Vibration Analysis of Sandwich Beam with Different Core Patterns

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***Abstract*: Sandwich beams offer designers a number of advantages, as the high strength to weight ratio, flexibility, high bending and buckling resistances. Sandwich construction results higher natural frequencies than none sandwich constructions, also it developed an adaptive tuned vibration absorber. In the present work, the natural frequencies and mode shapes of the sandwich beam structure are calculated under different core configuration and different core materials. Finite element (FE) method is used to analyze the beam.Sandwich beams are composite systems having high stiffness-to-weight and strength-to weight ratios and are used as light weight load bearing components. The use of thin, strong skin sheets adhered to thicker, lightweight core materials has allowed industry to build strong, stiff, light, and durable structures.There is a recent developments and successful applications of sandwich beams for structural engineering and construction. These include fibre composite railway sleepers, composite walers, and fibre composite replacement bridge girders. Sandwich beam is subject to a concentrated point load at the mid span of the beam. A systematic procedure is presented for comparing the relative performance of sandwich beams with various combinations of materials in the beam using ANSYS software.**

Keywords: Sandwich beam, application, FE analysis, ANSYS, face, core, natural frequency, mode shape

1.INTRODUCTION

Sandwich beams are composite systems having high stiffness-to-weight and Strength-to weight ratios and are used as light weight load bearing components. The use of thin, strong skin sheets adhered to thicker, lightweight core materials has allowed industry to build strong, stiff, light, and durable structures. This study examines the behavior of sandwich beams driven by the different core configuration and different core materials. Sandwich Beams are extensively used in the construction of aerospace, civil, marine, automotive and other high performance structures due to their high specific stiffness and strength, excellent fatigue resistance, long durability and many other superior properties compared to the conventional metallic materials. In general, these structures require high reliability assurance for which, the prediction of the maximum load that the structure can withstand. A sandwich structured composite is a special class of composite materials that is fabricated by attaching two thin but stiff skins to a light weight but thick core. The core material is normally low strength material, but its higher thickness provided the sandwich composite with high bending stiffness with overall low density. The core is bonded to the skins with an adhesive or with metals components by brazing together. There are different types of sandwich structures. Typically, materials such as steel and aluminum sheets are used for the skins.

Structural Sandwich is a special form of composite comprising of a combination of different materials that are bonded to each other so as to utilize the properties of each separate component to the structural advantage of the whole assembly. Sandwich materials are frequently used wherever high strength and low weight are important criteria. The most important application are found in the transport industry such as in the aerospace, aircraft, automobiles, railroad and marine industries where a high stiffness/ weight and strength/ weight ratio provides increased pay load capacity, improved performance and lower energy consumption. A sandwich structure consists of three elements, face sheets, core and the adhesive interface layers. The faces carry in-plane and bending loads, while the core resist transverse shear forces and keeps the facings in place.

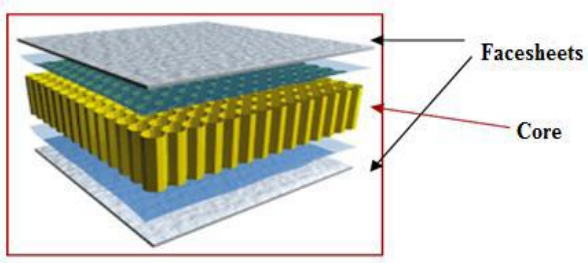

Fig.1.1 sandwich beam

Sandwich beam is made up of different layers ,The outer skins: If the sandwich is supported on both sides, and then stressed by means of a force in the middle of the beam, then the bending moment will introduce shear forces in the material.The shear forces result in the bottom skin in tension and the top skin in compression.
The application areas of sandwich structures

- In damped structures for effective vibration damping
- Aerospace field
- Building Construction
- Naval ships

- Rail Industry
- Automotive Industry

II. OBJECTIVES

1. To validate ANSYS software
2. To evaluate and compare sandwich beam with different core configuration using dynamic analysis .Core configurations used are:-
   - square collinear
   - honeycomb,
   - diamond collinear
   - pyramidal
3. To compare the behavior of sandwich beam with rubber core materials and Face material used is steel
4. To find out the natural frequencies and mode shape of the sandwich beam

IV.METHODOLOGY

This chapter describes the methodology of the thesis work..The methodology includes study of sandwich beam and ANSYS software. The whole thesis work is divided into the following sequential steps. The following flowchart represents the methodology of the thesis work to be completed. .

A. MODELLING

The models are created using ANSYS software. Then obtain the different models should be analysed. Anlysis was performed.After analysis the results obtained are evaluated to find out which type of composite sandwich beam is more better for different configruation is most effective in resisting lateral loads. From the literature survey helps to catch the knowledge about the sandwich beam Here the study is to be carried out for the behaviour of Core configurations are square collinear, honeycomb,corrugated truss and pyramidal.The material properties are selected based on several sources such as literature reviews. Materials used for core are rubber. sandwich beam specimens were made for analysis with four different core patterns. Specimen1: Steel- Rubber-Steel .Modelling is performed using SOLID WORKS software

B. DIMENSIONAL DETAILS

A sandwich beam is modeled using ANSYS software with the reference journal[3]. Finite element analysis results were used to develop static analysis of sandwich beams with 0.03m core thickness under fixed support condition is studied**.** Sandwich beam with visco elastic rubber core is used to modeling and evaluating. The specifications of the beam are as follows:

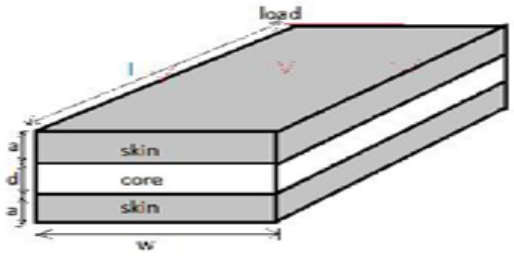

Fig.4.1 Dimensions of Sandwich Beam

Table.4.1 Dimensional details of Sandwich Beam

C. MATERIAL PROPERTIES

DIMENSIONS OF THE BEAM	VALUES
Thickness of the skin(a)	0.02m
Width of the beam(W)	0.2m
Load acting on the beam(P)	5000N
Length of the beam(L)	1m
Thickness of core(b)	0.03m

Sandwich beam are made up of different materials.The material properties of sandwich beam are given bellow

Table.4.2 Material Properties of Sandwich Beam

Type of material	Young's Modulus E (GPA)	**Shear Modulus G (GPA)**	**Density ρ in Kg/m3**	**Poisson's Ratio υ**
STEEL	210	80	7850	0.3
RUBBER	0.00154	0.005	950	0.45

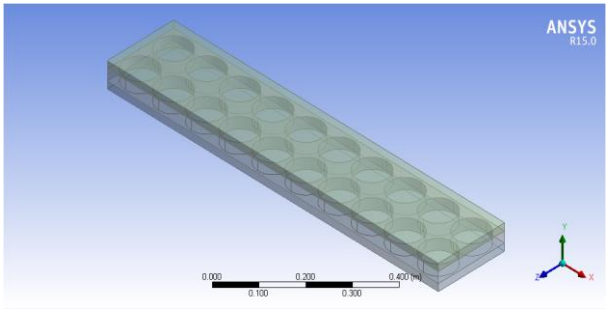

Fig.4.2 circular core Sandwich Beam

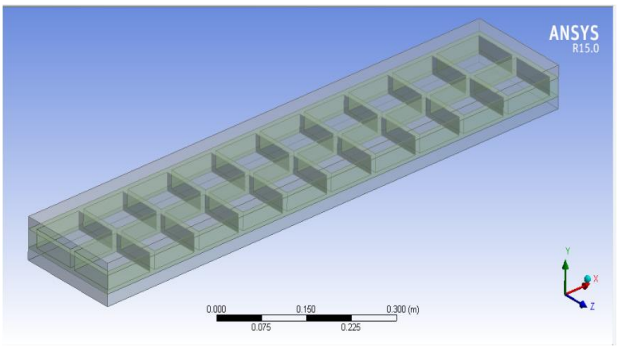

Fig.4.3 Square core Sandwich Beam

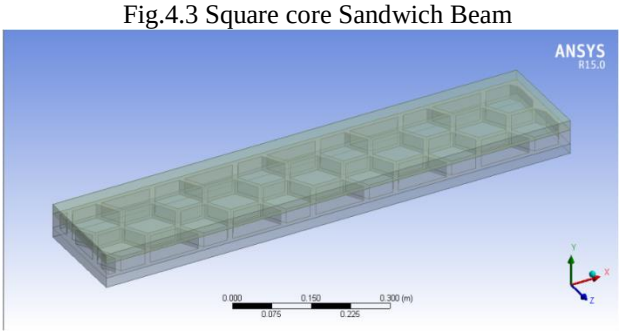

Fig.4.4 honey comb Sandwich Beam

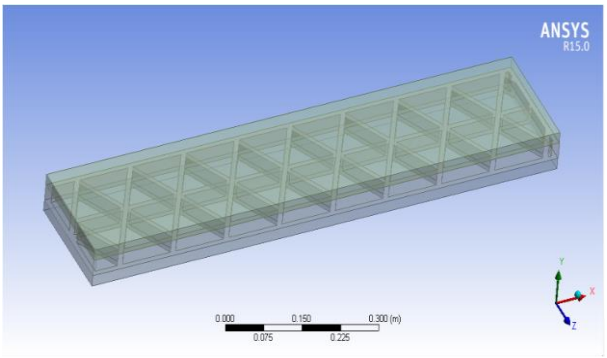

Fig.4.5 truss core Sandwich Beam

D.MESHING AND LOADING

The beam is modeled using a rectangular mesh which is a 4-node mesh. The element size of the mesh was provided as 5mm. Loading is provided on the top area, as pressure in 5000 N. The loading is given by point load with with fixed end support.

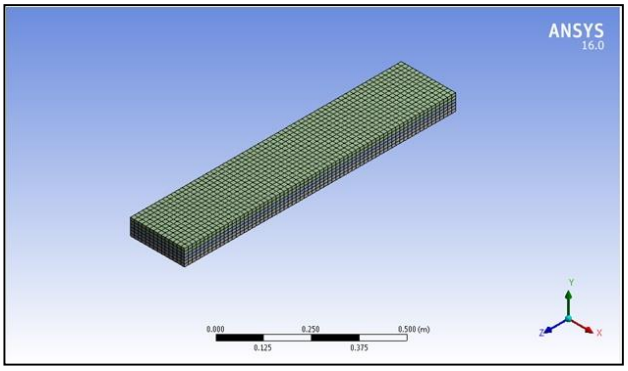

Fig.4.6 Meshing of sandwich beam

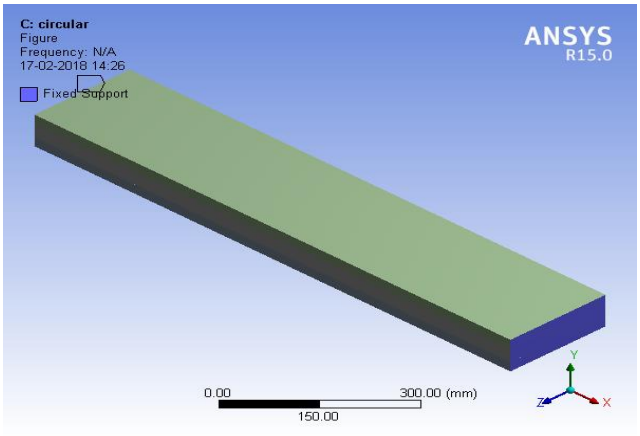

Fig.4.7 support condition of sandwich beam

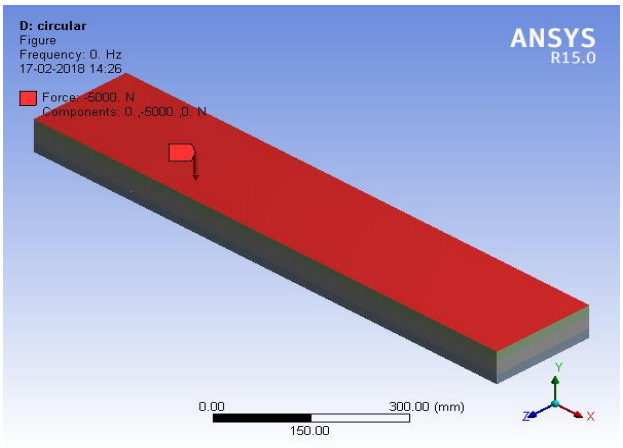

Fig.4.8 Loading of sandwich beam

E. ANALYSIS OF SANDWICH BEAM

Analysis was done using ANSYS software. Finite element analysis will provide indepth knowledge about the behavior of the member; it performed with proper boundary conditions and material properties. There are different analyses performed in this study. These include the effects of natural frequencys ,mode shapes ,vibration effects damping effects with point load conditions.

V RESULTS AND DISSCUSSION

DEFORMATION

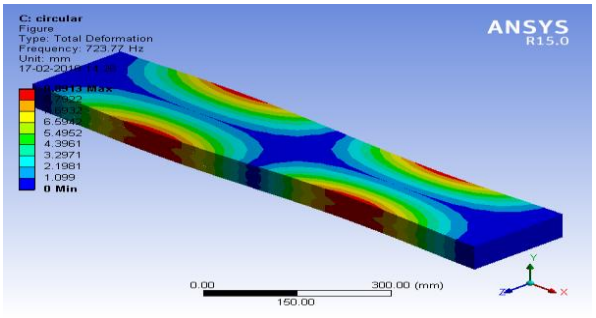

Fig.4.9 Deformation Diagram of Beam

Table.4.3 deformation of Sandwich Beam

MODELS (STEEL-RUBBER-STEEL)	DEFORMATIONS(mm)
Circular core	0.19488
Square core	0.2074
Truss core	0.1892
Honeycomb core	0.20094

B. MODAL FREQUENCIES

Five Mode shapes are considered and modal analysis is done for every thickness value

Table.4.4 modal frequencies of Sandwich Beam

MODE SHAPE	STEEL-RUBBER-STEEL			
	CIRCULAR	SQUARE	TRUSS	HONEY COMB
1	113.74	111.19	110.06	109.64
2	301.97	299.28	294.61	294.27
3	378.17	362.84	337.82	345.36
4	581.35	579.87	569.47	569.48
5	723.77	713.34	659.27	679.34

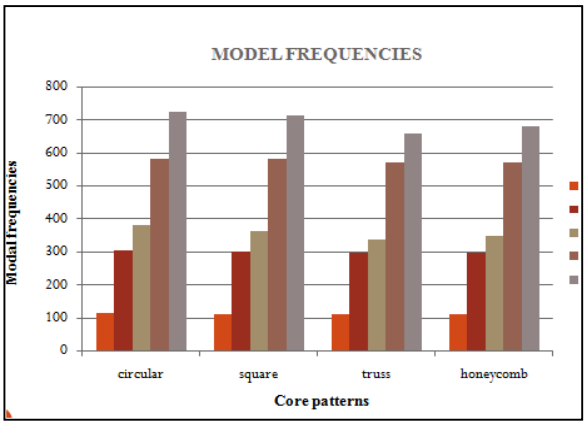

Fig.4.11 model frequencies of Beam

VI.CONCLUSIONS

Sandwich beam is analysed in ANSYS software and the results where compared. This section represents the validation result of finite element model for the visco elastic rubber core sandwich beam with 0.03m hick core. The following conclusions areobtained from the study using of steel-rubber-steel specimen are, Based on the deformation ;Truss core is more better which have low deformation,Based on the vibration;Circular core produces an effective responses

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