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ANALYSIS AND STUDY THE EFFECT OF CRACK ON DYNAMIC CHARACTERISTIC OF BEAM THROUGH ANSYS

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ABSTRACT

The dynamic characteristics of a beam with four cracks are studied in this paper. A systematic approach has been made in the present investigation to develop model and simulate for evaluation of natural frequencies and mode shapes of fixed-fixed and cantilever beam. A finite element model has been developed for the three layer composite beam. The equation of motion for the composite beam is derived by using the Hamilton's principle for both boundary conditions and first order shear deformation theory is used for vibration analysis of composite beams. Different specimens have been modelled by changing the core and face material and studied under the fixed-fixed and cantilever boundary conditions for modal analysis. Core is made up of viscoelastic material. The modelling and analysis is done on ANSYS Workbench 14.0. The results obtained for both without crack and with crack beam are compared to study the change in the behavior of dynamic characteristic of fixed-fixed and cantilever beam due to crack.

Key words: Composite beam, Finite Element Modal, Simulation, Mode Shape, Viscoelastic, ANSYS

INTRODUCTION

Beams and beam like elements are the basic structural components. Their strength to weight ratio increases when they are made of composites. They can be used for different application just by changing the layering sequence in the same weight and dimensions. Therefore, the complete analysis of composite beam is necessary. Robot applications, turbine blades, helicopter blades, medical instruments, etc are various engineering applications. In the dynamic analysis of composite beams, computation of natural frequency and mode shape is required because it is the most important parameter which is responsible for the failure of the machine or structure. It is also important because they are used in complex environmental conditions and are frequently exposed to a different dynamic excitations. A dynamic analysis is carried out which involves finding of natural frequencies and mode shapes for different core and face material combination and boundary conditions. Rishi Raj (2015) Doing practical and simulation on software under same boundary condition gives the same result. Because in earlier researches based on analysis of natural frequency, result obtained by practical is verified by the result obtained by simulation software as well as theoretically. Then, practical is equal to simulation with lot of possibility and minimum error.[9] Chasalevr is and Papadopoulos in (2006) have studied the dynamic behavior of a cracked beam with two transverse surface cracks. Each crack is characterized by its depth, position and relative angle.[3] Yang et al.(2001) have developed an energy-based numerical model is to investigate the influence of cracks on structural dynamic characteristics during the vibration of a beam with open crack. Upon the determination of strain energy in the cracked beam, the equivalent bending stiffness over the beam length is computed.[10] Ertuğrul et al.(2005) have studied to obtain information about the location and depth of cracks in cracked beams. For this purpose, the vibrations as a result of impact shocks were analyzed. The signals obtained in defect-free and cracked beams were compared in the frequency domain. The results of the study suggest to determine the location and depth of cracks by analyzing the from vibration signals. Experimental results and simulations obtained by the software ANSYS are in good agreement.[5] Bassiouni (1999) proposed a finite element model to investigate the natural frequencies and mode shapes of the laminated composite beams.[2] Krishnaswamy (1992) Dynamic equations governing the free vibration of laminated compositebeams are developed using Hamilton's principle. Analytical solutions are obtained by the method of Lagrange multipliers. Natural frequencies and mode shapes of clamped-clamped and clamped supported composite beams are presented to demonstrate the efficiency of the methodology.[7] Spadea and Zinno (1994) analysis shows that the finite element approach requires more computer equipment and engineer expertise but enables a more general and consistent analysis. Nevertheless, if a more realistic assessment of the behavior of this kind of structure is carried out, the cost is reduced and a higher safety factor usually gained.[6]Di Toranto (1965) has derived auxiliary equation for the effect of visco elastic layers. Theuse of this equation with the ordinary bending equation formed for homogeneous beams for solving static and dynamic bending problems.[4]In this thesis dynamic analysis of sandwich beams of different core and face material combination under fixed-fixed and cantilever with crack and without crack condition is studied.

Material and Methodology

Material properties of sandwich beam for face and core layers

Type of material	Young's Modulus E (GPA)	Density ρ (kg/m^3)	Poisson's Ratio υ
Aluminum	71	2766	0.33
Rubber	0.00154	950	0.45
Neoprene	0.0008154	960	0.49

For modeling and analysis four different types of sandwich beam specimens are considered.

Combination	(face-core-face)
1	Aluminum-Rubber-Aluminum
2	Aluminum-Neoprene-Aluminum

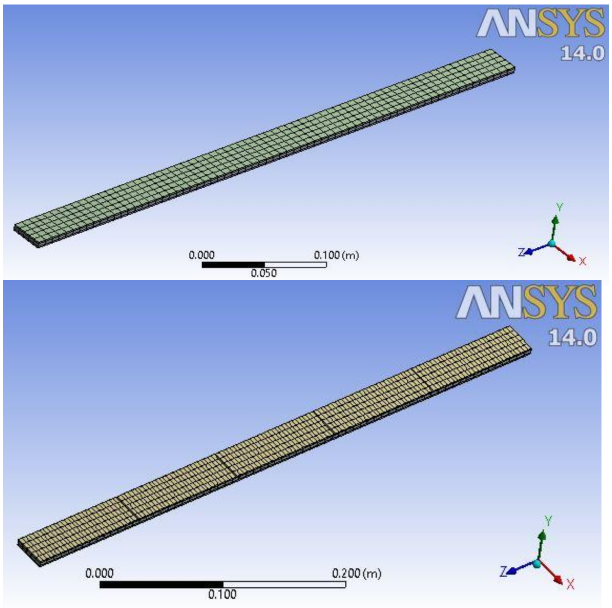
Modeling of Sandwich beam

A sandwich beam of different core and face material is modeled using ANSYS. After the modelling and analysis of without crack beam, crack is modeled in the beam and same analysis is performed on it.

Dimension of the beam

Thickness of the Face, t_1	1.5 mm
Thickness of the Core, t_2	3 mm
Width of the beam, w	30 mm
Length of the beam, P	500 mm
Depth of Crack	1 mm

Modeled Beam

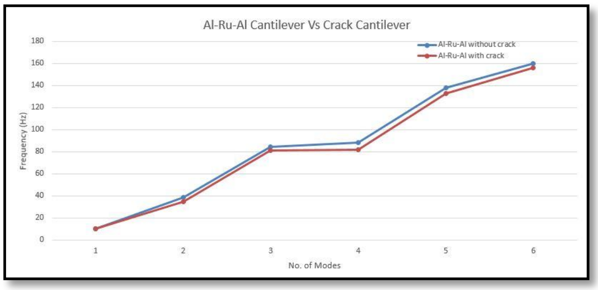


Without Crack (Above)
With Crack (below)

Analysis of Cantilever beam

Aluminium-Rubber-Aluminium

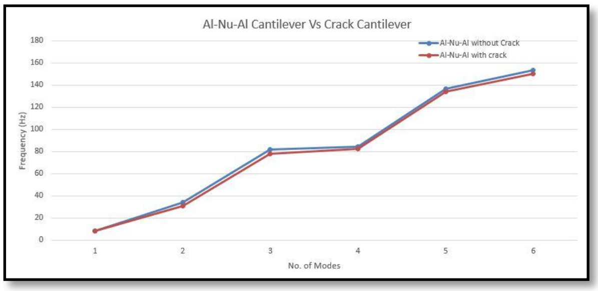
Al-Ru-Al	Natural Frequency at Different Modes					
	1	2	3	4	5	6
Without Crack	10.269	38.902	84.584	88.351	137.76	160.27
With Crack	10.19	38.518	84.173	87.568	137.41	158.73



Graph-1

Aluminium-Neoprene-Aluminium

Al-Nu-Al	Natural Frequency at Different Modes					
	1	2	3	4	5	6
Without Crack	8.4283	34.063	82.147	84.464	136.43	153.79
With Crack	8.3644	33.755	81.451	84.053	136.09	152.36

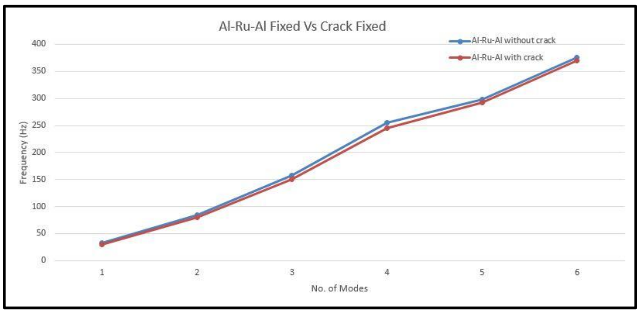


Graph-2

Analysis of Fixed Beam

Aluminium-Rubber-Aluminium

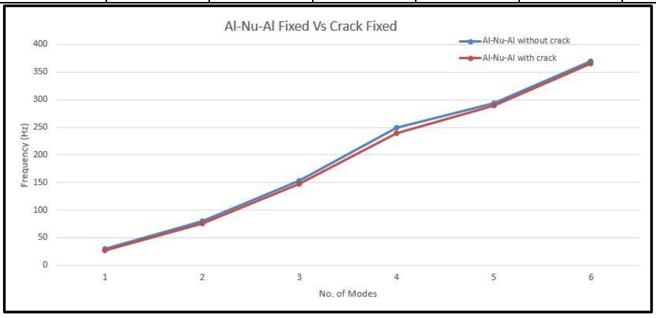
Al-Ru-Al	Natural Frequency at Different Modes					
	1	2	3	4	5	6
Without Crack	33.215	83.775	157.27	254.45	298.28	375.74
With Crack	33.012	83.153	155.92	251.08	297.61	374.58



Graph-3

Aluminium-Neoprene-Aluminium

Al-Ru-Al	Natural Frequency at Different Modes					
	1	2	3	4	5	6
Without Crack	30.508	79.72	152.5	249.23	294	370.16
With Crack	30.34	79.168	151.23	245.93	293.35	369.07



Graph-4

Conclusion

The aim of this analysis is to study the effect of crack on dynamic characteristic of composite cantilever beam and composite fixed beam.Graph-1 & 2 shows that the decrease in natural frequency of aluminium-rubber-aluminium and aluminium-neoprene-aluminium composite cantilever beam due to development of crack. And graph-3 & 4 shows that the decrease in natural frequency of aluminium-rubber-aluminium and aluminium-neoprene-aluminum fixed beam due to development of crack. Therefore it is concluded that due to the development of crack in the cantilever and fixed beam, natural frequency of the beam decreases which leads or increases the percentage of failure.

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