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TO STUDY ANALYSIS OF SANDWICH BEAM WITH ANSYS AND FEM

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ABSTRACT

This paper presents the analysis of sandwich beam. The simple software has developed for calculating the data. The software are validated by compare data using the software package **ANSYS.** 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. Due to the use of viscoelastic polymer constituents, sandwich beams can exhibit time-dependent behaviour. This study examines the behaviour of sandwich beams driven by the viscoelastic rubber core. Finite element method (FEM) is used to analyze the overall transient responses, harmonic responses and the static responses of the sandwich systems subject to a concentrated point load at the mid span of the beam. In this study the skin, i.e. the top and bottom layers are made up of mild steel while the core is made up of rubber. The stress, strain, and deformation fields are analyzed. The core thickness is varied keeping the skin thickness constant and the behaviour of the sandwich beam is studied under static and dynamic conditions.

KEYWORDS: Sandwich Beam, Sandwich Material, Light Weight Structure, ANSYS

INTRODUCTION

Beam and frames systems made of more than one material are often used in structural system to utilize the advantage of the different material in the composite. As an illustration a reinforced concrete structure comprises of two principal materials having specific function, the concrete is excellent in compression but performs badly in tension whilst the steel can resist tensile force that may produce bending in the system. The inclusion of a material in a composite should take into account in function with the composite.

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. Open and closes cell structured foams like polyvinylchloride, polyurethane, polyethylene or polystyrene foams, and honey combs are commonly used core materials. Open and closed cell metal foam can also be used as core materials. Laminates of glass or carbon fiber reinforced thermoplastics or mainly thermo set polymers (unsaturated polyesters, epoxies...) are widely used as skin materials. Sheet metal is also used as skin material in some cases. The core is bonded to the skins with an adhesive or with metals components by brazing together.

Sandwich beam is nothing but a composite beam in which a viscoelastic layer is sandwiched between two elastic layers.

According to the sandwich theory, it describes the behavior of a beam which consists of three layers - two face sheets and one core that is used in between the two face sheets. The most commonly sandwich theory that is applied is a linear and is an extension of first order beam theory. Linear sandwich theory is of utmost importance for the design and analysis of sandwich panels, which are of use in building construction, vehicle construction, airplane construction and refrigeration engineering.

The systematic diagrams of sandwich are:

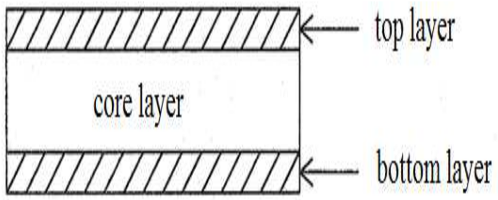

Figure 1.1: Sandwich Beam Model

- **CORE MATERIAL**

The function of the cores is to give support for the thin skin layers so that they do not deform outwardly or inwardly, and to keep them in relative position to each other. The main requirements of the core are generally the shear and compressive modulus and strength. The main objective of any designer in choice of core material is that it would not fail under the any applied load and there should not be any deformation of core in thickness wise, thus requiring a high modulus of elasticity perpendicular to face layers. The core layer is exposed to shear so that global deformations and core shear stresses are developed by the shear strains in the core. The thickness of core and core material are two main parameters that decide the most of the properties of the sandwich structure.

The core layer consists of some typical features as given below:

- Lower density
- Damping of vibration and noise
- Shear strength and shear modulus
- Stiffness perpendicular to the top and bottom faces
- Thermal insulation

- **FACE MATERIALS**

The bottom and top layers of conventional sandwich structure are called as face layers or face sheets (as layers are in sheet form). From any structural materials that are available in the form of thin sheets can be used as a face material. The top and bottom layers face materials carry the compressive and tensile stresses in the sandwich.

The face layer consists of some typical features as given below:

- High impact resistance
- High compressive and tensile strength
- Wear resistance
- Resistance to different conditions (chemical, heat, etc.)
- High stiffness giving high flexural rigidity
- Good surface finish

Historically, the first use of the concept of sandwich construction dates back to Sir William Fairbairn in England, 1849. The idea to combine two different materials to increase the strength of a structure was first used in the 1930s. In 1940, sandwich construction was used extensively in building the English Mosquito bomber during the War II. The Mosquito was implemented with a plywood sandwich construction. In the United States the core was originated. In the late 1940's, Hexcel Corporation was formed and it has played the most role in the development of sandwich construction. Sandwich beams are widely used in a variety of applications such as satellites, railroads and automobiles to name a few (Vinson, 2005).

Due to the use of polymer constituents, sandwich beams can exhibit time dependent behavior. Viscoelasticity is the study of time dependent materials showing a combined elastic solid and viscous fluid behavior when subjected to external mechanical loadings. The response of viscoelastic materials is determined not only by the current state of the load, but also by the history of the loading.

Sandwich beams are generally thick structures in which the thickness is not negligible as compared to other dimensions. Thus, shear deformation accounts for a significant amount of transverse deflection. In polymer foam cores, shear deformation often continues to increase under a constant load (stress). The strength of a sandwich beam is determined by the resistance of the skins or core to failures. Ideally, the skins should be designed to resist axial stresses, whereas the core should be designed for limited shear. Although the distribution of the shear stress through the thickness in sandwich beams is not uniform, for design purposes the shear stress through the core thickness is often assumed uniform.

The material choice in sandwich structures depends upon the need of employment such as high strength, high temperature resistivity, surface finish etc. In recent times

The number of available cores has increased enormously due to the introduction of more competitive cellular plastics. Combining options of face sheet materials with different core materials give the new ideas to be integrated with a wide range of applications.

Arrangement of soft core material that requires more energy to deform provides internal damping of structures known as sandwich treatment. Sandwich treatment will reduce the amplitude of oscillation depending upon the location, volume and mechanical properties of core layer in the structure. It is also important to study the effect of sandwich treatment on static response of the structure in order to confirm the safe design. When a sandwich structures with thin soft core is transversely loaded, the two faces tend to act as two independent beams, bending along their centroids, rather than along the neutral axis of the beam as a whole.

DIMENSIONS OF BEAM

a=0.002m……..thickness of the skin.

w= 0.2m………..width of the beam.

P=5000N………..load acting on the beam.

L=1m…….length of the beam

Core = 0.04 Neoprene

Table 1: Variation of Core Thickness

Condition	Thickness (M)
1	0.02
2	0.03
3	0.04
4	0.05
5	0.06

Table 2: Material Properties

Parameter	Skin	Core
Material	Steel	Neoprene
Young Modulus	210	0.0008154
Poisson Ratio	0.3	0.49
Density	7850	960
Shear Modulus	27.3	0.000273

STATIC ANALYSIS

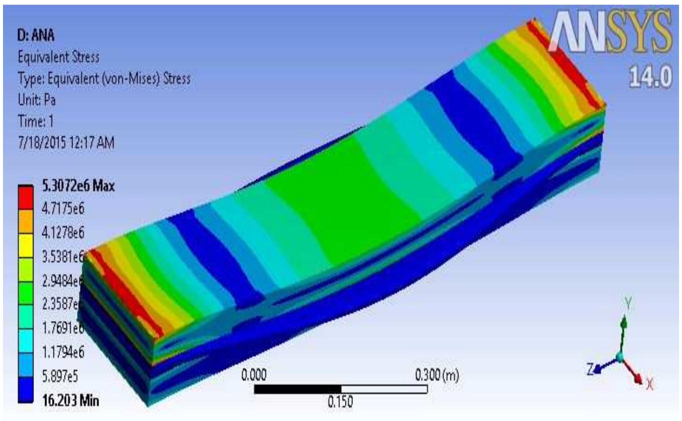

Figure 1: Von Misses Stress for 0.02m Thick

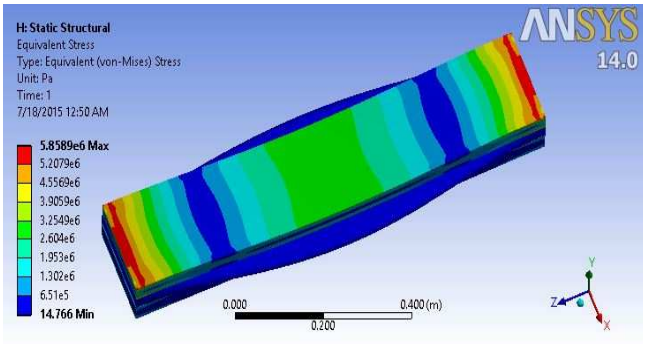

Figure 2: Von Misses Stress for 0.03m Thick

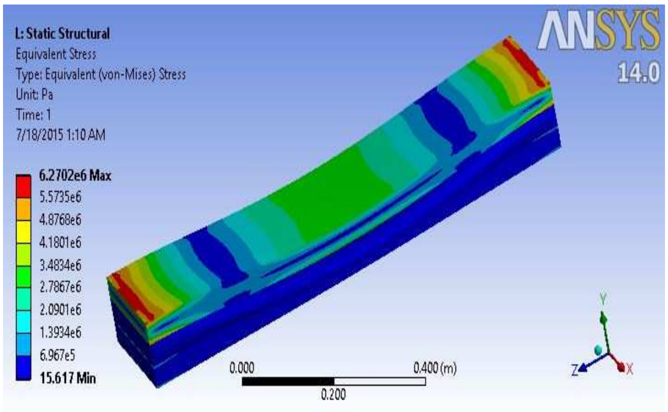

Figure 3: Von Misses Stress for 0.04 M Thick

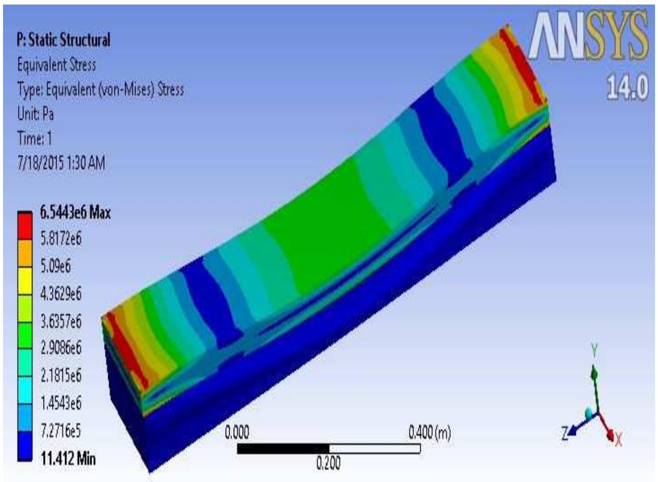

Figure 4: Von Misses Stress for 0.05 M Thick

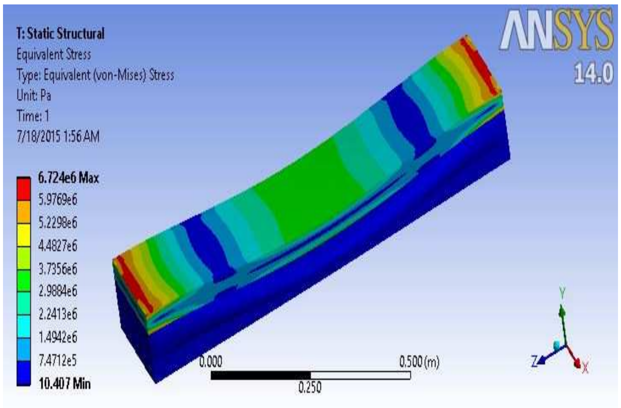

Figure 5: Von Misses Stress for 0.06 M Thick

Variation of Deflection and Stress with Thickness

Thickness	Deformation	Stress
0.02	6.70E-05	5.30E+06
0.03	8.95E-05	5.85E+06
0.04	9.63E-05	6.27E+06
0.05	9.16E-05	6.54E+06
0.06	8.67E-05	6.72E+06

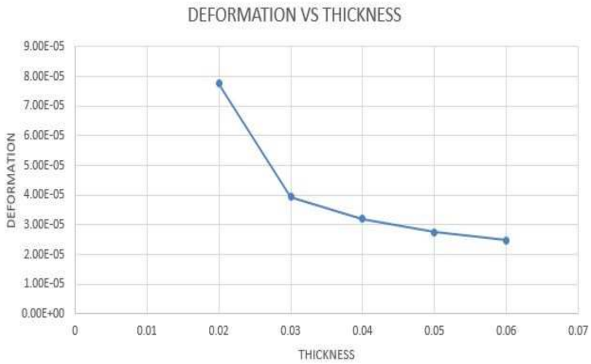

Figure 6: Graph between Deformation and Thickness

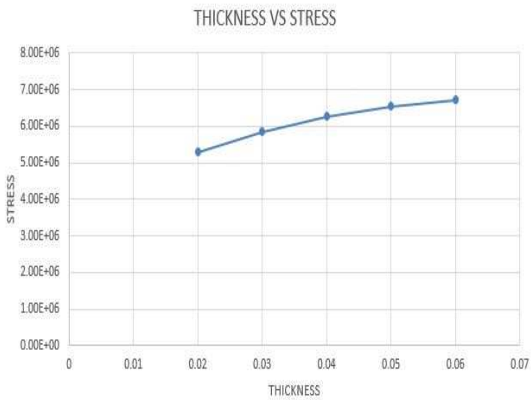

Figure 7: Graph between Thickness and Stress

From this we can note that the deformation is decreasing with that the thickness. It is the same as in case of the stress also. The decreasing will continue in the same fashion as the skin change then optimum value could be found out.

Modal Analysis

Six mode shapes are considered and modal analysis is done for every thickness.

The following are the mode shape for thickness value of 0.02

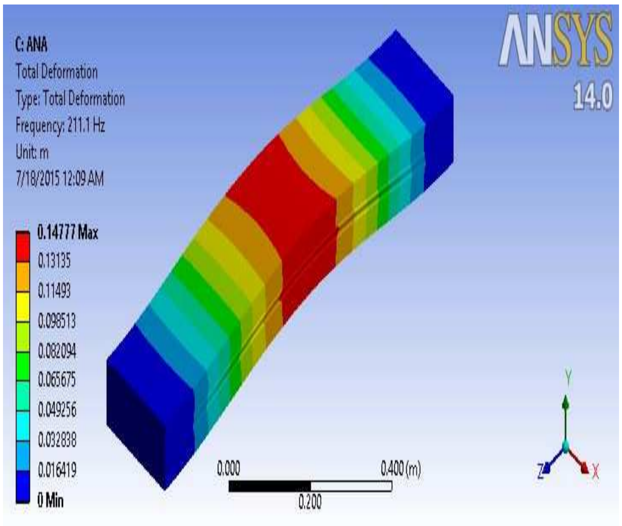

Figure 8: First Mode Shape for Thickness 0.02m

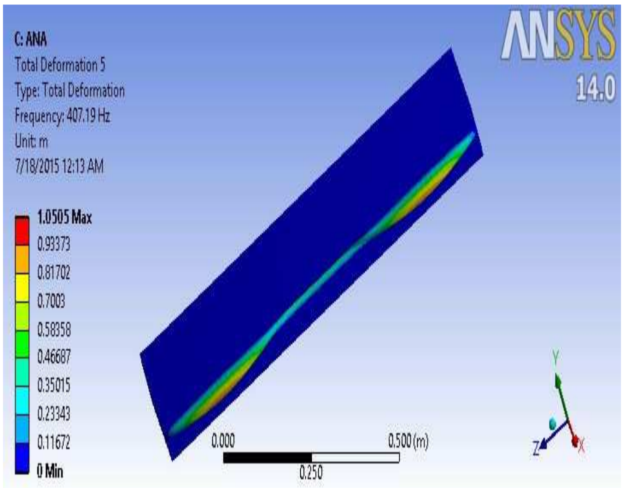

Figure 9: Fifth Mode Shape for Thickness 0.02m

Modal Frequencies

Modal Shape	0.02	0.03	0.04	0.05	0.06
1	*211.1*	*209.49*	204.91	*163.82*	*136.56*
2	*302.71*	*242.82*	*205.64*	*164.52*	*137.28*
3	*404.8*	*271.92*	*206.38*	*165.41*	*138.31*
4	*406.65*	*272.84*	*207.37*	*166.58*	*139.50*
5	*407.19*	*273.45*	*207.39*	*166.66*	*139.78*
6	*407.64*	*274.23*	*207.82*	*168.29*	*141.66*

Harmonic Analysis

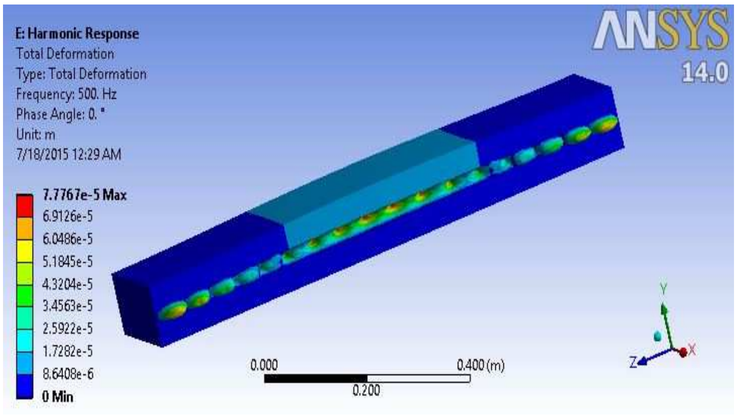

Figure 10: Harmonic Frequencies for Thickness 0.02m

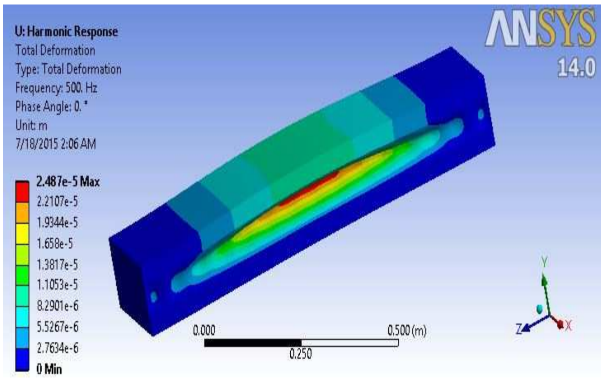

Figure 11: Harmonic Frequencies for Thickness0.06 M

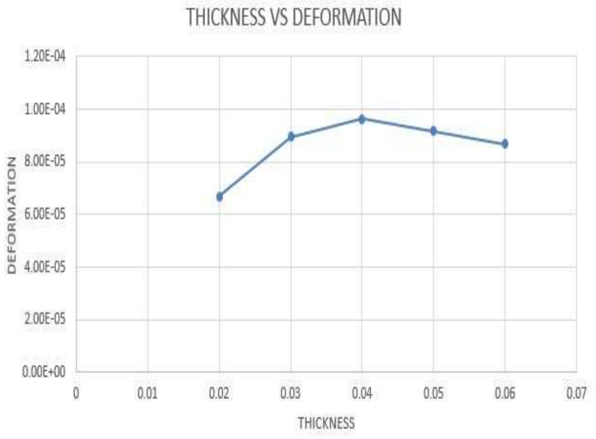

Figure 12: Graph of Harmonic Analysis

The harmonic analysis is done for all the thickness values and the graphs have been plotted. It is found that the amplitude of the beam increases up to a certain frequency value and then decreases gradually. Hence we can calculate an optimal value where the amplitude may not reach very high and also the fundamental frequency could be found out**.**

CONCLUSIONS AND FUTURE SCOPE

The following conclusions are drawn from the present work:

- Analysed the sandwich beam and observed various parameters for varying thickness.
- It is observed from the results that the fundamental frequency increases as the core thickness increases which implies that the natural frequency also increases as the core thickness increases.
- By this analysis we can determine the frequency at which vibrations are maximum and avoid operating the system at that frequency and operate it at other frequencies.

The sandwich beam modeled here with varying core and face layer. The sandwich beams modeled here are carried out for modal analysis using ANSYS by varying core thickness. The result obtained from the modal analysis clearly shows that with increases in the thickness of the core layer there is a decrease in the natural frequency for the same mode.

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