

ABSTRACT

In the current research, the natural frequency of a beam with a crack, is investigated numerically by finite part methodology victimization analysis software system ANSYS APDL 15.0. In this research "Vibration Analysis of Elastic Cracked Beam" the response characteristics of a beam is predicted for both intact and cracked beams. In addition to that the response characteristics for different crack depth were studied. Crack depth and location were main parameters for vibration analysis. So it becomes for very important monitor to change the response parameters of structures to access structural integrity performance and safety. To observe the effect of crack to the natural frequency of the beam. In the current work, the natural frequency of a beam with a crack, was investigated by finite element method using analysis software ANSYS APDL 15.0. Different crack depth effects were considered & the results are compared with that of the beam without crack. The results obtained from the vibration analysis of the beam show that the lowest fundamental frequency of the beam without crack was higher than the lowest frequency obtained for beam with cracks.

KEYWORDS: Vibration Analysis, ANSYS, Beam, Crack, natural frequency, mode shape.

I. INTRODUCTION

It is needed that structures should safely work throughout its service life. But, damages initiate a breakdown amount on the structures. Cracks are among the foremost encountered harm varieties within the structures. Cracks in an exceedingly structure is also venturesome owing to static or dynamic loadings, so crack detection plays a vital role for structural health watching applications. Beam sort structures are being normally employed in steel construction and machinery industries. within the literature, many studies traumatize the structural safety of beams, especially, crack detection by structural health watching. Studies supported structural health watching for crack detection traumatize modification in natural frequencies and mode shapes of the beam. The presence of a crack couldn't solely cause a neighborhood variation within the stiffness however it may have an effect on the mechanical behavior of the whole structure to a substantial extent. Cracks are also caused by fatigue below service conditions as a result of the restricted fatigue strength. they will additionally occur owing to mechanical defects. Another cluster of cracks are initiated if a structure is flawed, there's a modification within the stiffness and damping of the structure within the region of the defect. Usually, stiffness decreases and damping will increase if the defect seems within the sort of a small or macro crack.

- ❖ The natural frequency
- ❖ The amplitude response owing to vibration
- ❖ Mode form

Research work

- ❖ To study the vibration behaviour of a cracked beam exploitation FEM package ANSYS subjected to a 2 crack beneath free vibration.
- ❖ To Modify the boundary conditions owing to presence of crack are wont to decide the theoretical expressions for natural frequencies and mode form for the beams.
- ❖ To analyse the variation in location and depth of cracks in cracked steel beams is obtained exploitation this system.

Analysis Work

- ❖ A crack on associate degree elastic structural component introduces significant native flexibility because of the strain energy within the neighborhood of the crack tip underneath load.
- ❖ Expressions for bending vibrations of associate degree Euler-Bernoulli cracked beam are analysed. they need studied the consequences of the magnitude relation of crack location to the length of the beam and conjointly magnitude relation of depth of the crack to the peak of the beam.
- ❖ Krawczuk and Ostachowicz have investigated the impact of the longitudinal static hundreds on lateral vibrations of beam

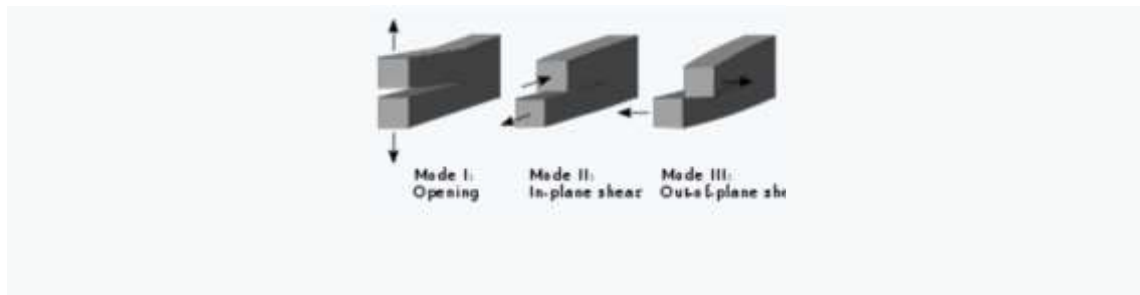
Physical parameters affecting dynamics characteristics of crack structure: Physical dimension, precondition, and therefore the material properties of structure play vital role for the determination of its dynamics response.

- ❖ The position of crack
- ❖ The depth of crack
- ❖ The orientation of crack
- ❖ The variety of cracks

The following side of crack greatly influence of the dynamic behaviour of structure.

II. MODES OF FRACTURE:

There are three types of loading that experiences crack



- ❖ Mode I crack – gap mode (a tensile stress traditional to the plane of the crack).
- ❖ Mode II crack – slippery mode (a shear stress acting parallel to the plane of the crack and perpendicular to the crack front).
- ❖ Mode III crack – Tearing mode (a shear stress acting parallel to the plane of the crack and parallel to the crack front).

The manner through that the crack propagates through the fabric offers nice insight into the mode of fracture. In ductile materials (ductile fracture), the crack moves slowly and is amid an oversized quantity of plastic deformation. The crack can typically not extend unless associate redoubled stress is applied.

III. PROBLEM ANALYSIS

Stress concentration factor(k)

It is outlined as a live of the strain intensity close to the tip of a perfect crack in a very linear elastic solid once the crack surfaces square measure displaced within the gap mode (Mode I). (SIFs) square measure wont to outline the magnitude of the singular stress and displacement fields (local stresses and displacements close to the crack tip).

Beam

Consider AN Euler-Bernoulli uniform beam undergoing crosswise vibration condition as For free vibrations the equation of motion of beam will be given as

$$EI \frac{d^4 w}{dx^4} + \rho A \frac{d^2 w}{dt^2} = 0 \quad (1)$$



$$c^2 \frac{d^4 w}{dx^4} + \frac{d^2 w}{dt^2} \quad (2)$$

$$\text{Where, } C = \sqrt{\frac{EI}{\rho A}} \quad (3)$$

Free vibration solution can be found using the method of separation of variable. Assuming solution as-

$$W(x, t) = W(x).T(t) \quad (4)$$

From equation (2) and (4)

$$\frac{c^2 d^4 w}{w dt^4} = w^2 = a \quad (5)$$

$$\frac{d^4 w}{dt^4} - \beta^4 w(x) = 0 \quad (6)$$

Where,

$$\beta^4 = \frac{\rho A w^2}{EI} \quad (7)$$

From the equation (7) the natural frequency of beam can be written as

$$\frac{d^2 T(t)}{dt^2} + w^2(t) = 0 \quad (8)$$

$$W = (BL)^2 \sqrt{\frac{EL}{\rho A L^4}} \quad (9)$$

IV. PROBLEM FORMULATION

The problem involves calculation of natural frequencies and mode shapes for beam while not a crack and with 2 transversal crack of various crack depths. The results obtained by simulation analysis. Following steps show the rules for ending Modal analysis. Details step by step rationalization is given in any sections.

Define Materials

1. Set preferences. (Structural)
2. Outline constant material properties

Model the pure mathematics

3. Follow bottom up modeling and make the pure mathematics

Generate Mesh

4. Outline part kind.
5. Mesh the world.

Apply Boundary Conditions

6. Apply constraints to the model.

Obtain Solution

7. Specify analysis varieties and choices.
8. Solve.

Material Properties

Young's modulus $E = 2 \times 10^{11} \text{ N/m}^2$, Poisons ratio = 0.3, Density, $\rho = 7850 \text{ kg/m}^3$

Model the pure mathematics

First key points square measure created, these key points square measure joined to make line segments then victimisation these lines square measureas are fashioned. The crack is sculptural by making 2 key points at a similar coordinates then victimisation these key points 2 lines lying at a similar location square measure created in crosswise direction, these lines indicate crack.

Modeling crack region

The most necessary region during a crack model is that the region round the fringe of the crack. the sting of the crack is referred as a crack basketball shot a 2-D model and crack front during a 3D model. to choose up the singularity within the strain, the crack face ought to be coincident, and therefore the parts round the crack tip (or crack front) ought to be quadratic.

Applying Boundary Conditions and resolution

Initial static analysis is disbursed so the analysis kind is modified from static to modal analysis. In modal analysis, the quantity of modes to be extracted. The numbers of modes extracted ar three so they're distended to look at the results. No external load is given as this is often free vibration analysis. Then this model is solved for the results. we will read the various natural frequencies and mode shapes. The frequency for various modes shapes are listed as result outline. once finishing of these file needs to be saved by a file name for future viewing and modifications. The on top of steps ar continual for various conditions like 2 cross crack depth five-hitter of dimension, 100 percent of dimension, V-day of dimension and twenty fifth of dimension depth and with no crack.

Simulation Result

The problem involves calculation of natural frequencies and mode shapes for Cantilever beam while not a crack and with 2 cracks of various crack depths. The results calculated analytically area unit valid with the results obtained by simulation analysis .The method delineated has been applied to a cracked Bernoulli-Euler beam. Steel has taken the beam.

Properties:

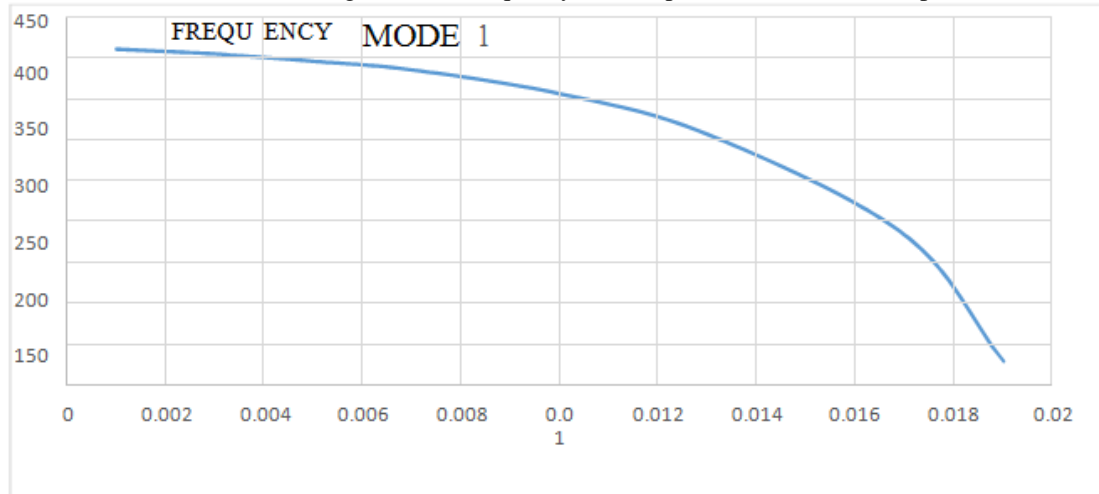
Width of the beam = 0.02 m
Depth of the beam = 0.05 m
Length of the beam = 0.5 m
Elastic modulus of the beam = 2×10^{11} N/m²
Poisson's Ratio = 0.3
Density = 7850 kg/m³

Finite element modeling

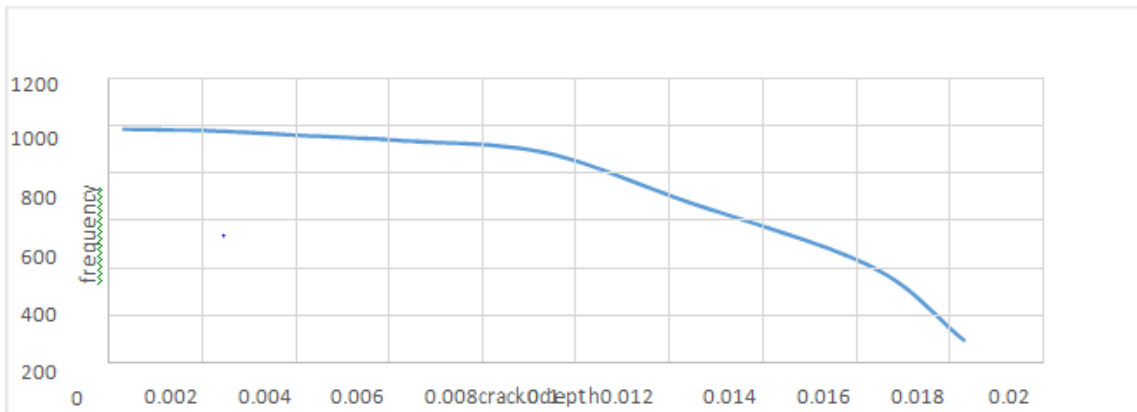
The ANSYS fifteen.0 APDL finite part program was used for gratis vibration of the cracked beams. For this purpose, the key points were 1st created so line segments were fashioned. The lines were combined to make a part. Finally, this space was extruded and a 3 dimensional formed edge cracked beam model was obtained.

RELATIVE CRACK DEPTH	FREQUENCY FOUND IN ANSYS	FREQUENCY FOUND IN ANSYS	FREQUENCY FOUND IN ANSYS
a =	MODE 1	MODE 2	MODE 3
0.001	413.28	1005.8	1128.9
0.002	410.33	1002.8	1125.8
0.003	407.28	998.43	1121.1
0.005	398.38	978.18	1071.52
0.007	387.709	957.818	1005.93
0.01	358.4891	908.2708	964.07
0.013	308.559	706.317	804.08
0.017	185.26	430.62	504.78
0.019	30.1772	120.42	240.59

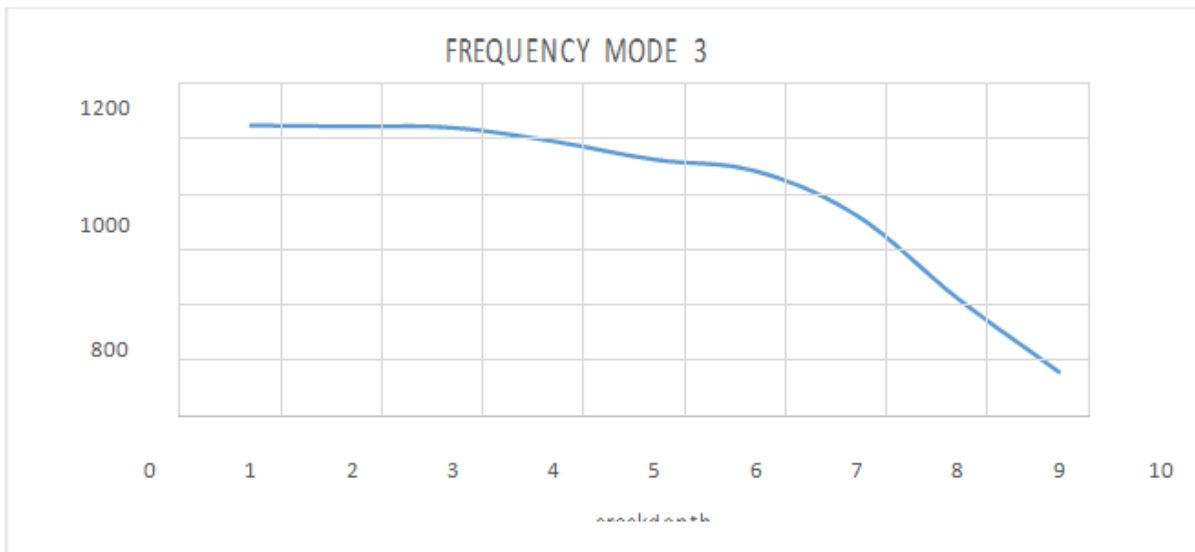
Variation of first second and third eigen value frequency with respect to relative crack depth.



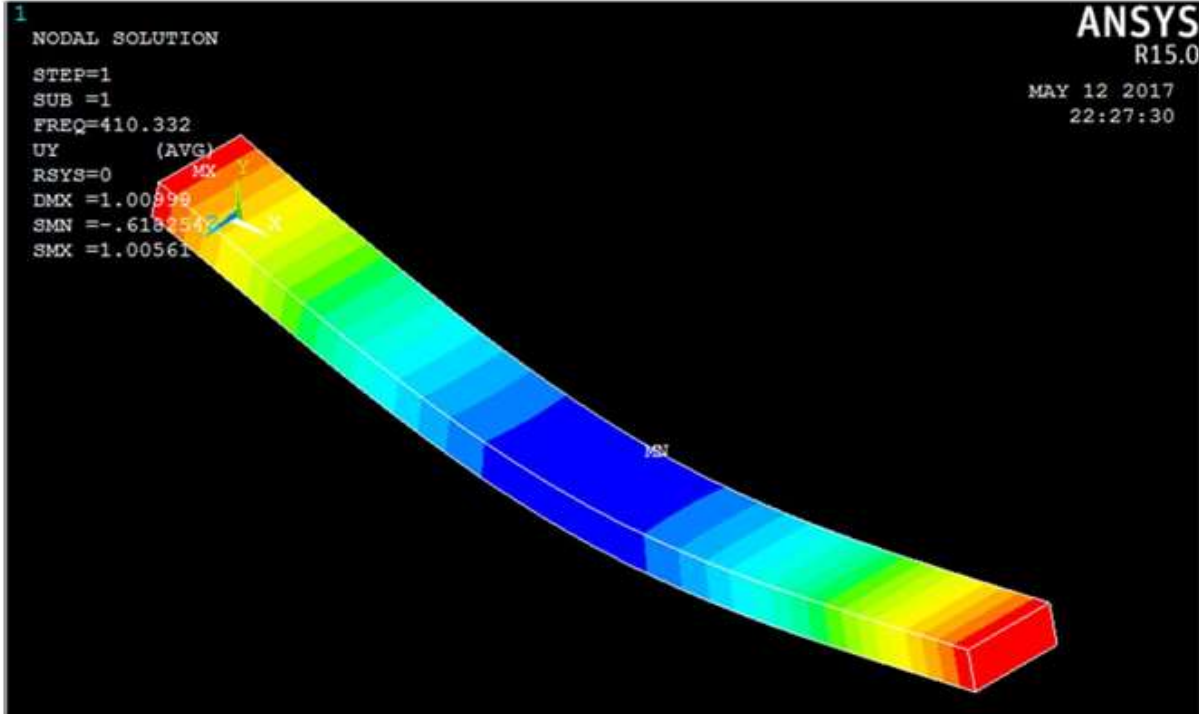
Variation of first eigen value of a cracked beam vs.the crack depth.



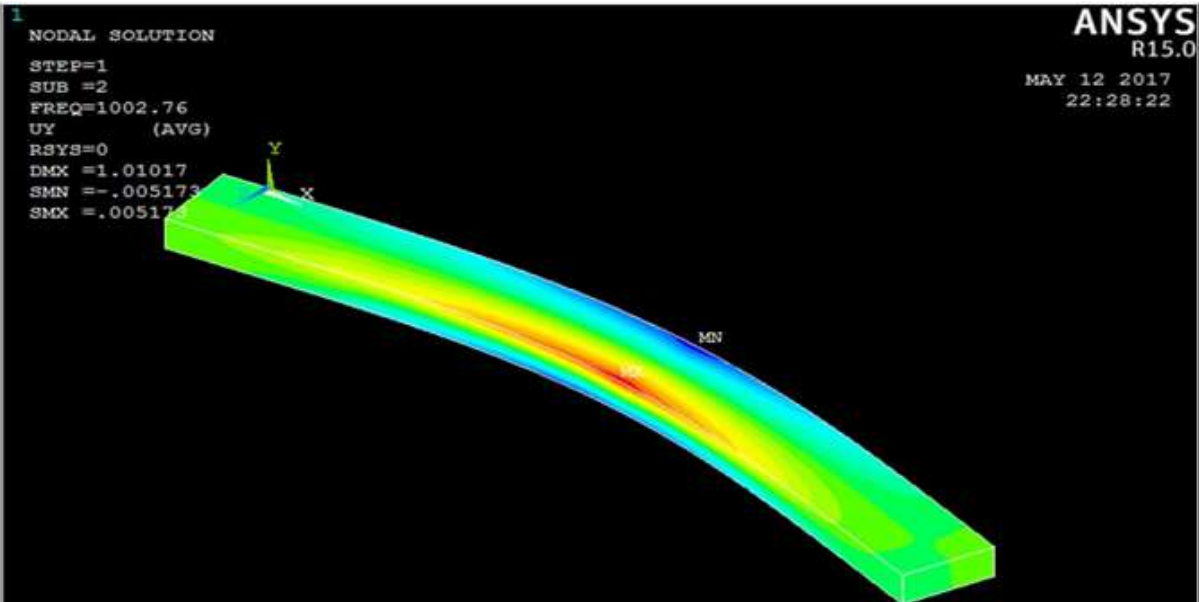
Variation of second eigen value of a cracked beam vs.the c



Variation of third eigen value of a cracked beam vs. the crack depth



first mode of vibration, $a_1/w=0.1$, $a_2/w=0.1$, $L_1/L=0.19$, $L_2/L=0.54$



second mode of vibration, $a_1/w=0.1$, $a_2/w=0.1$, $L_1/L=0.19$, $L_2/L=0.54$

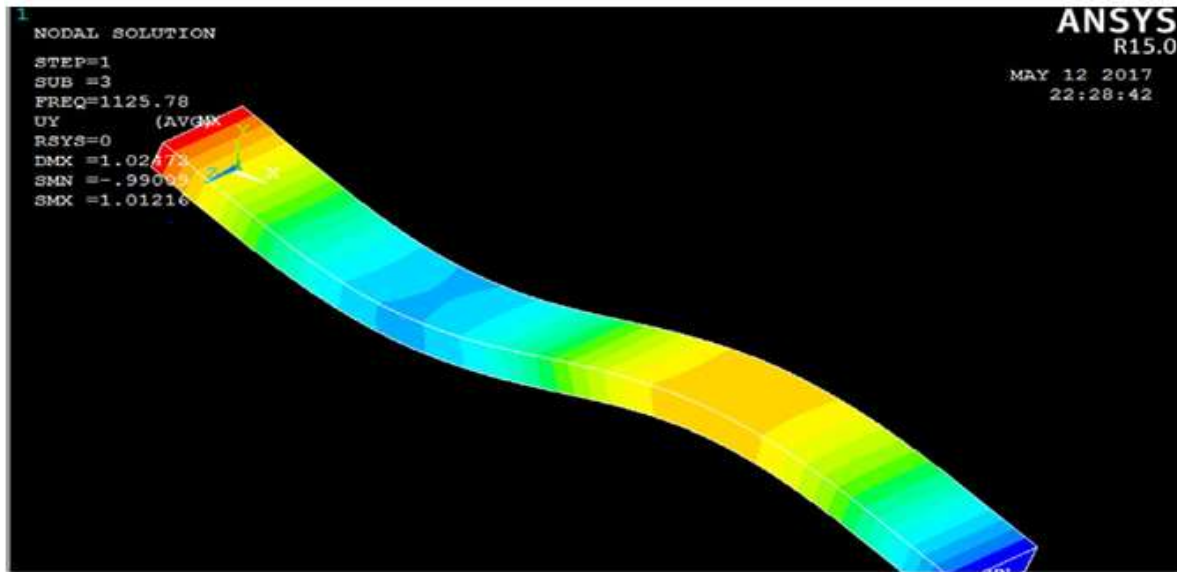
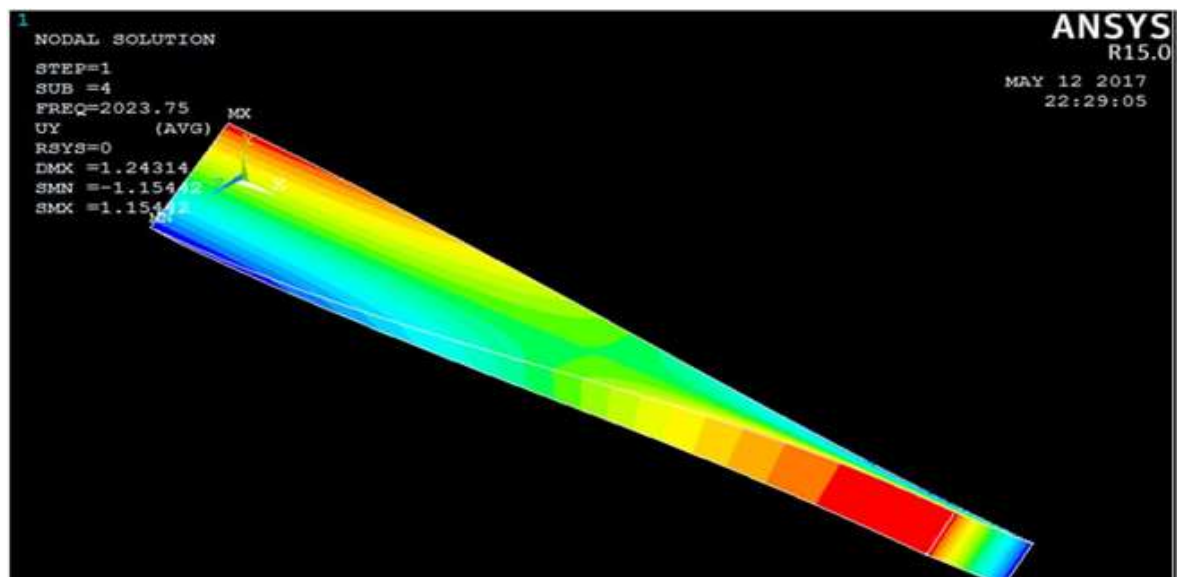


Fig.5.6. third mode of vibration, $a_1/w=0.1$, $a_2/w=0.1$, $L_1/L=0.19$, $L_2/L=0.54$



V. CONCLUSION

- Analytical machine technique may be used for determination the frequency of equation of elastic beam with cracks. it's shown that the natural frequency changes considerably as a result of the presence of cracks.
- The changes relying upon the placement and size of cracks. The position of the cracks may be expected from the deviation of the elemental modes between the cracked and uncracked beam.

VI. WORK CAN BE EXTENDED

- The cracked cantilever may be analysed underneath the influence of external forces.
- The dynamic response of the cracked beams may be analysed for various crack Orientations.
- Stability study of the cracked beams may be done

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