International Journal of Engineering Technology and Applied Science
(ISSN: 2395 3853), Vol. 2 Issue 2 February 2016

Natural Frequency Analysis of Composite Beam of Channel Cross Section with Varying Length

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ABSTRACT:- The use of composite materials increasing across various field like as aerospace, automotive, civil and other high performance of engineering applications due to their characteristics light weight, high specific strength, stiffness, thermal characteristics, ease to fabrication and other significant. The present study deals with the free vibration of laminated composite beam and compared with the numerical prediction of finite element method (FEM) in ANSYS environment. The scope of present study to observe and understand the effect of different parameters like natural frequency and mode shape. Natural frequency analysis of various cross section of beam was observed, compared and discussed. The finite element modelling has been done by ANSYS software and compared their results with experimental method. In this analysis two node of three degree of freedom per node, rectangular cross section and channel cross section has taken for free vibration of composite beam. And analyse the effect of length on beam and various boundary conditions.

KEYWORDS:- Finite Element Method (FEM), ANSYS software, channel and rectangular beam.

INTRODUCTION

There is widespread use of composite structure in aerospace application to study various aspects of their structural behaviour. The composite materials are mostly used in problems where large strength to weight ratio is required. Similarly isotropic material and composite material are subjected to various kinds of damage, cracks, flaws etc. Their results changes in stiffness of elements and consequently their dynamic behaviour changes.

The vibration analysis of composite beam has tedious problem for structural engineers though all element have natural frequencies with the potential to suffer the excessive vibration under dynamic load. This is mainly done by modal analysis which allow to find out the natural frequencies, mode shape and damping also. Once the natural frequencies are known the structure can be designed safe against vibration. This is mainly due to feeling vibration while crossing the foot bridge with the frequency close to the first (fundamental) natural frequency of bridge. Therefore vibration analysis of such structure can be determined as a serviceability issue. Model parameters are of a structure for frequency, damping and mode shape. The frequency of a structure is directly proportional to stiffness of structure and inverse of structural mass.

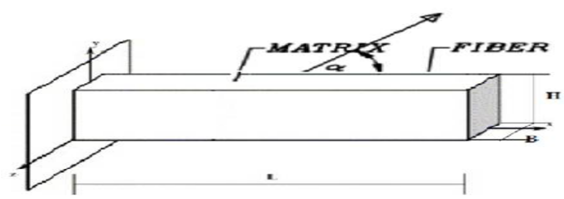


Fig.1 Mathematical model of Cantilever beam.

Present work deals with the vibration analysis of composite channel section and box section composite beam created. To stimulate the free vibrations in beam, the finite element software ANSYS is used. ANSYS is commercial finite element software with capability to analyze a wide range of different problems

Procedure in modelling ANSYS-

There are major and important steps in ANSYS,

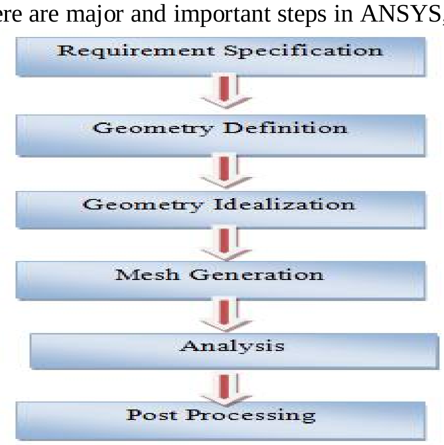


Fig.2 Required Specifications

Table 1:Data of Modelling of the beam

Geometry Definition	Values
Thickness	0.025m
Young Modulus	216.16 x10^9
Width	0.0078m
Length of the beam	0.2 m
Poisson ratio	0.28
Density	7.85 x10^3

Boundary Condition-

Cantilever beam: - $u = v = w = \Theta_x = \Theta_y = 0$
At $x = 0$

Fixed beam: - $u = v = w = \Theta_x = \Theta_y = \Theta_z = 0$
At both end

Vibration analysis studies of channel Composite beam with variable length-

Table 2: Natural frequencies of channel composite cantilever beam

	ANSYS			
Frequency	**L =400 mm**	**L=600 mm**	**L=800 mm**	**L=1000 mm**
ω1	1.2137	2.0666	0.81081	0.54665
ω2	2.5415	2.6732	0.90464	0.72251
ω3	2.5493	2.9384	1.0981	0.74846
ω4	3.0935	3.2034	1.6483	1.3177
ω5	3.3041	4.1178	2.1153	1.4622

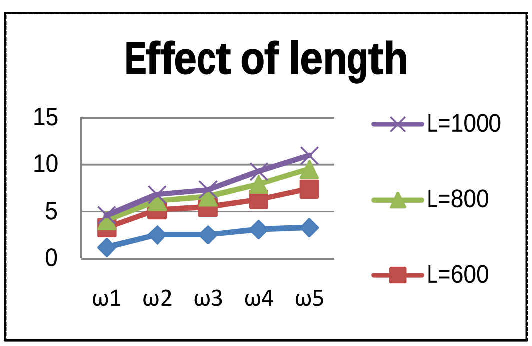
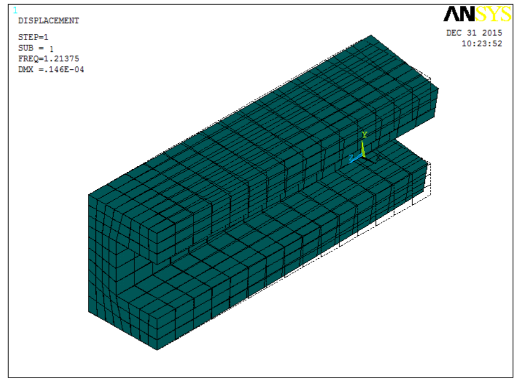
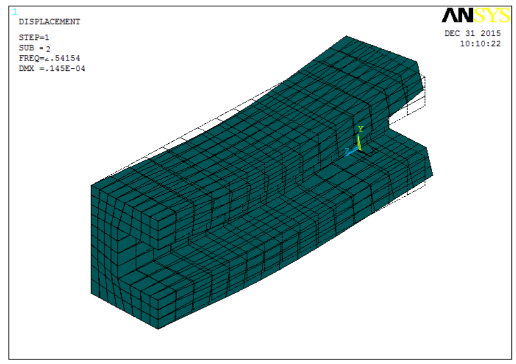
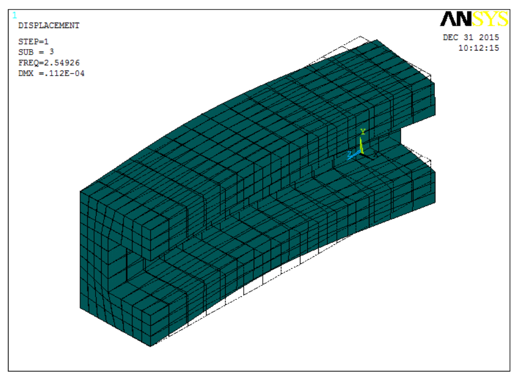
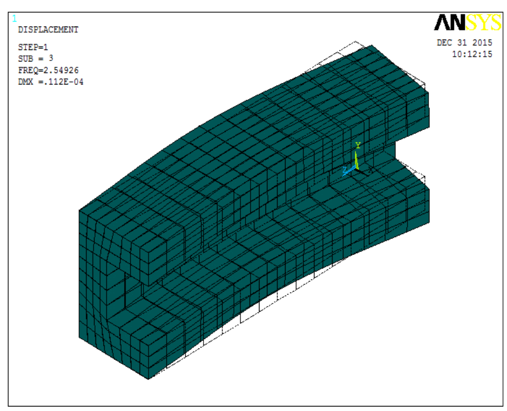


Fig.3 Natural frequencies of channel composite cantilever beam









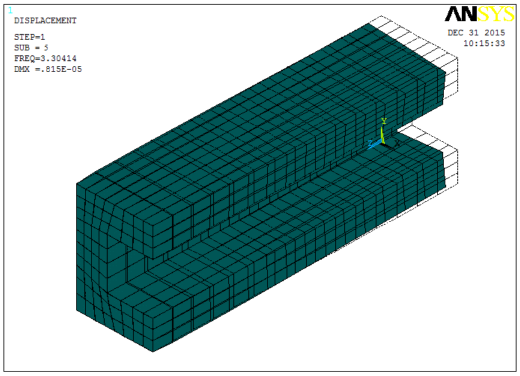


Fig.4 First five mode shape channel cantilever beam

Table 3: Natural frequencies of channel composite fixed beam

	ANSYS			
Frequency	**L =400 mm**	**L=600**	**L=800**	**L=1000**
ω1	2.2190	1.2410	0.13757	0.5479
ω2	2.4656	1.3020	0.20769	0.6035
ω3	3.4131	2.0941	0.49845	1.0697
ω4	3.7670	2.8476	0.80494	1.4091
ω5	4.9269	3.0949	0.97516	1.4131

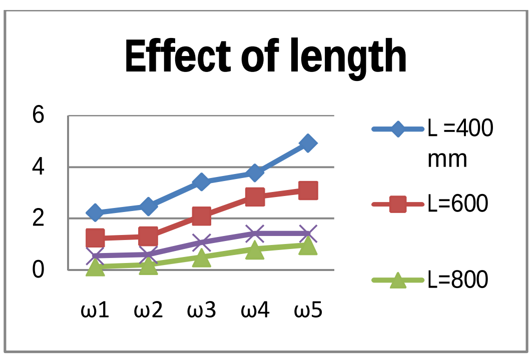


Fig.5 Natural frequencies of channel composite fixed beam

CONCLUSION

The following conclusions have made from the present investigations for the rectangular and channel shaped composite beam by finite element analysis. This element is versatile and can be used for static and dynamic analysis of a composite or isotropic beam.

1. The natural frequencies of different boundary conditions of composite beam have been observed.
2. It has found that in present investigation the natural frequency is minimum for cantilever supported beam and maximum for fixed supported beam.
3. It is found that natural frequencies decrease with the increase of beam length.

Future Scope

1. The dynamic response of an unsymmetrical orthotropic laminated composite beam, subjected to moving loads, can be derived. The study should be including the effects of transverse shear deformation, rotary and higher-order inertia.
2. It can provide more number of degree of freedom and then should be analysed by higher order shear deformation theory.
3. The free vibration characteristics of laminated composite cylindrical and spherical shells can be analyzed by the first-order shear deformation theory and a mesh less global collocation method based on thin plate spline radial basis function.
4. The damping behaviour of laminated sandwich composite beam inserted with a visco-elastic layer can be derived.
5. Static and dynamic stability of composite beams with cracks can also be derived.

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