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Vibration Analysis Of Cracked And Un-Cracked Structure Using ANSYS

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***Abstract:*- In present work, the problem of crack detection for cracked beam using software analysis. FEA is performed on simply supported I cross section beam by using finite element method based on software ANSYS. Crack is discontinuation in a body. The presence of crack in structural member induces the flexibility which affects the vibration response of structural member. The beam having different kinds of loading which cause cracks in beam. These cracks and locations are effects on the in natural frequency and mode shape. Modal analysis is used for determine the natural frequency and mode shape of cracked and un-cracked beam having both end is simply supported investigated by using ANSYS software. Different crack depth are considered and results are compared with uncrack beam. Structural steel and aluminium materials are considered for beam and appropriate loading conditions acting on beam. Creo software is used for designing of simply supported I cross sectional beam.**

***Key words*:-- ANSYS, Creo, Natural frequency, Mode shape, Crack, Vibrational analysis.**

I. INTRODUCTION

Beam is horizontal and inclined member which is supported by two or more support . Beams are most used as structural member in civil, mechanical, naval and aeronautical engineering. In beam or any structural member, damage is one of the important aspects in structural analysis and experience a wide variety of static and dynamic loads of certain frequency of vibration which leads to be its failure due to resonance. Vibration testing is become a standard procedure in design and development of most engineering systems. The cracks in a structural member may develop from flaws due to applied cyclic loadings, mechanical vibrations, aerodynamic loads, rocket fuel exhaust or acoustical fatigue. An important task of engineersis to determine the effect of these damages on the stability characteristic of these structures. Vibration analysis is an effective technique used to detect fatigue cracks in structural members. The members form an important part of building or mechanical systems. Fatigue cracks in it due to repeated loading causes the structure failure. So the cracks must be detected to avoid such calamities. In the vibration analysis, many researchers have confined only to the linear model.

A. Vibration:

Motion which repeats itself after a certain interval of time is called vibration. A vibration can caused due to the external unbalanced force also. A vibratory system, in general, includes elastic member for storing potential.

II. LITERATURE SURVEY

D.Ravi Prasad Modal analysis is a process of describing the structure in terms of its natural characteristics which are the frequency, damping and mode shapes –its dynamic properties. The change of modal characteristics directly provides an indication of the structural condition based on changes in frequencies and mode shapes of vibration[1].Ruotolo et al. has investigated forced response of a cantilever beam with a crack that fully opens or closes, to be determine depth and location of the crack. In their study, left end of the beam is cantilevered and right end is free. The harmonic sine force was applied on the free end of the beam. Vibration amplitude of the free end of beam was taken into consideration. It was shown that vibration amplitude changes, when depth and location of the crack change[2]. J.P. Chopade and R.B. Barjibhe have worked on Free Vibration Analysis of Fixed Free Beam using Euler-Bernoulli equation to find the natural frequencies theoretically and used Ansys to validate[3].Aniket S. Kamble has presented crack is modeled as a rotational spring and equation for non dimensional spring stiffness isdeveloped. By evaluating first three natural frequencies are using vibration measurements, curves of crack equivalentstiffness are plotted and the intersection of the three curves indicatesthe crack location and size. The time amplitude data obtained is further used in the vibration analysis to obtain time frequency data[4].

PatilAmitV.has presented measurement of natural frequencies is presented for detection of the location and

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size of the crack in a cantilever beam. Numerical calculations has been done by solving the Euler equation for un-crack beam and cracked beam to obtain first three natural frequencies of the different modes of vibration considering various crack positions for a beam. ANSYS software is used for analysis of crack and un-crack cantilever beam[5].

III. METHODOLOGY

Analytical Method

Mostly FEM equilibrium equations have been used in ANSYS software for analysing the structural member like as beam, column etc. problems. Steel and Aluminium are considered beam material and boundary conditions are modeled and analysed for comparison in material.

Modelling Of Beam

The designing of I cross section beam with crack and without crack is modeled in creo software using its dimensions which is taking into steel table ISLB275.the vibration analysis of cracked beam, the crack width is 6mm and the crack depth is taking as 3mm, 6mm, 9mm, 12mm, 15mm.The all model of cracked beam is built in workbench V.15.Properties of I section beam:-Table1

Parameters	Values	
Material	Steel [mm]	Aluminium [mm]
Length	3000	3000
Depth	275	275
FlangeWidth	140	140
Flangedepth	8.8	8.8
Thk.web	6.4	6.4
Youngs Modulus	2x10^11	7.1x10^10
Density	7850 Kg/m^3	2770 Kg/m^3
Poisons ratio	0.3	0.33
Crk. location	1500	1500

Boundary conditions

The I section beam is simply supported at both end.The displacement at both end is x=0, y=0, z is free as per co-ordinate system.The vibration analysis of without crack of beam with structural steel and aluminium material, find the natural frequency of beam. Then after that find the natural frequency of cracked beam.

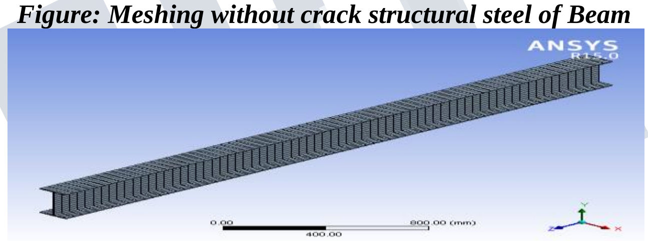
a) analysis of structural steel beam

The vibrational analysis of structural steel I section simply supported beam Without crack and crack is done to determine its natural frequency and mode.

Table 2 Frequencies of structural steel without crack beam

Mode	Frequency[Hz]
1	0.087367
2	25.894
3	34.464
4	94.994
5	104.75

Figure: Meshing without crack structural steel of Beam



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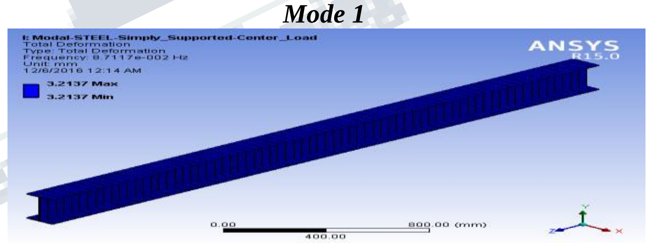

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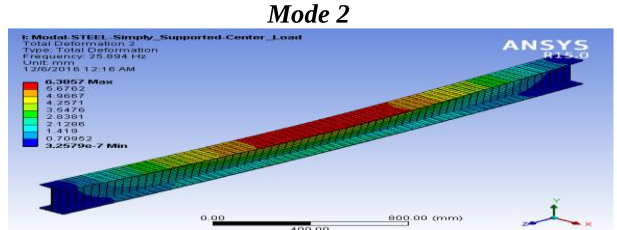

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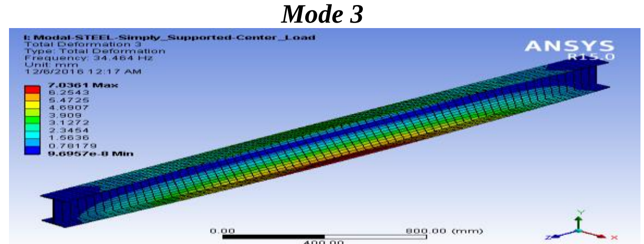

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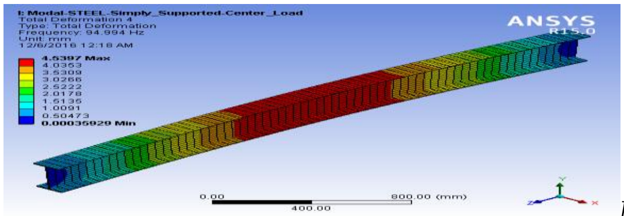

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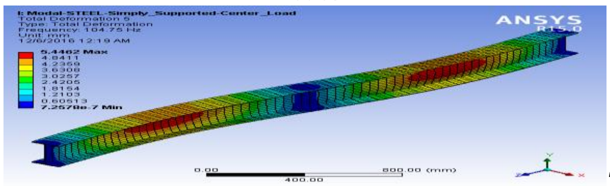
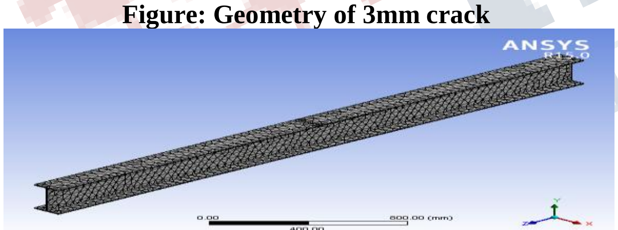


Table 3 Frequencies structural steel crack beam

Crack depth	3mm	6mm	9mm	12mm	15mm
mode	Freq. [Hz]	Freq. [Hz]	Freq. [Hz]	Freq. [Hz]	Freq. [Hz]
1	0.0685	0.0684	0	0	0
2	25.933	25.853	0.0684	0.0684	0.0682
3	34.765	34.752	33.391	33.301	33.300
4	95.01	94.911	91.289	89.72	89.29
5	105.18	105.18	105.04	104.80	104.70

Figures of 3mm crack depth at 1500mm centre of beam.

Figure: Geometry of 3mm crack



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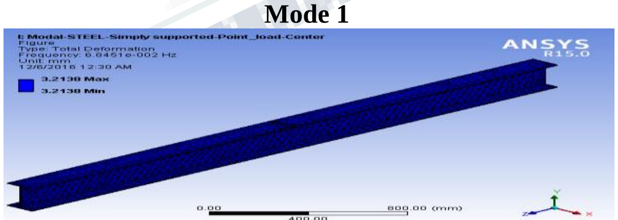

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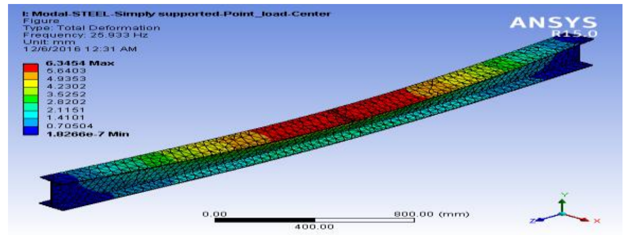

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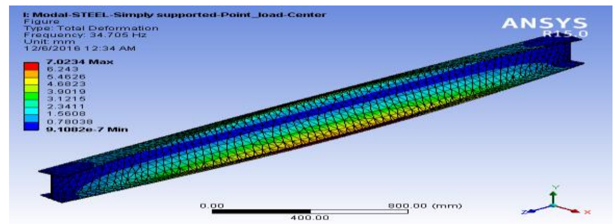

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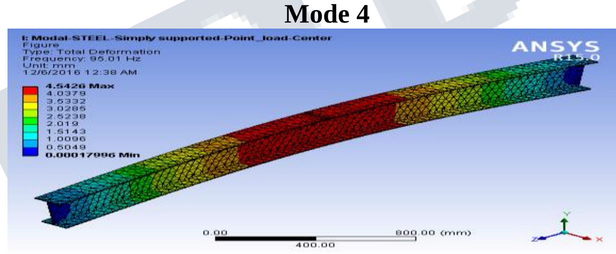

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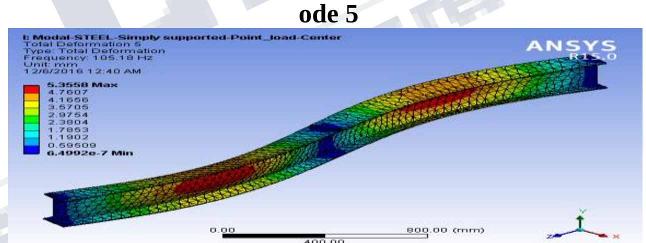
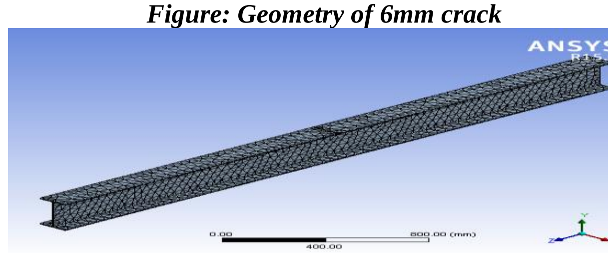


Figures of 6mm crack depth at 1500mm centre of beam.

Figure: Geometry of 6mm crack



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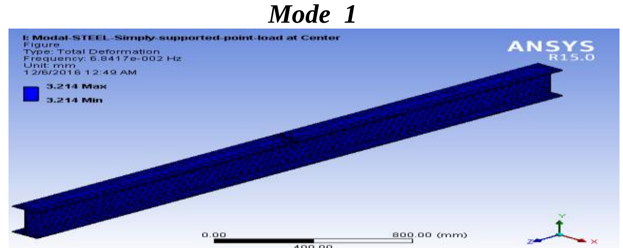

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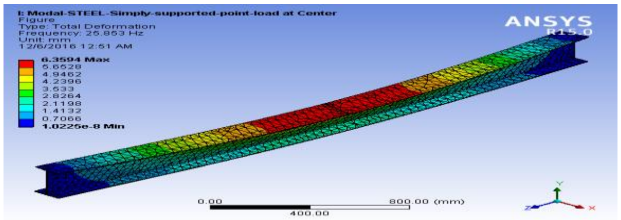

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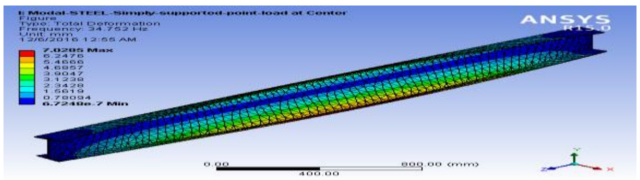

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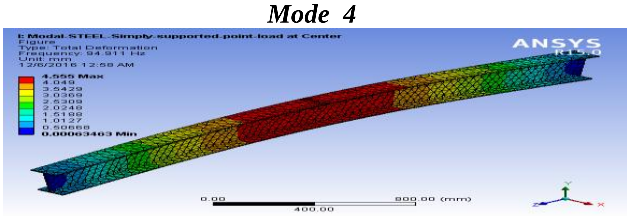

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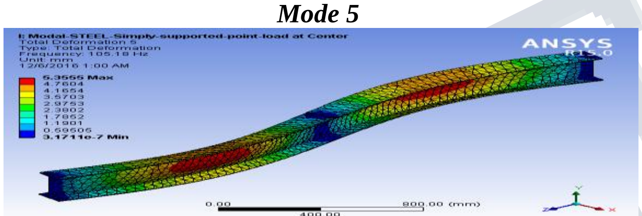
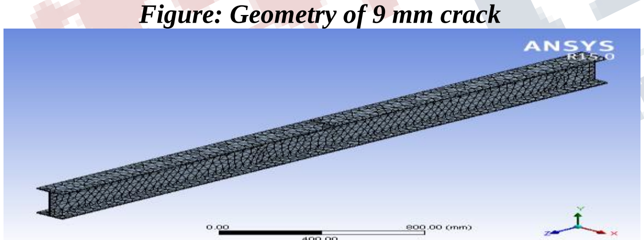


Figures of 9 mm crack depth at 1500mm centre of beam.

Figure: Geometry of 9 mm crack



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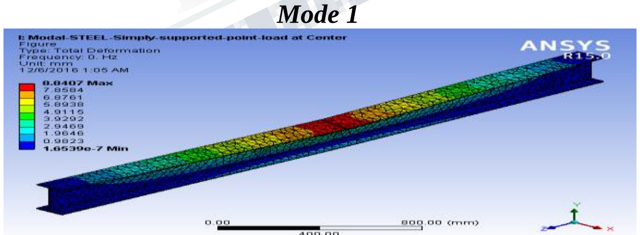

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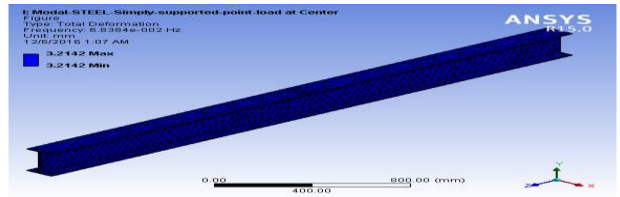

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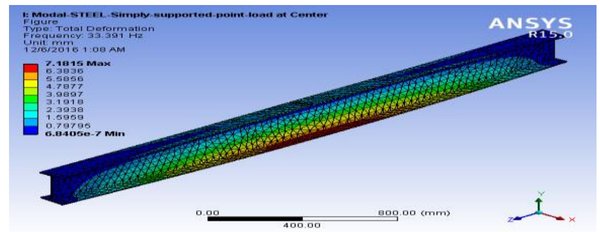

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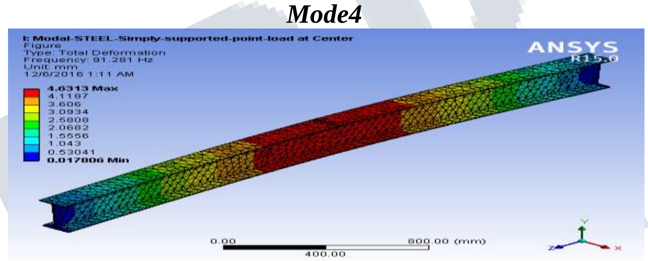

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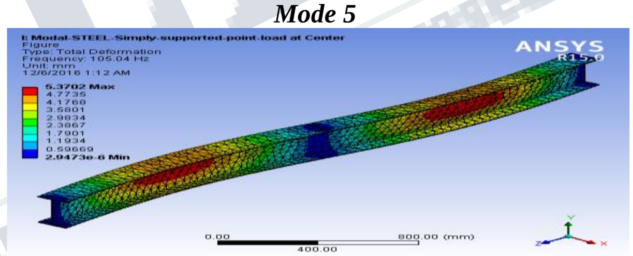
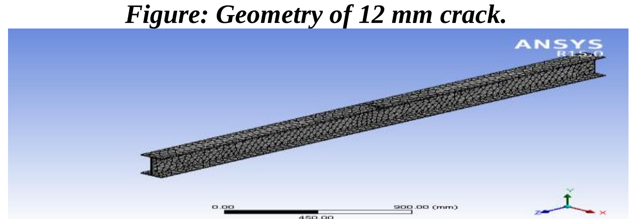


Figures of 12 mm crack depth at1500mm centre of beam.

Figure: Geometry of 12 mm crack.



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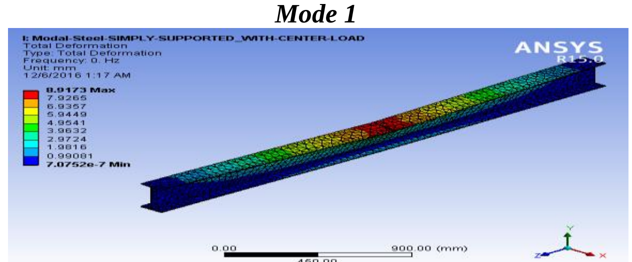

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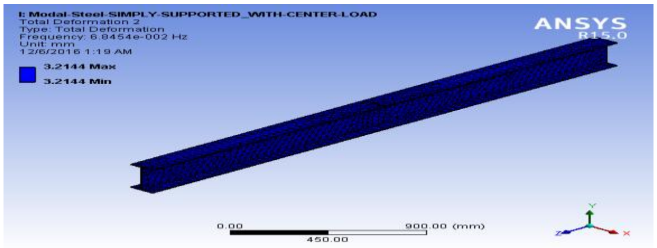

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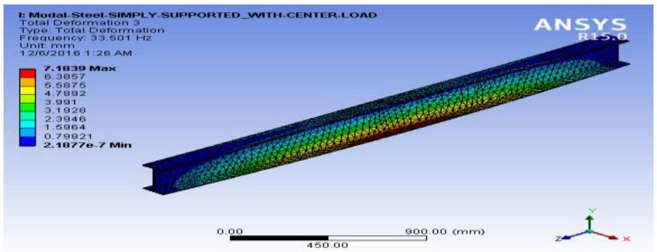

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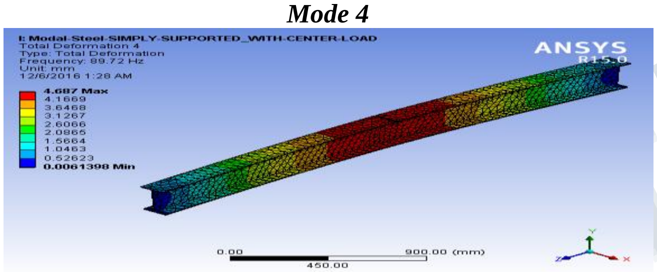

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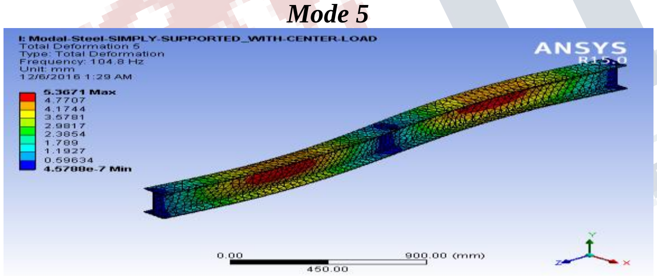
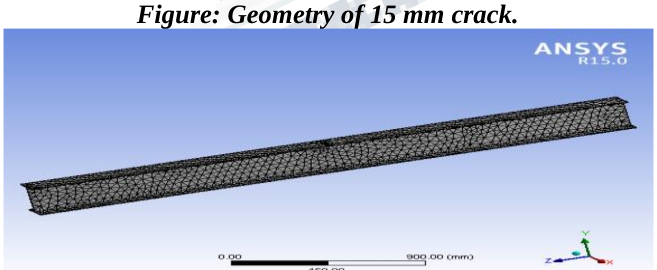


Figures of 15 mm crack depth at 1500mm centre of beam.

Figure: Geometry of 15 mm crack.



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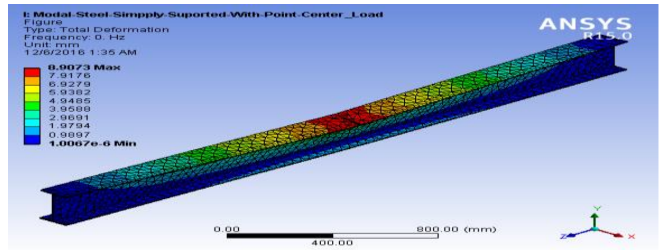

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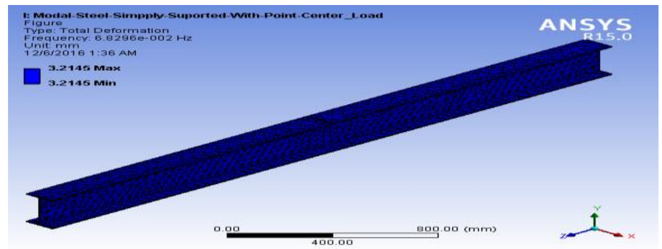

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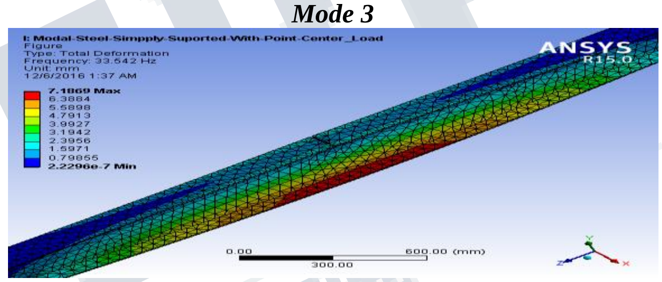

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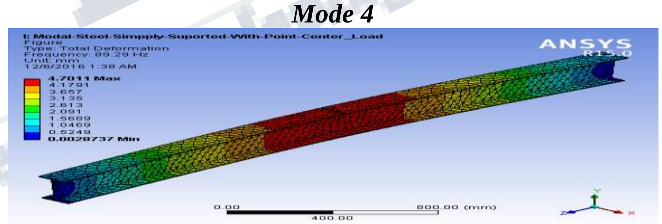

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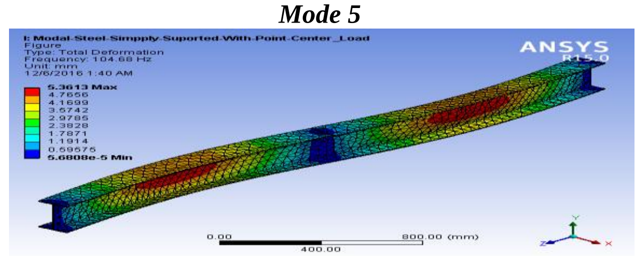

b] Analysis of aluminium beam

Table 4 Frequencies of aluminium beam without crack beam

Mode	Frequency[Hz]
1	0.0873
2	10.289
3	34.437
4	95.199
5	103.76

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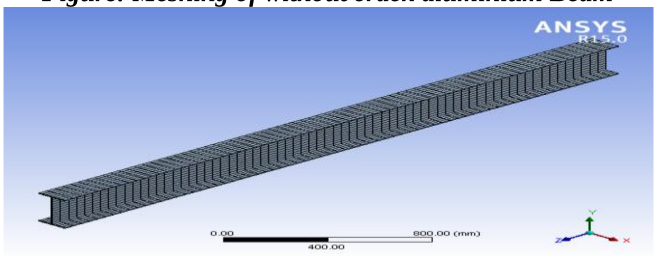
Figure: Meshing of without crack aluminium Beam



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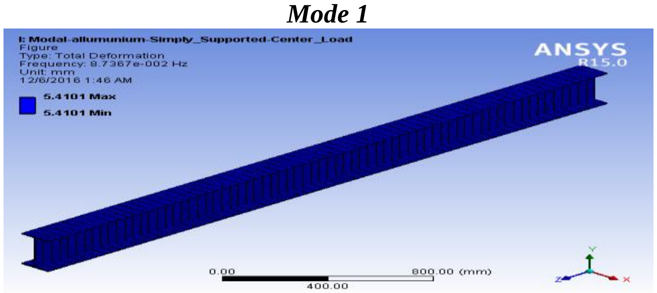

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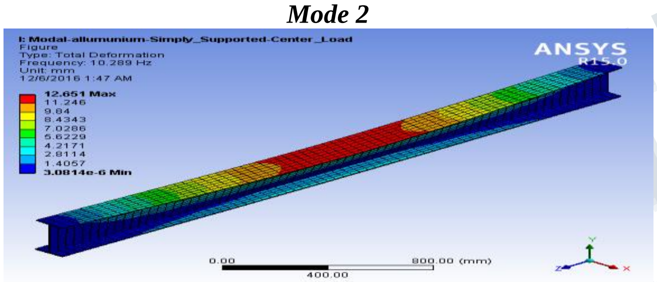

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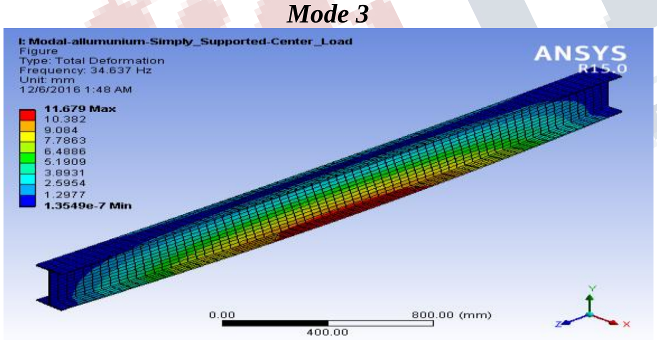

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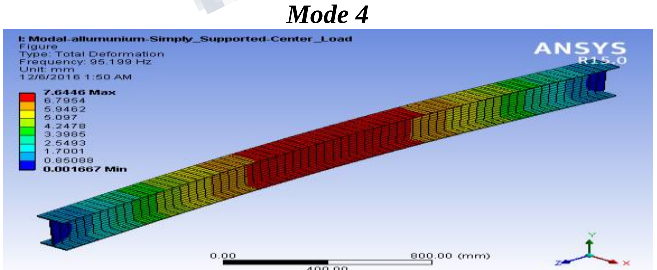

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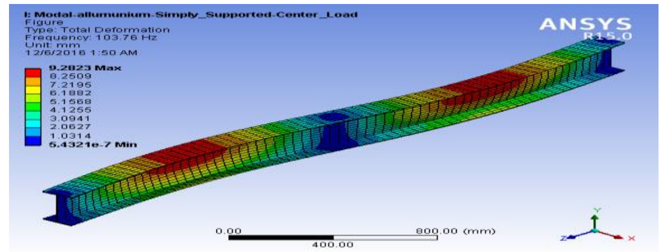
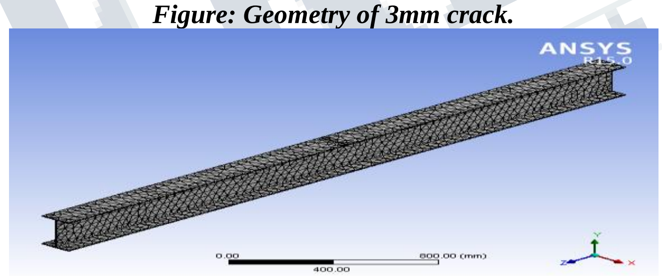


Table5 Frequencies of Aluminium crack beam

Crack depth	3mm	6mm	9mm	12mm	15mm
mode	Freq. [Hz]	Freq. [Hz]	Freq. [Hz]	Freq. [Hz]	Freq. [Hz]
1	0.0686	0.0686	0	0	0
2	11.117	11.116	0.0685	0.0684	0.0681
3	34.864	34.773	34.65	34.587	34.562
4	95.216	94.118	91.486	89.924	89.499
5	104.17	104.17	104.01	103.63	103.44

Figures of 3mm crack depth at 1500mm centre of beam.

Figure: Geometry of 3mm crack.



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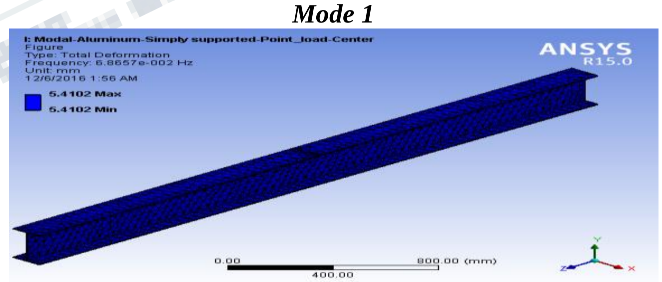

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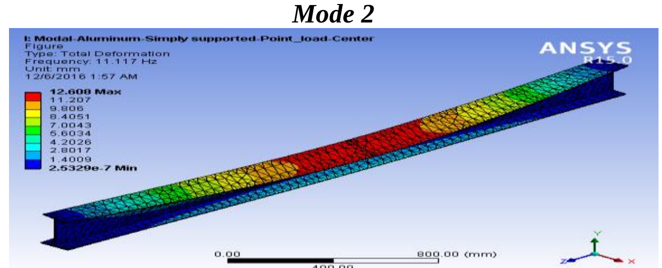

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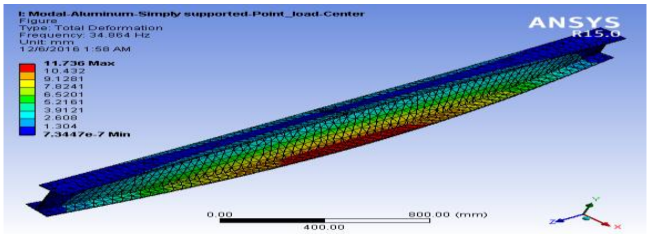

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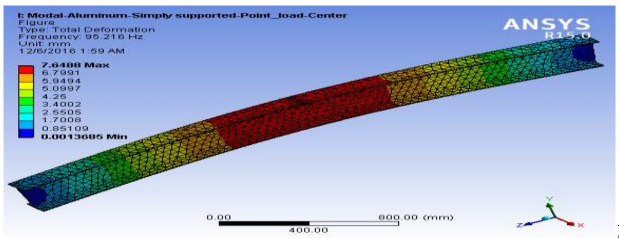

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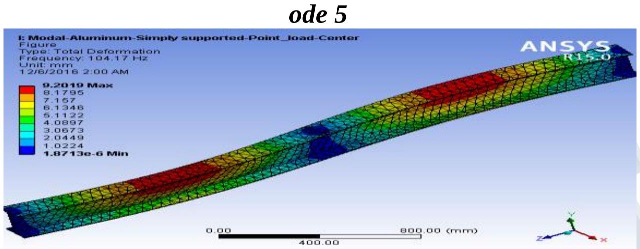
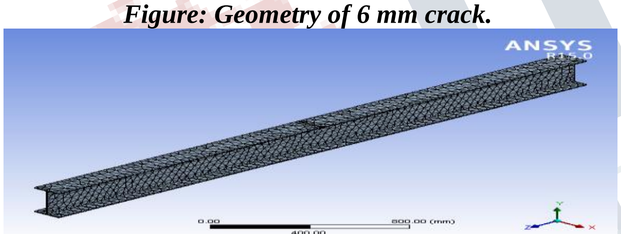


Figures of 6 mm crack depth at 1500 mm centre of beam.
Figure: Geometry of 6 mm crack.



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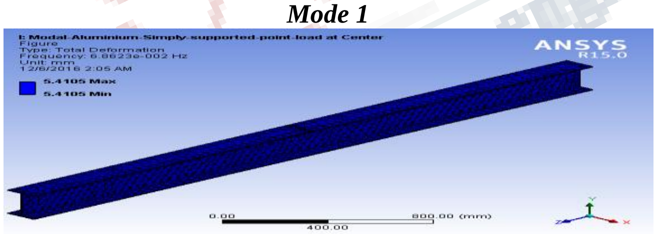

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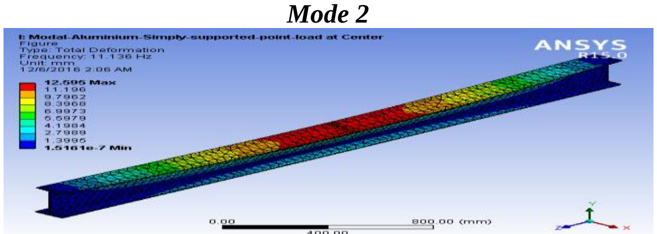

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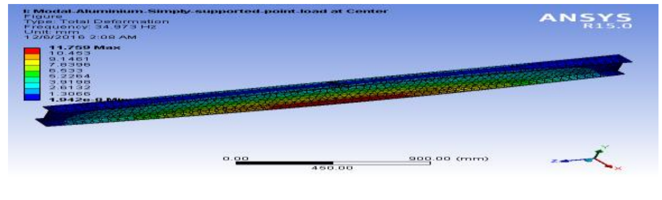

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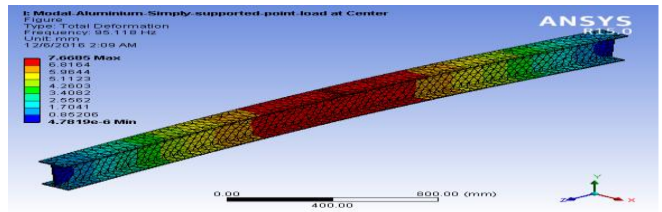

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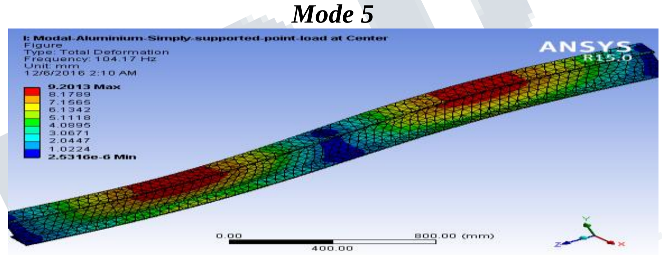
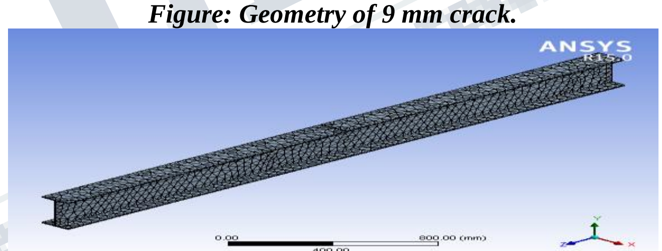


Figures of 9 mm crack depth at 1500 mm centre of beam.
Figure: Geometry of 9 mm crack.



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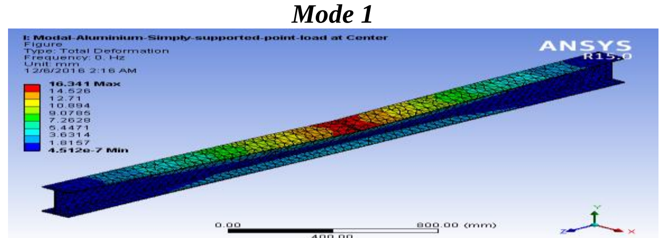

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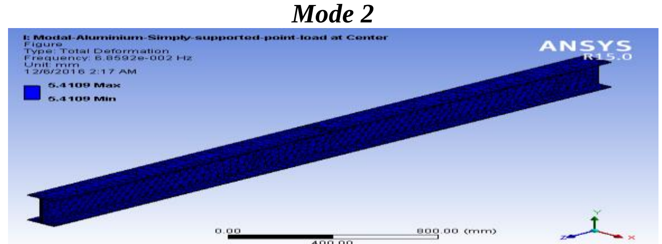

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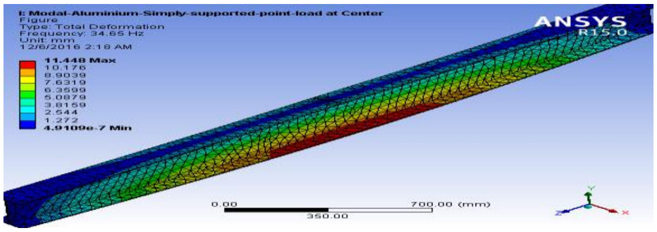

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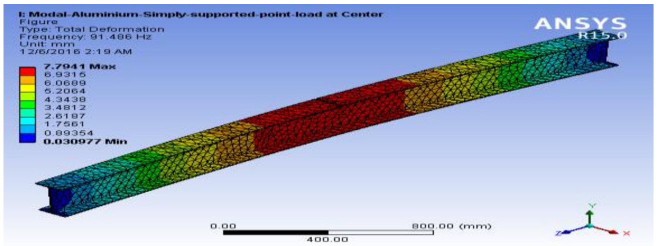

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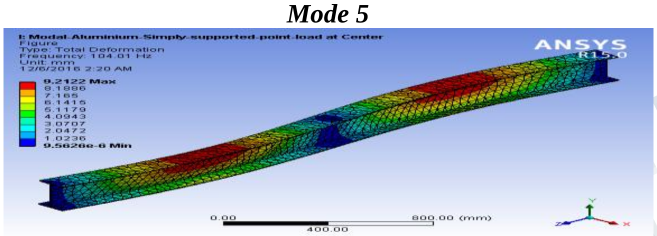

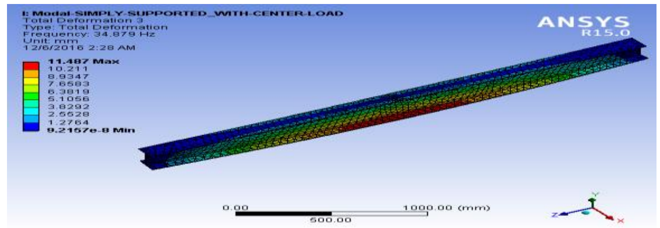

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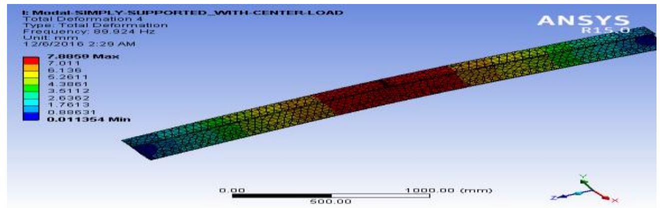

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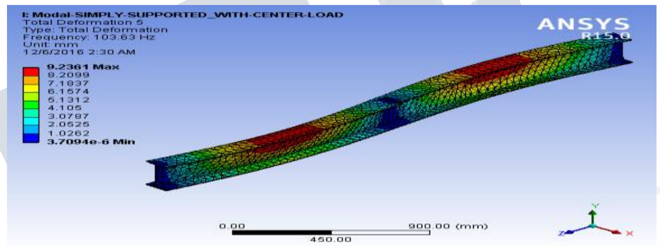
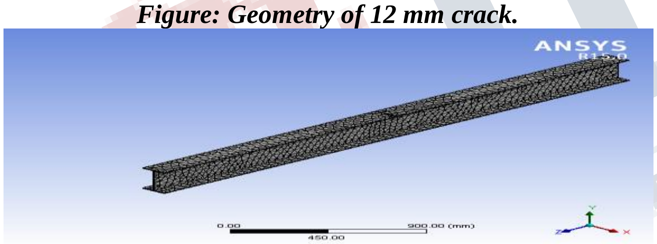


Figures of 12 mm crack depth at 1500 mm centre of beam.

Figure: Geometry of 12 mm crack.



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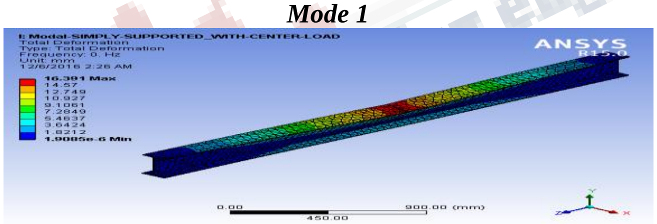

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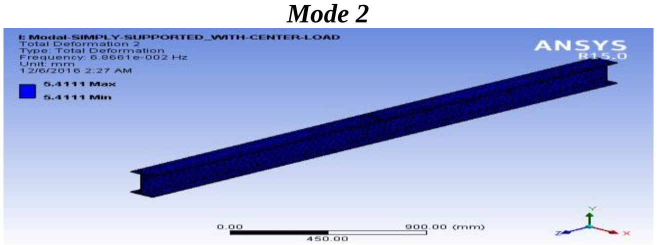

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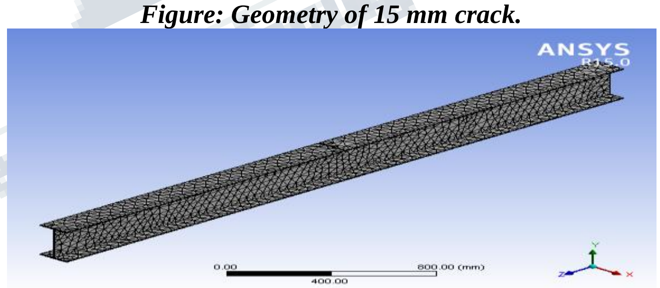
Figures of 15 mm crack depth at 1500 mm centre of beam.

Figure: Geometry of 15 mm crack.



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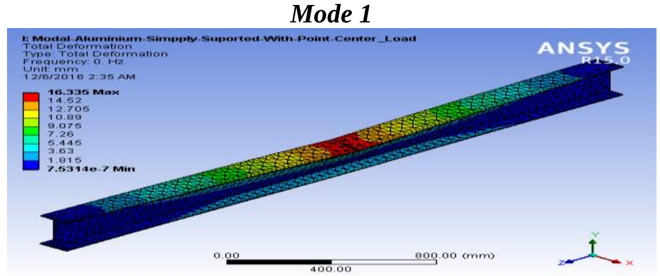

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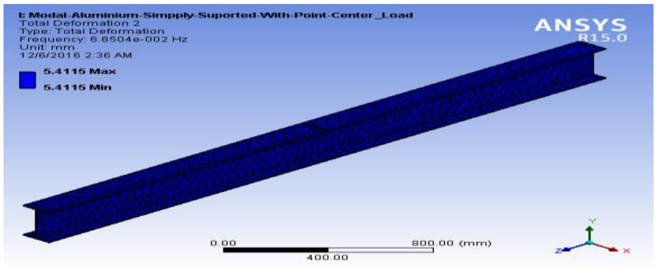

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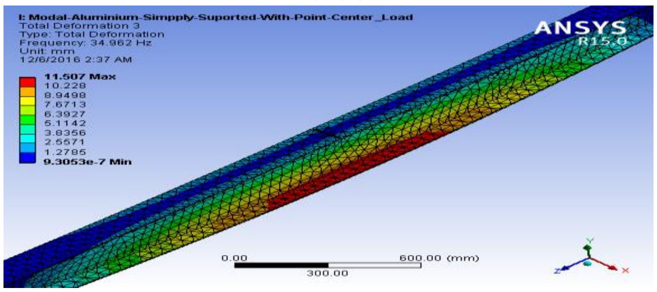

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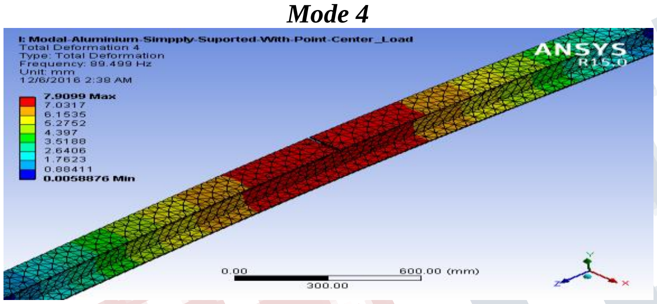

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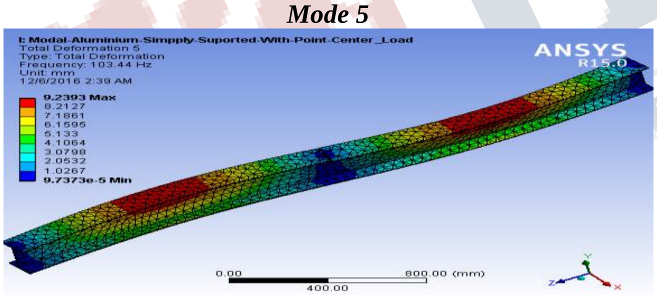
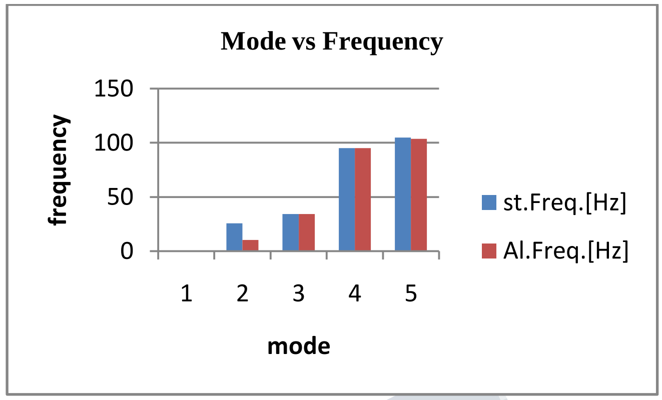
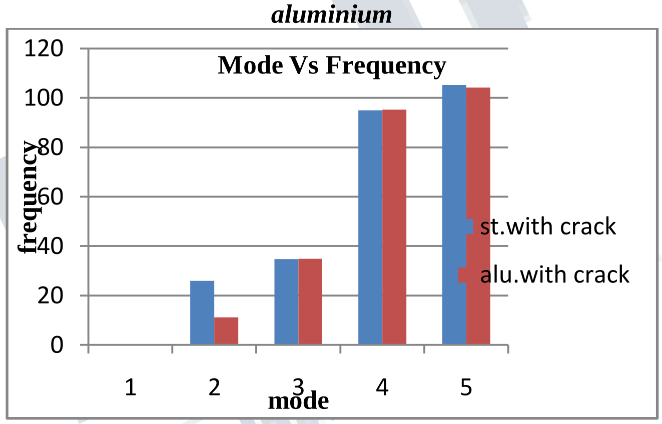


IV. RESULTS AND DISCUSSION

In this present work,FEM method has been used in order to obtain the analytical solution for simply supported beam with crack and without crack with two different material structural steel and aluminium. In ANSYS, modal analysis is used to determine its natural frequency and mode at diiferent crack depth.



Graph 1 Mode vs Frequency of structural steel and aluminium



Graph 2 Mode vs Frequency structural steel and aluminium at 3mm crack depth

V. CONCLUSION

The main objective of present study is to calculate the natural frequencies and modes of simply supported I section with crack and without crack with two materials structural steel and aluminium. It is observed that the natural frequencies for aluminum are slightly higher than that of structural steel for simply supported beam.The natural frequencies of these two materials having minium difference in them. It is also observed that the when increase the crack depth the natural frequency of beam is slightly decreases. The difference between the natural frequency of crack and uncracked beam is also having minium difference.

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