TEST Engineering & Management

March-April 2020
ISSN: 0193-4120 Page No. 2892 - 2897

Study the Effect of the Internal Crack on the Vibration Values using the FEM

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Article Info
Volume 83
Page Number: 2892 - 2897
Publication Issue:
March - April 2020

Article History
***Article Received**: 24 July 2019*
***Revised**: 12 September 2019*
***Accepted**: 15 February 2020*
***Publication**: 20 March 2020*

Abstract:

This study of changing the locations of internal crack in medal of loaded simply supported beam by finite Element method (FEM) using of FE analysis software (ANSYS v.14.0) ,the results show that changing the locations of crack along (Y-axis) for(1/2H,1/4H,3/4H) changing the values of fundamental frequency and mod shapes of beam. It been found that the higher frequencies values at the even frequencies, and the frequency increases as we approach the upper and lower beam where it is less for the first and second frequencies when the crack closer to the upper end and more at the remaining frequencies and this reflects the amount of energy absorbed in the crack

Keywords: *vibration analysis , beam buckling , natural vibration frequency, critical load.*

1. Introduction:

Beams are one of the most important parts in engineering applications, and it had been under different kinds of loading which cause filed these parts, cracks could be one of its resins which can defined by noticed the change in vibration analysis values . So, this study of changing the locations of internal crack in medal of loaded simply supported beam by finite Element method (FEM) using of FE analysis software (ANSYS v.14.0) ,the results show that changing the locations of crack along (Y-axis) for(1/2H,1/4H,3/4H) changing the values of fundamental frequency of beam , the frequency and mod shapes gives lost value of odd one and highest values at even one when crack at(1/2H) comparing with other two locations of crack in general the first fundamental frequency when crack(1/2H) .

Introduction and theoretical side:-

Many mechanical structures are exposed to different operating conditions and loads that may lead to the failure of the installation or part of it, especially structures that form vibration as part of the external conditions and cracks (worsening the external "open or spiral" or inside the installation) may be the cause of the installation failure. Many researchers are interested in a number of research studies for the effect of cracks affecting vibration values (frequencies, mode shape, side values ... etc). In 1983, Polanyi, orowan & Taylor, presented a fracture study due to the fissure bundle and presented a stress-strain relationship design to fit the description of the effect of the microscopic and progressive fissure and describe it within the stiffness matrix(1).

J. Fernandez and et al presented a simplified method for calculating the basic frequencies of the Euler-Bernoulli beam vibration with an open and pulsed fissure. The results of the natural frequencies of the two beams gave a significant correlation with the values obtained by numerical solution using the element differentiation method using ABAQUS(2).

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Natural frequencies in terms of the crack location and depth and comparing the results with a sample No other crack by using an application (ANSYS) was observed decline in the frequency of natural values in the beam Slotted(3).

In 2007, Julio & et al demonstrated ways to solve linear fracture problems and solve them with two computer applications (ANSYS)and (FRANC2D) using element differentiation method(4) . (Ever & J.) A model for slotting prediction and calculation of the slit matrix and the compensation matrix of the stiffness analytically(5). In 2012 (A.S.Bouboulas and et al) presented a study on the vibration analysis of an open crack sample, using the FEM method. It was concluded that the presence of the crack in the beam structure affects the stiffness values and this depends on the location of the crack and the depth of the crack. Vibrations for the entire structure (6).**2- Vibration analysis for the current research:-**

Previous studies and research have shown that the presence of the crack makes a difference in the frequency values and the use of element differentiation method (FEM) provides the possibility of obtaining high accuracy results for the entire composition and calculation of the pattern of the vibration and characteristic frequency values and distinctive trends (eigenvalue & eigenvector (7),(8),(9),(10).

Therefore, the present research presents the vibration analysis of a simple stabilization beam (s.s.b) using the (ANSYS v.14)application with FEM method. The beam contains a single internal microscopic crack under free vibration. The beam and slit characteristics are shown. The beam is loaded with an external load. The effect of shifting the slit location in a longitudinal direction (along the y axis) has been studied in three locations.

The presence of the crack reduces the values of natural frequencies and shape pattern due to the reduction of stiffness values, so many researches rely on these features in the beams.2-**2The model under study:-**

The first five natural frequency values were calculated for a simple stabilization beam (s.s.b) with an internal slit in the middle and under an external load on the beam (concentrated load). Figure (2-1) The model under study which was designed using ANSYS application:

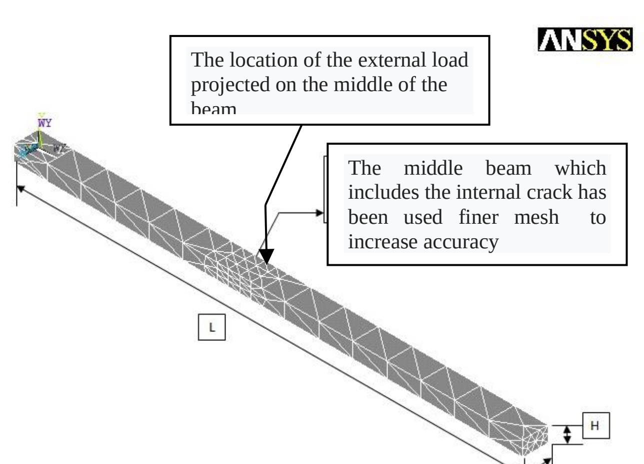

Fig. (2-1) model under study(11)

Table (2-1) shows the beam specifications under consideration(11). A 3D model was used the following specifications using an(ANSYS v. 14) application with (SOLID 189 tetrahedral 20 node brick element) and use finer mesh in the middle of the beam to increase the accuracy of the results, changed the crack length in 3 locations (1/4H,1/2H,3/4H)To calculate the first five natural frequencies of each site and then compare the results, the Block Lanczos method was used as the most suitable in symmetrical structures:

properties of (s.s.b)		properties of (s.s.b)	
Width(H)	15mm	Location of crack	Medal of (s.s.b)
Depth (W)	25 mm	Length of crack	0.1 mm
Length (L)	0.5m	Width of crack	0.5 mm

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modulus of Elasticity of the beam	207 Gpa	The value of the load at medal of (s.s.b)	140 N
Passon's ratio	0.3		
Density	7800 kg/m^3		
Type of vibration	Free analysis		
Outside load	650*10^{5}pa		

Table(2-1) beam properties under study [11]

3-Results :

Table (3-1) shows the comparison of the first five natural frequency values for the three different slit locations:

Mode No.	Freq.(Hz)for(1/4H)	Freq.(Hz)for(1/2H)	Freq.(Hz)for(3/4H)
1	254.97	220.37	232.76
2	360.05	433.89	317.34
3	731.14	553.89	871.47
4	896.89	1222.2	919.79
5	1467.8	1372.3	1709.0

Table (3-1) Effect of longitudinal position change of crack on the values of the first five frequency beam

From the observation of the values of the table above we generally find that the values of the first natural frequencies of the beam are recorded when the crack is in the middle of the beam towards the Y axis at the frequencies first, third and fifth (for individual frequency values) and higher at the second and fourth frequency (at even frequency values), The remaining frequency values are higher The closer the upper and lower beams, also the lower first and second frequencies they are less when the crack is closer to the upper end(3/4 H) and more at the remaining frequencies When the crack is at the position (1 / 4H) at the first and second frequency and the opposite is recorded for the rest of the third, fourth and fifth frequencies, and this difference between the values of natural frequencies is an indicator of the amount of energy lost (absorbed) in the crack, which in turn reflected on the values of the natural frequencies of the structure, which It is possible to use it to determine the location of the crack in the future from the normal frequency values. In turn the effect of changing the crack location shown in Figures (3-1-1), (3-1-2), (3-1-3), (3-1-4), (3-1-5) showing mode shape and frequency values when crack in distance (1/4 H):

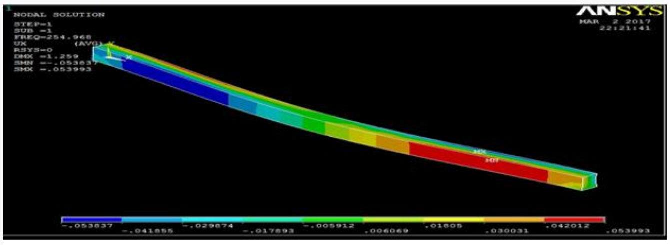

Figure (3-1-1) The first mode of the(s.s.b) with a crack at (1 / 4H)

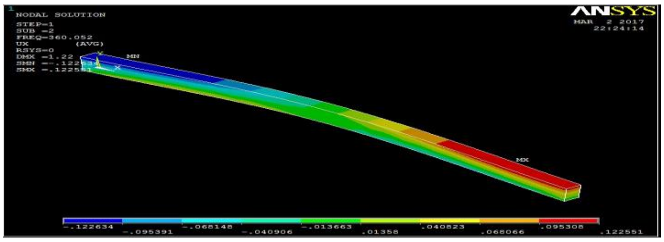

Figure (3.1.2) The second mode of(s.s.b) with a crack at (1 / 4H)

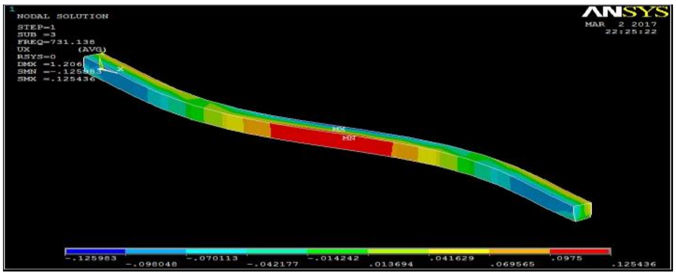

Figure (3.1.3) The third mode of the (s.s.b) with a crack at (1 / 4H)

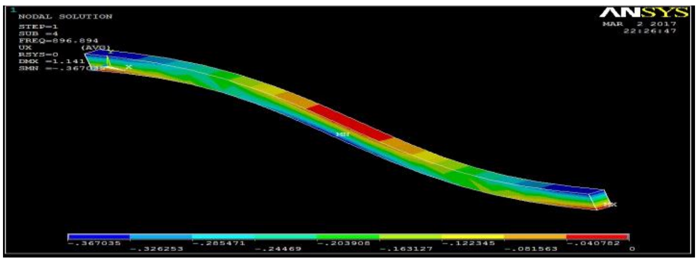

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Figure (3.1.4) The fourth mode of the (s.s.b) with a crack at (1 / 4H)

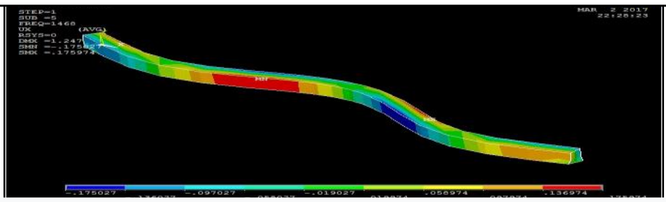

Figure (3-1-5) the fifth mode (s.s.b) with a crackh at (1 / 4H)

Figures (3.2.1), (3.2.2), (3.2.3), (3.2.4), (3.2.5) showing the mode shape and frequency values when the crack is in Distance (1/2 H):

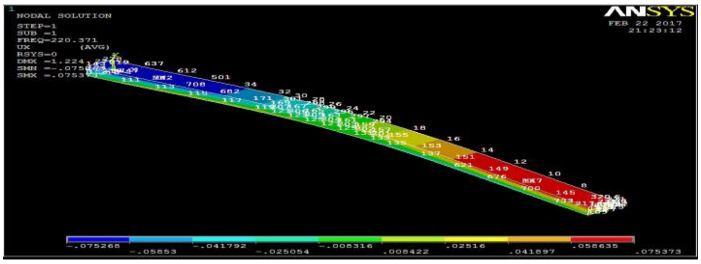

Figure (3-1-1) The first mode of the (s.s.b) with a crack at (1 / 2H)

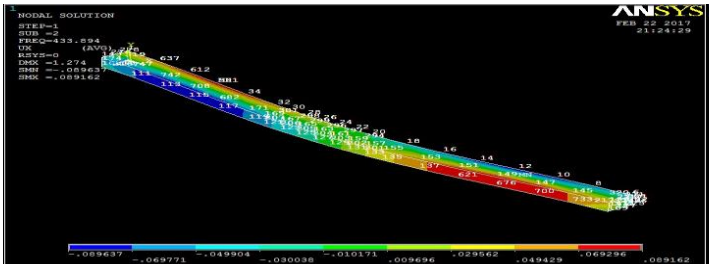

Figure (3.2.2) The second mode of (s.s.b) with a crack at (1 / 2H)

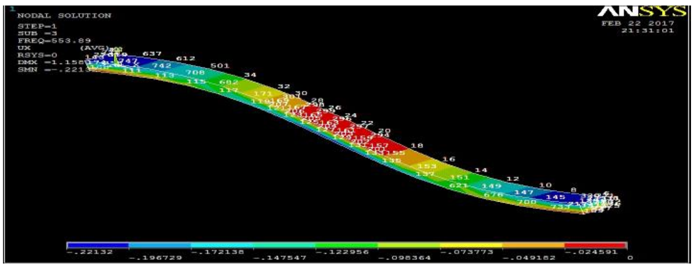

Figure (3-2-3) The third mode of(s.s.b) with a crack at (1 / 2H)

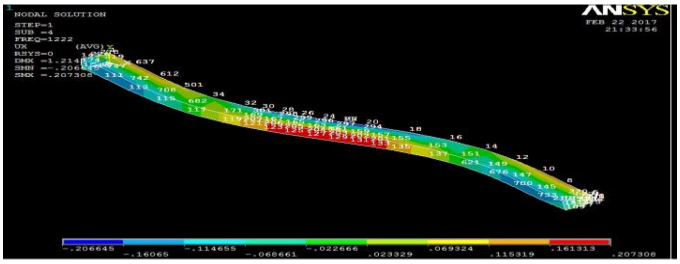

Figure 4-2-4) The fourth mode of the (s.s.b) with a crack at (1

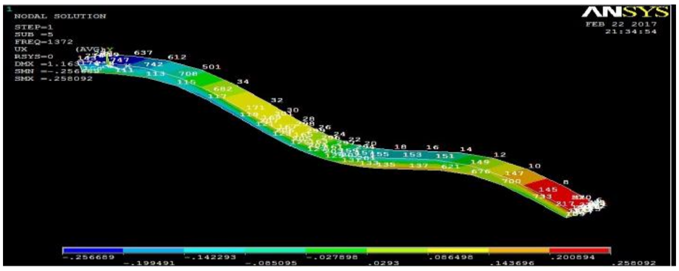

Figure 4-2-4) The fourth mode of the (s.s.b) with a crack at (1 / 2H)

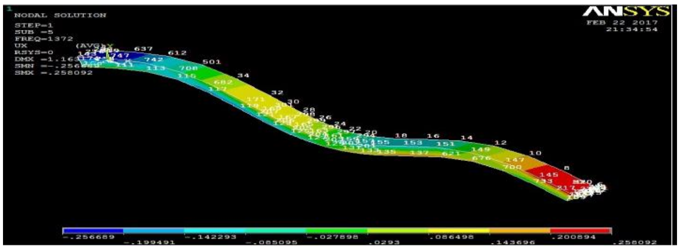

Figure (3-2-5) the fifth mode of the (s.s.b) with a crack at (1 / 2H)

Figures (3.3.1), (3.3.2), (3.3.3), (3.3.4), (3.3.5) showing the shape pattern and frequency values when the crack is in Distance (3/4 H):

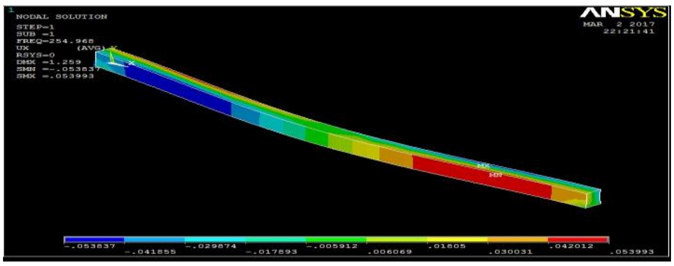

Figure (3-3-1) The first mode of the (s.s.b) with a crack at (3 / 4H)

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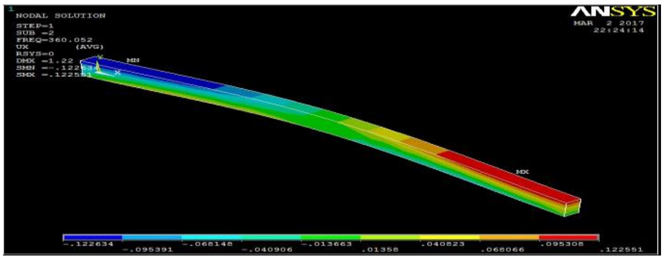

Figure(3.3.2) The second mode of the(s.s.b) with a crack at (3 / 4H)

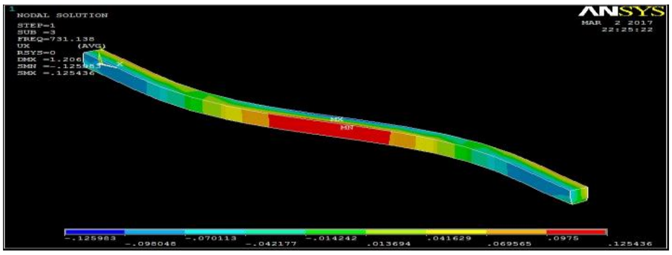

Figure (3-3-3)The third mode of the (s.s.b) with a crack at (3 / 4H)

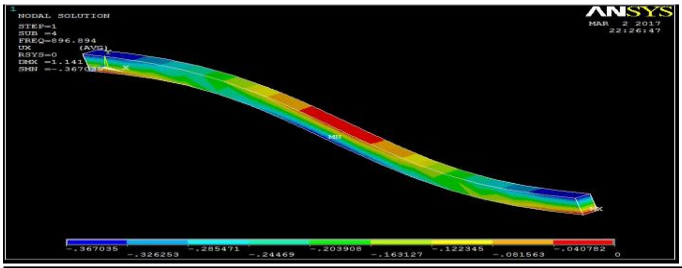

Figure (3-4-4) fourth mode beam (s.s.b) with a crack at (3 / 4H)

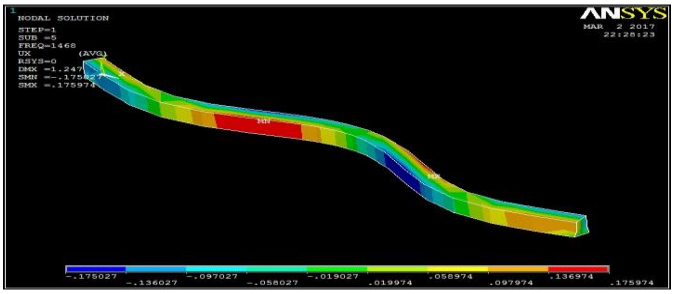

Figure (3-3-5) fifth mode beam (s.s.b) with a crack at (3 / 4H)

4- **Conclusion**:

A simply supported beam model of steel was analyzed numerically and the characteristics of the metal were previously reported. The first five natural frequencies of the beam, which includes an internal crack in the middle of the beam and under the influence of external load, were calculated.The first was at (1/4 H), the second at (1/2 H) and the third at (3/4 H). The model was analyzed using the (FEM) using the (ANSYS 14) application. It been found that the higher frequencies values at the even frequencies, and the frequency increases as we approach the upper and lower beam where it is less for the first and second frequencies when the crack closer to the upper end and more at the remaining frequencies and this reflects the amount of energy absorbed in the crack

This has caused a change in the values of the natural frequencies depending on the phase and the location of the crack.

The use of the FEM method provides a tool with high flexibility in calculations. The natural frequency change provides a method to predict the presence of an crack within the structure in case it is internal and not visible.

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