Vibration Analysis of Inclined Edges simply supported Cracked Beam Using Mode Shape by ANSYS Software

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ABSTRACT

The presence of crack greatly affects physical properties & dynamic response of machine elements. This paper concentrates on analysis of vibration of beam, mode shapes & its frequency. The Ansys is used to analyze the dynamic behaviour of the structural beams by finite element analysis. The variation of natural frequency with variable inclination angles & with variable depth of crack is studied in this paper.

Keyword : - *Inclined edge, cracked beam*

I. INTRODUCTION

Beams can be used as structural elements in various engineering fields such as mechanical, civil etc. Crack damage is one of the vital aspects in engineering and structural analysis. Beam crack analysis is useful for the safety & financial growth of the companies. The crack in the beams that may increases structural defects like crack, which results in breakdown of the beam structure. The early stage crack identification is useful for sudden breakdown of the structure. Regular maintenance and repair is required for many rotating machines which are used in the manufacturing industry. Due to sudden failure of this machines in the plant there is huge loss in production, manpower and in maintenance and repair of the machines. Many techniques are found by many scientists for early stage identification of crack depth, crack location, crack size and damage pattern in the beam structure. For crack identification many non-destructive methods are used all over the world such as vibration analysis which is fast and cheaper method of analysis. Kaustubha v. Bhinge find out technique for crack analysis in beams. Many links of the engineering structures are running under full loading condition, which leads to crack propagation in overstressed areas. The change in local stiffness in beam structure is found due to crack presence in the beams. The presence of the crack greatly affects the physical properties & dynamic response of machine elements. The measure of the change in response characteristics of a beam structure greatly used for structural integrity & safety. Many scientists find that there is variation in characteristics of vibration response depends on whether the crack is open or closed. The most of published papers says that the crack in structural element any time remains open during vibration of the structural element. When effect of dynamic loading is more, this assumption is not valid. In this case there is change in structural stiffness along with regularly open & close crack. The beams with crack open and close regularly shows natural frequency in between non cracked beams & open cracked beams.

II.PROBLEM STATEMENT

As discussed above the failure of machine component is loss of time, money and life. Most of the machine components failures are because of the crack. So there is necessity to predict such failures in advance so that losses because of failure are avoided or minimized. Condition based monitoring is one of the preventive maintenance method used in the plant Maintenance. So there is requirement to develop the methodology which can be used easily to predict the crack in the machine component from the machine condition such as vibration data.

III. FINITE ELEMENT ANALYSIS

The structures can be analyzed by a numerical method like finite element analysis method (FEM). This tool is popular for numerical analysis. The finite element method uses digital computer to generate simultaneous algebraic equation. The important rule in finite element analysis method is "DIVIDE & ANALYZE". The only one feature which divides finite element method from rest of methods is, it separates the whole complex geometry into small and simple parts called finite element. Depend on the type of analysis to be performed the finite elements divided into many types. Distribution of domain into elements is called as mesh. Nodes are the degrees of freedom which are the transfer of forces & moments from one element to next. A finite element gives approximate solution of the beam geometry and this solution is exact when

The approximate solution becomes exact when

1. The beam geometry divides into infinite elements.

2. Every element of beam must have complete set of infinite terms.

To solve many engineering problems the finite elements method is very useful tool for numerical solution. method developed along with the use of digital computer.

Dimensions and Properties	**Aluminum**
Length	0.8 m
Width	0.03 m
Thickness	0.006 m
Density	2700 kg/m^3
Young modulus	70 Gpa
Poisson's ratio	0.3

Table. 1 Material Properties and Dimensions of Aluminium Beam

IV.BEAM MODELLING USING ANSYS

ANSYS is used for beam modeling. In table 1 the properties of the beam are listed. Twelve models are prepared with crack at beam Centre for various angles of inclination. After beam meshing FEM of ANSYS is used to find out natural frequency of beam with crack at various crack inclinations. Then applying boundary conditions for cracked beam natural frequency find out. The table 1 and 2 shows mode shapes of cracked beam and un-cracked beam as shown in the next figure.

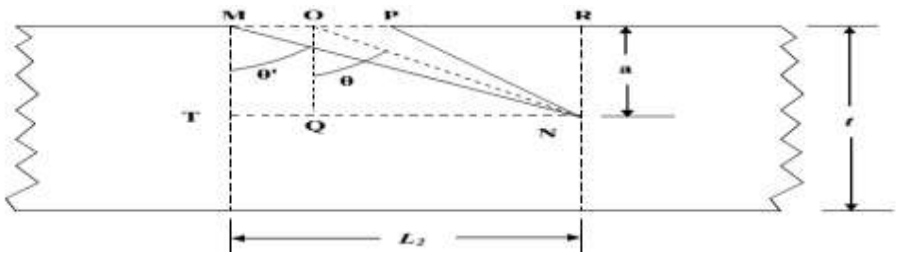

Fig. 1 Cracked Beam

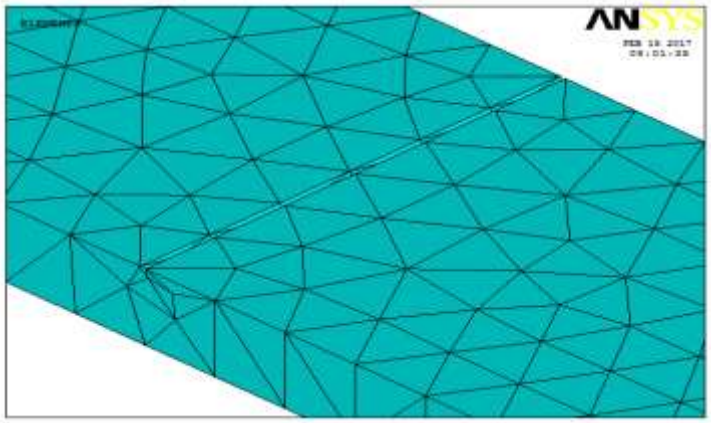

Fig. 2 Mesh Model

	Natural Frequency			
Beam	**Ist Mode**	**IInd Mode**	**IIIrd Mode**	**IVth Mode**
Un-cracked Beam	33.899	109.848	229.187	391.937

Table 2: Natural Frequencies of Simply Supported Un- cracked beam (ANSYS)

Crack angle θ	**α**	**Natural Frequency**			
		Ist Mode	**IInd Mode**	**IIIrd Mode**	**IVth Mode**
0	0.1	60.802	195.905	406.577	695.435
0	0.2	60.192	194.231	401.997	688.162
0	0.3	59.896	193.316	400.434	686.624
15	0.1	61.313	198.818	409.91	700.404
15	0.2	60.802	196.824	407.005	694.49
15	0.3	59.413	192.689	398.4	681.673
30	0.1	61.137	198.082	408.49	698.152

30	0.2	60.987	197.025	408.16	695.622
30	0.3	60.434	195.458	403.161	690.407
45	0.1	61.195	197.998	409.266	696.775
45	0.2	60.764	195.878	406.466	691.445
45	0.3	60.488	196.071	404.156	691.159

Table 3: Natural Frequencies of cracked beam with varies crack Inclination angle and depth of crack by Using ANSYS

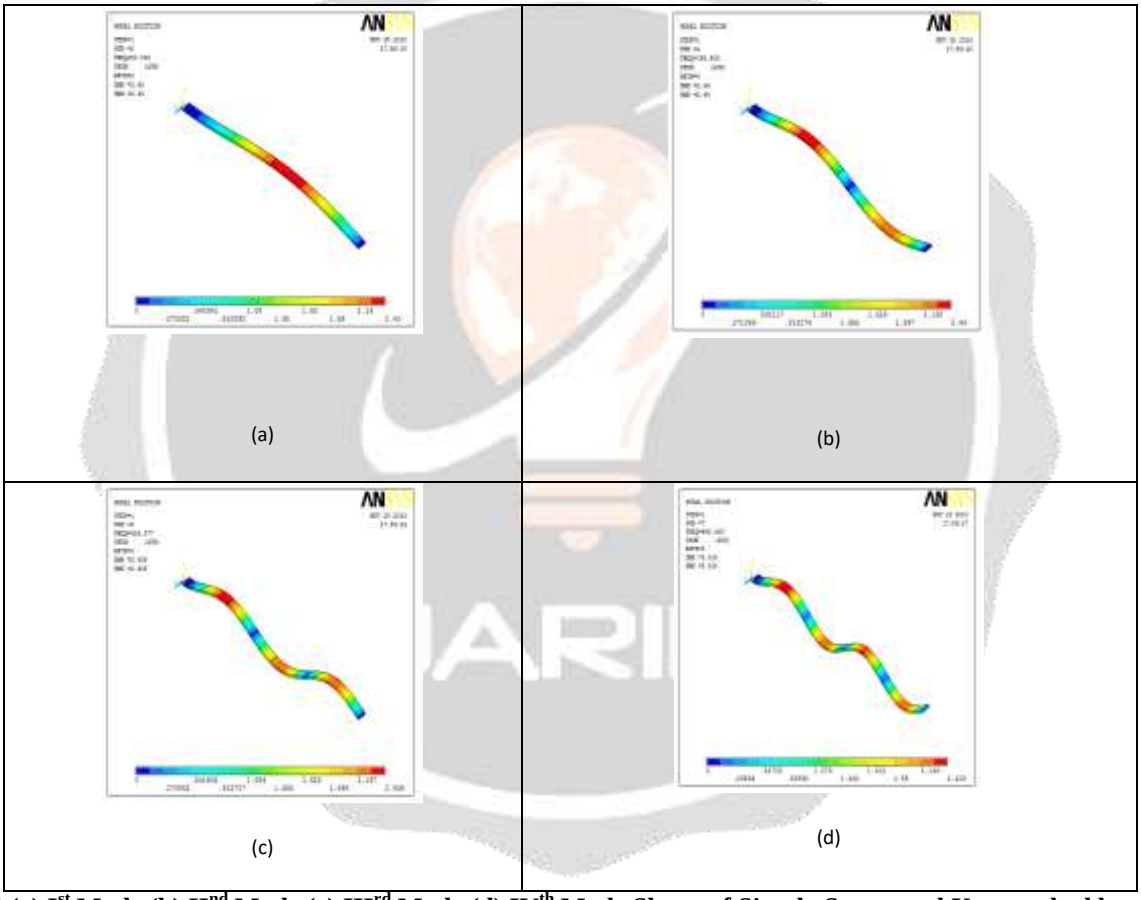

Fig.3 (a) Ist Mode (b) IInd Mode (c) IIIrd Mode (d) IVth Mode Shape of Simply Supported Un- cracked beam

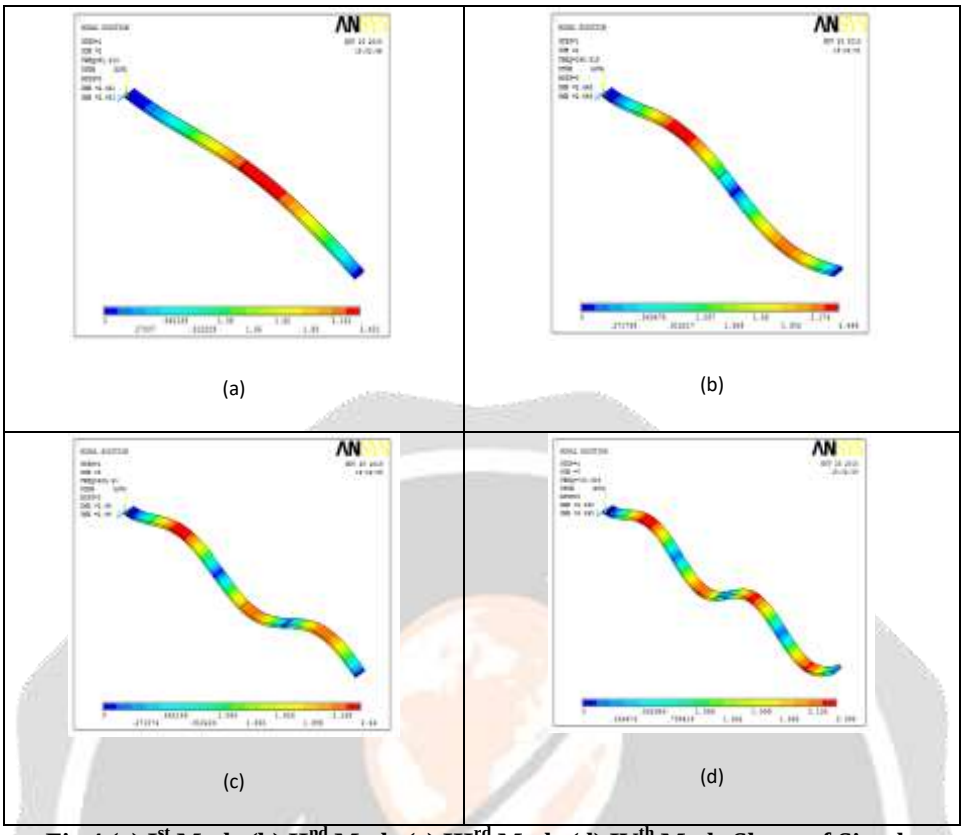

Fig.4 (a) Ist Mode (b) IInd Mode (c) IIIrd Mode (d) IVth Mode Shape of Simply Supported crack beam (θ=15^0 and α= 0.1)

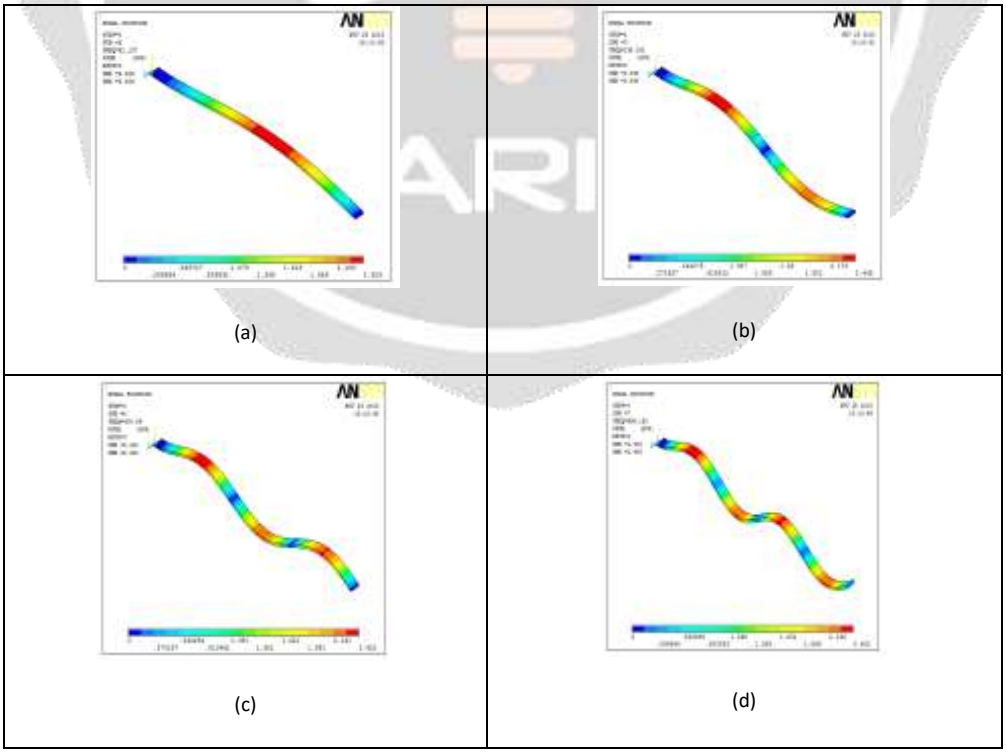

Fig.4 (a) Ist Mode (b) IInd Mode (c) IIIrd Mode (d) IVth Mode Shape of Simply

Supported crack beam ($\theta=30^0$ and $\alpha= 0.1$)

V.RESULTS AND DISCUSSION

Above figure shows first, second, third, fourth mode of vibration for natural frequencies of simply supported beam with and without surface crack at various inclined crack and crack depth. Results show the natural frequency variation of cracked and uncracked simply supported beam. Due to stiffness reduction the natural frequency of the cracked simply supported beam decreases with the increasing crack depth and crack inclination.

VI.CONCLUSION

It has been observed that crack inclination and depth of crack changes the natural frequency of the structure. The modal analysis using ANSYS is done to obtain result of crack parameters by comparing the results of the cracked and uncracked simply supported beam. As the crack depth increases the natural frequency of the cracked beam decreases when the parameters such as location of crack and inclination of crack kept constant. The changes in natural frequencies is proportional to crack depth in addition with the crack inclination angle as well as mode number. The largest effects are obtained at 30^0 crack inclination and 0.1 depth ratio on simply supported beams. Natural frequency decreases more for a crack located where higher bending moment is observed.

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