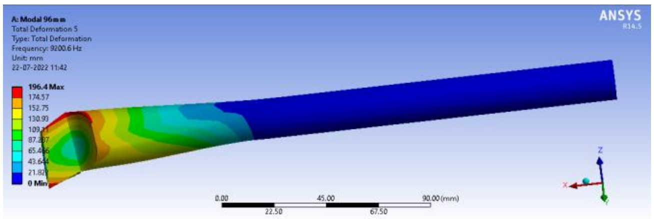

Fig 5.10 Mode shape 5 deformation of 96mm tool without lamination

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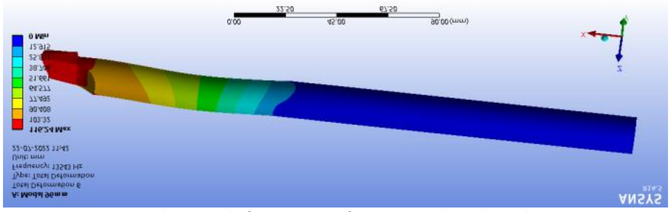

Fig 5.11 Mode shape 6 deformation of 96mm tool without lamination

Tool Length 96mm with lamination

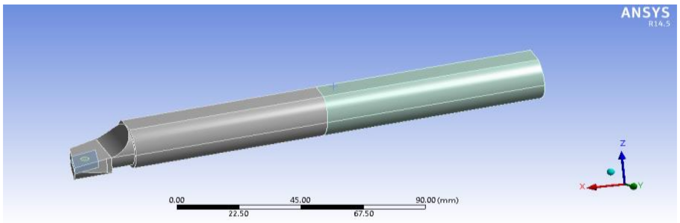

Fig. 5.12 3D geometry of 96mm tool with lamination Meshing

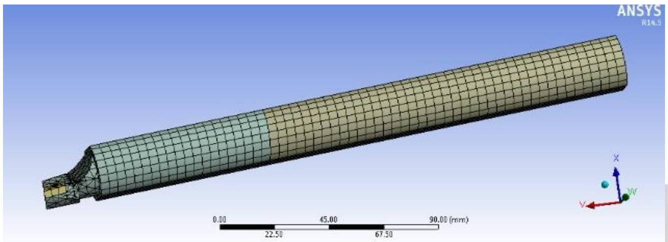

Fig5. 13 Meshing model of 96mm tool with lamination Fixed Support

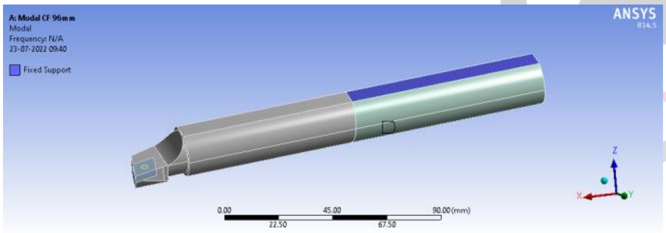

Fig 5.14 Fixed support applied to 96mm tool with lamination

5.4 Modal Result of 96mm tool with lamination

Tabular Data

	Mode	Frequency [Hz]
1	1.	1629.2
2	2.	1781.7
3	3.	8172.7
4	4.	8707.5
5	5.	9704.5
6	6.	13627

Table 5.2 Frequency of all mode shape at 96mm tool with lamination

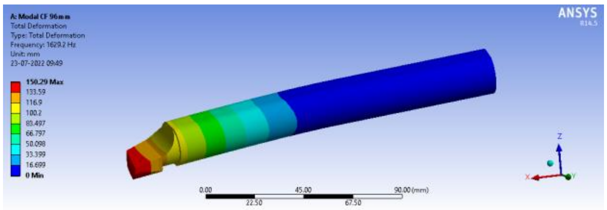

Fig 5.15 Mode shape 1 deformation of 96mm tool withlamination

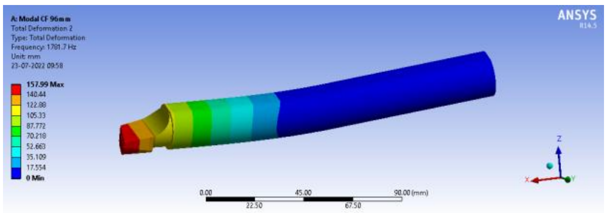

Fig 5.16 Mode shape 2 deformation of 96mm tool with lamination

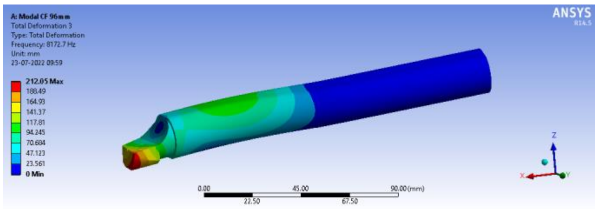

Fig 5.17 Mode shape 3 deformation of 96mm tool with lamination

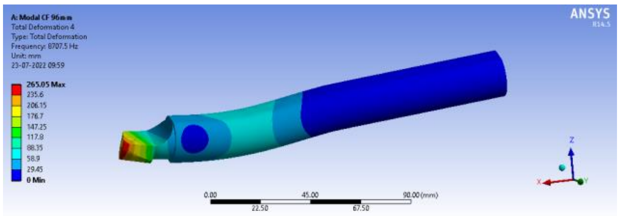

Fig 5.18 Mode shape 4 deformation of 96mm tool with lamination

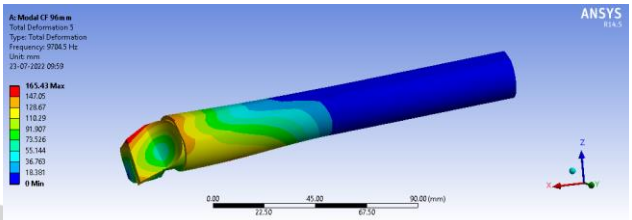

Fig 5.19 Mode shape 5 deformation of 96mm tool with lamination

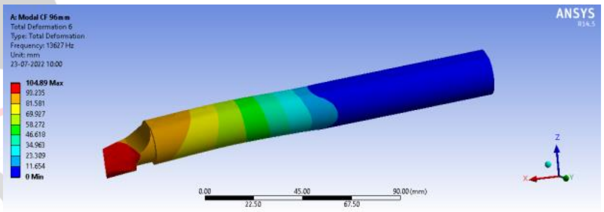

Fig 5. 20 Mode shape 6 deformation of 96mm tool with lamination

VI. RESULTS

Result of Harmonic Analysis

	Acceleration Amplitude (m/s^2)		
Overhang Length(mm)	Standard Tool	Cross 0^0 FibreOrientation	% Reduction in AccelerationAmplitude
96	103.2	88	14.23002
	213.79	190.8	10.75354
112	225.54	69.88	69.01658
	132.85	46.08	65.31426
128	296.21	74.78	74.7544
	271.75	113.88	58.09384

Table 6.1

VII. RESULTS AND DISCUSSION

In order to study the effect of different fiber orientation on the damping of the boring tool, four tools were prepared. First the pilot experiments were performed to investigate the performance of each boring tool. At first by keeping spindle speed and feed rate constant i.e. 710 R.P.M. and 0.05 mm/rev respectively, 9 readings were taken by using combination of overhang tool length (96 mm, 112 mm,

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128 mm) and depth of cut (0.1 mm, 0.2 mm, 0.3 mm). From the pilot experiments, it is found that the tool with cross 10- degree lamination and cross 45-degree lamination gives the better results over the other two tools.

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