Analysis of Natural Frequencies of Cantilever Beam Using Ansys

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Abstract - *Experimental Modal Analysis (EMA) is a method to predict the behavior of a system by effectively using the modal or vibration data. It helps in understanding and evaluating the dynamic behavior of a system in actual scenario. In this paper, an attempt is made to study the free vibration analysis of the cantilevered beams of different materials and lengths. The results obtained theoretically are cross checked using the ANSYS simulation package.*

Key Words: EMA, ANSYS, Natural Frequencies, Vibration, Mode Shape.

1. INTRODUCTION

Vibration analysis is very significant from the design point of view. It gives an idea about the dynamic behaviour of the structural elements in the actual harsh working environments. The information collected from the vibration data helps the designer to make the necessary changes in the design to avoid the resonance condition of extreme amplitude of vibration, thereby increasing the reliability of the system. So it is imperative to design the system prior to installation to avoid its vibration born failures. Beam structures find widespread applications. They are found in various configurations like fixed-fixed, fixed-free, overhang, continuous etc. as per the application [1]. The parameters for all such configurations differ from application to application. Defects may exist as residue from production stage or form during its service and because of those vibrating components could to lead catastrophic let-down, so it is required to diagnose changes in dynamic behaviour of damaged and undamaged structure [2]. The non-destructive testing is very useful technique that obtains information of interior region of structure without any damage to it. It contains many branches like liquid penetrant, magnetic particles, eddy current, ultrasonic testing, modal analysis, etc. This paper gives the Comparison of change in natural frequencies with respect to change in dimension on ANSYS and theoretically respectively [3].

2. THEORY

The frequency of a simple uniform cantilever beam with rectangular cross section can be obtained from the following equation:

$$\omega_n = \frac{1}{2\pi}(\beta l)^2 \sqrt{\frac{EI}{\rho A L^4}}$$

Where,

A = area of cross section of beam

L = length of the beam

ρ = density of material

EI = equivalent bending stiffness and is the constant relative to the vibration bound condition.

Using the formula, we can derive the fundamental mode shape frequencies of the beam specimens of different materials [1].

3. SPECIFICATION

Table -1: Beam Specification

Material	Unit	Aluminium	Brass	Steel
Length	mm	480	480	480
Width	mm	30	30	30
Thickness	mm	5	5	5
Density	Kg/m³	2800	8600	7800
Young's Modulus	GPa	72	110	190

4. MODAL ANALYSIS ON ANSYS

Using the ANSYS software the below results are obtained [5] [6].

4.1 ALUMINIUM

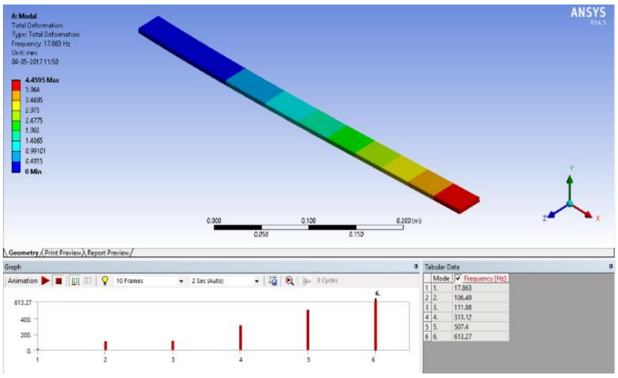


Fig -1: Original Dimension

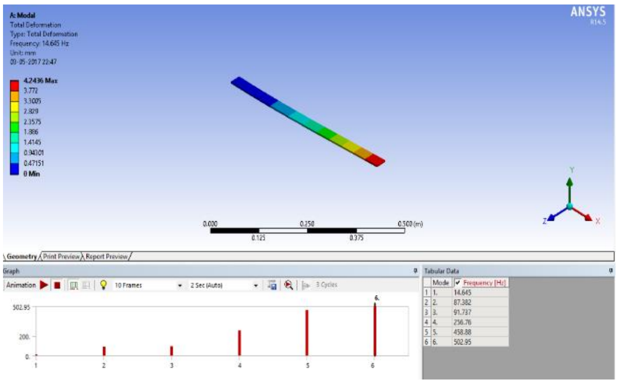


Fig -2: Long

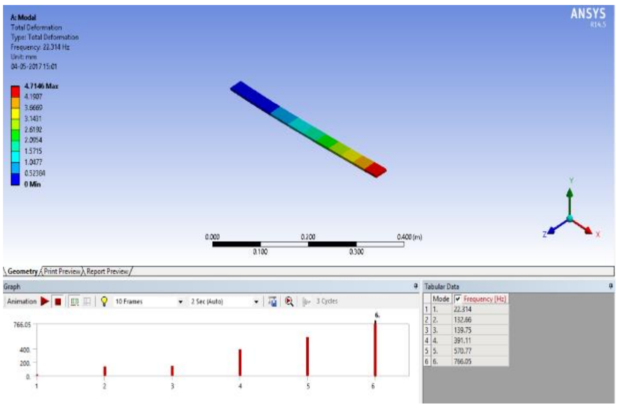


Fig -3: Short

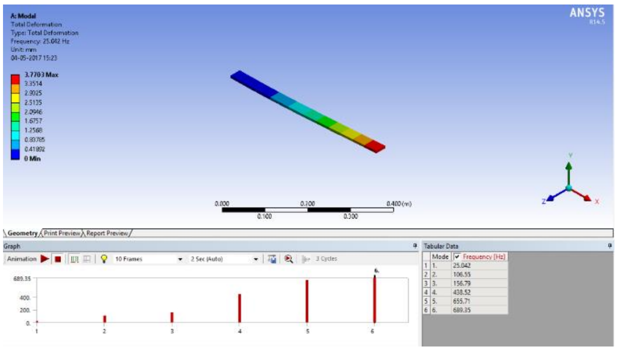


Fig -4: Thick

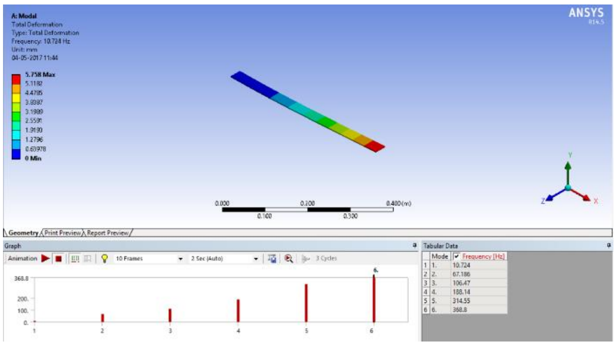


Fig -5: Thin

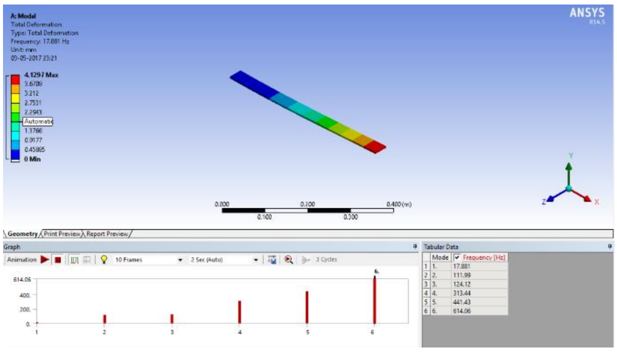


Fig -6: Wider

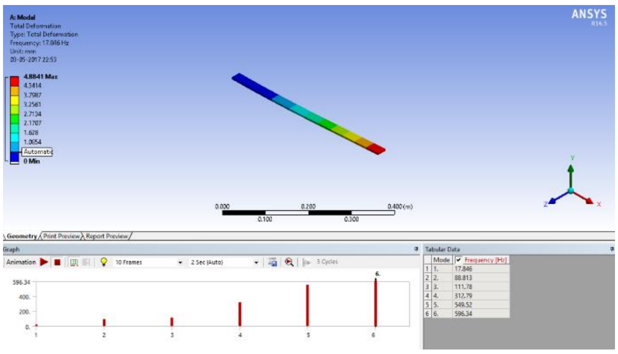


Fig -7: Narrow

Table -2: Frequencies for Aluminium at 1st Mode

ALUMINIUM			
Dimension	L×B×D (mm)	ANSYS Frequencies	Theoretical Frequencies
Original	480×30×5	17.863	17.3115
Long	530×30×5	14.465	14.19
Short	430×30×5	22.314	21.57
Thick	480×30×7	25.042	24.236
Thin	480×30×3	10.724	10.386
Wide	480×35×5	17.881	17.297
Narrow	480×25×5	17.864	17.31

Where L= Length, B=Width, D=Depth/Thickness.

4.2 BRASS

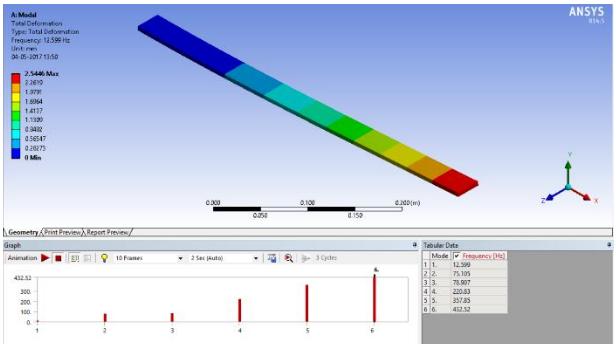
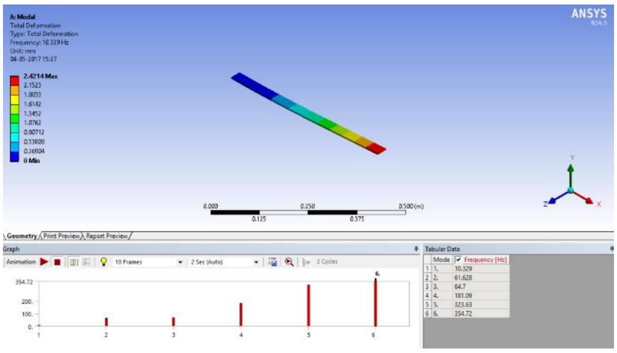


Fig -8: Original



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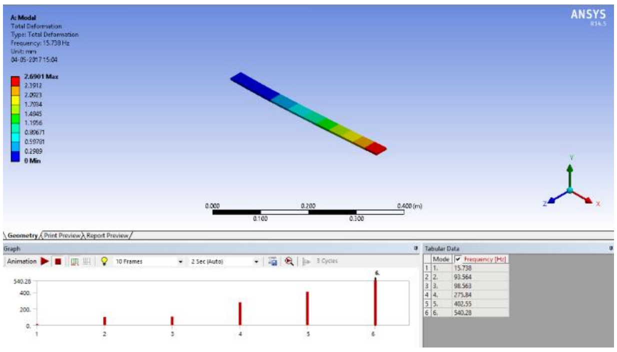

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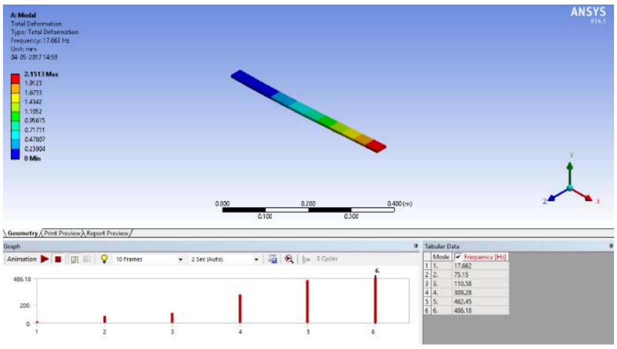
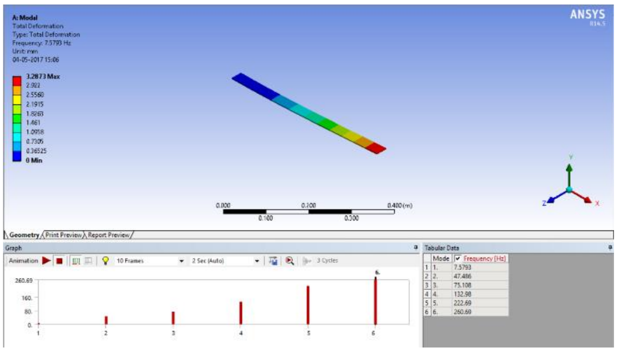


Fig -11: Thick



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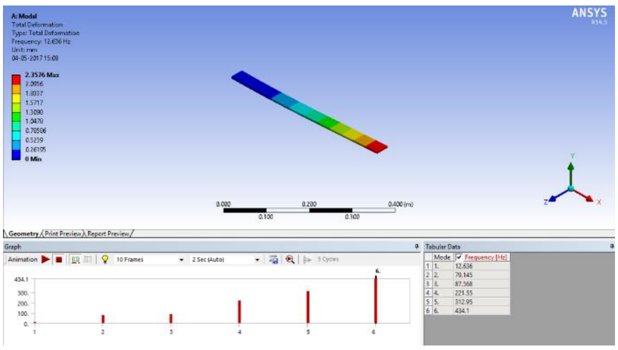


Fig -13: Wide

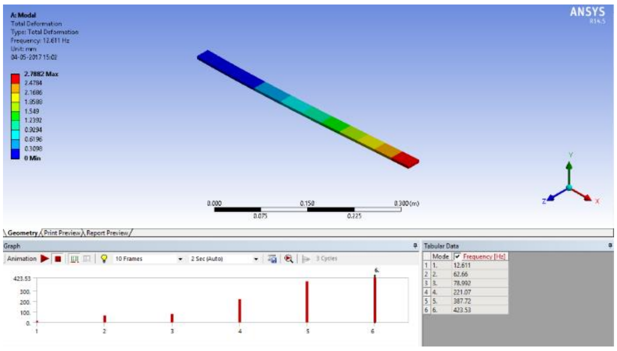


Fig -14: Narrow

Table -3: Frequencies for Brass at 1st Mode

BRASS			
Dimension	L×B×D (mm)	ANSYS Frequencies	Theoretical Frequencies
Original	480×30×5	12.599	12.53
Long	530×30×5	10.329	10.28
Short	430×30×5	15.738	15.62
Thick	480×30×7	17.662	17.21
Thin	480×30×3	7.579	7.5
Wide	480×35×5	12.636	12.52
Narrow	480×25×5	12.611	12.53

Where L= Length, B=Width, D=Depth/Thickness.

4.3 STEEL

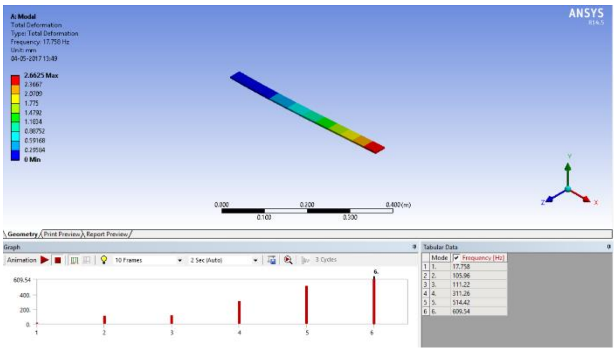
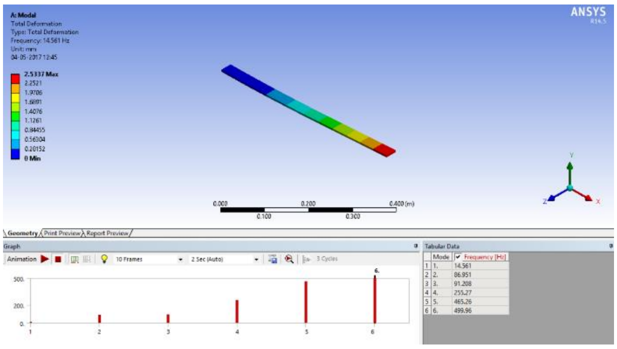


Fig -15: Original



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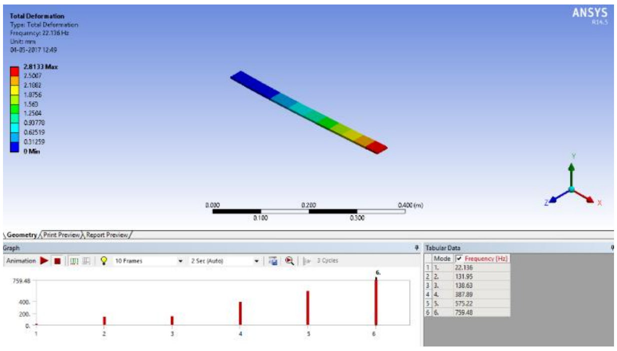

Fig -17: Short

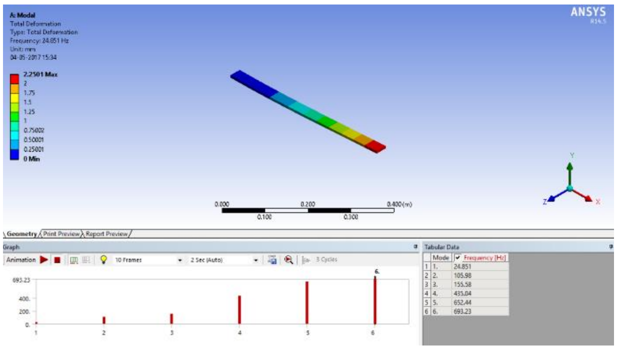

Fig -18: Thick

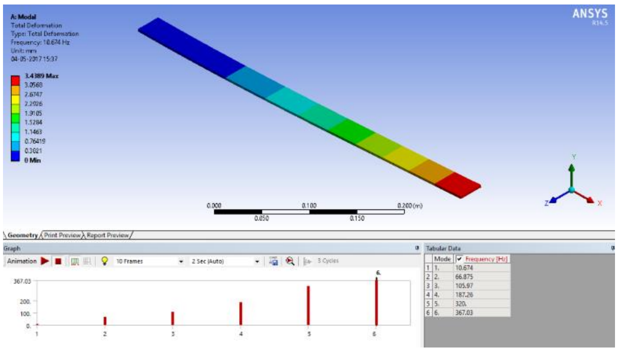

Fig -19: Thin

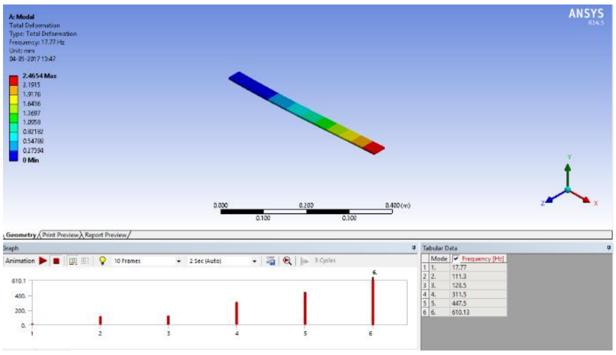

Fig -20: Wide

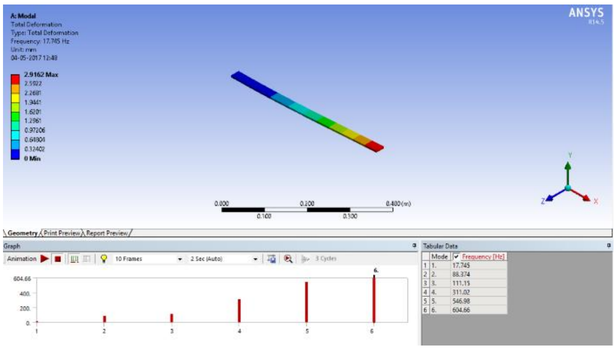

Fig -21: Narrow

Table -4: Frequencies for Steel at 1st Mode

STEEL			
Dimension	L×B×D (mm)	ANSYS Frequencies	Theoretical Frequencies
Original	480×30×5	17.758	17.3
Long	530×30×5	14.561	13.92
Short	430×30×5	22.136	21.14
Thick	480×30×7	24.851	23.7
Thin	480×30×3	10.674	10.18
Wide	480×35×5	17.77	16.95
Narrow	480×25×5	17.745	17.30

5. CONCLUSIONS

Thus by comparing theoretical Frequencies with ANSYS Frequencies for selected materials, we conclude that FREQUENCY INCREASES when length decreases/thickness increases and FREQUENCY DECREASES when length increases/thickness decreases. Also we found that frequency remains almost same due change in width.

6. ACKNOWLEDGEMENT

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7. REFERENCES

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