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FINITE ELEMENT VIBRATION ANALYSIS OF SANDWICH PLATE

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ABSTRACT:

This research work focuses on free vibration analysis of sandwich composite plates using finite element vibration methods. The finite element formulations are developed based on the First Order Shear Deformation Theory (FSDT) considering layer wise FSDT for each of the three sandwich layers. Displacement equations for core are linearly interpolated between the face plates using continuity of the displacement fields.

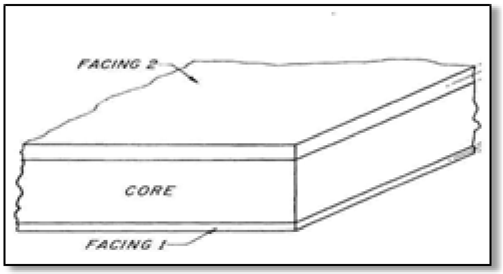
A sandwich plate is fabricated from jute fiber honeycomb core and glass fiber face plates to study the vibration response. Hand layup technique is used to fabricate the composite plate. The vibration responses are acquired to study the free vibration behavior of composite plates. Experimental results are analyzed and are compared with analytical solution. Comparable results are obtained, thus indicating the accuracy of the formulation. Findings of this study provide useful insights and will be very helpful for further studies in vibration analysis of sandwich composite plates.

KEYWORDS:

FEM, FSDT, MODE SHAPE, SANDWICH STRUCTURE, NATURAL FREQUENCY, COMPOSITE MATERIAL.

INTRODUCTION

Sandwich composite is a special kind of laminate consisting of a thick core of weak, lightweight material sandwiched between two thin layers called face sheets of strong material fig. (1.1). This is done to improve structural strength without a corresponding increase in weight. The choice of face sheet and core materials depends heavily on the performance of the materials in the intended operational environment.



(1.1) Sandwich plate

SANDWICH CONSTRUCTION

THERE ARE BROADLY TWO TYPES OF SANDWICH CONSTRUCTIONS:

SOFT CORE In this type of sandwich, the core is made up of low-density viscoelastic material. A uniform thickness of core is placed in between the two face plates

TRUSS CORE Truss core sandwich have an open wall type construction of thin sheet arranged perpendicular to the face plates. These walls are arranged in various shapes and the uniform thickness core is placed between the two face plates. Arrangement of different types of truss structured cores in a sandwich plate.

MATERIALS AND METHODS:

1. FACE MATERIALS

Almost any structural material which is available in the form of thin sheet may be used to form the faces of a sandwich panel. Panels for high-efficiency aircraft structures utilize steel, aluminum or other metals, although reinforced plastics are sometimes adopted in special circumstances.

2. CORE MATERIALS

The epoxy-based laminates are preferred for the construction of face plates. Also, the natural fibers like, jute, silk, paper pulp, banana, cotton, flex, sisal etc are being studied as a substitute. Newer methods for fabrication of natural fiber core are being developed.

Sr No.	Property	Jute Fibre (raw untreated)	Glass Fibre (E class)
1	Density (g/cm^3)	1.45	2.5
2	Young's Modulus (GPa)	30	73
3	Poisson's Ratio	0.3	0.2

4	Shear Modulus (GPa)	**7.24**	**30.4**

Natural frequency can be calculated from

$\omega_n =$ ω_d

RESULTS:

Material assignment to the plate is as per the table 4.2. Material is assigned to each component of the plate. and both the end are fixed. Boundary conditions are same as the experimental work carried. this configuration is at fixed-fixed beam configuration. Modal analysis is carried to get the natural frequency of the plate. Figure 5.3 shows the higher modal natural frequency of the plate. The Results section should include the rationale or design, optimization, validation of the experiments as well as the results of the experiments.

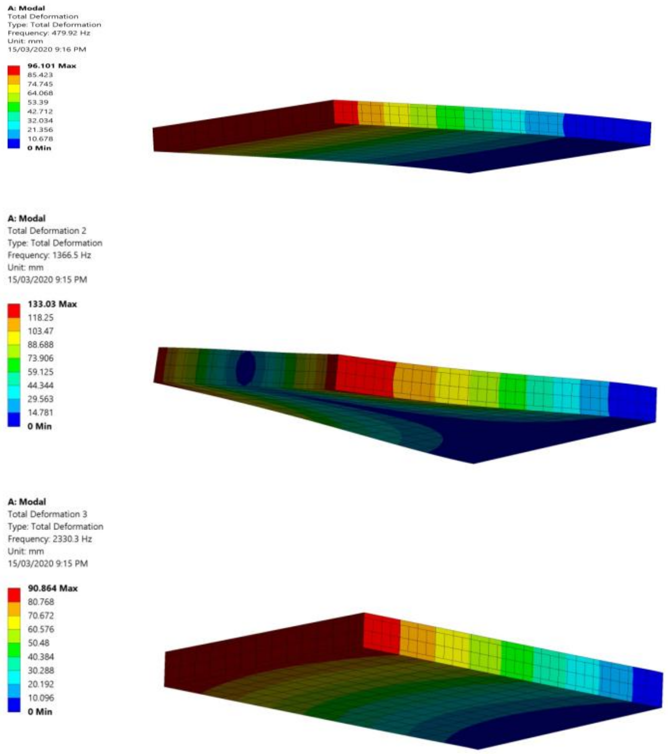


FIG.5.3 MODAL NATURAL FREQUENCIES OF THE PLATE

$\sqrt{1-\xi^2}$ $\sqrt{1-\xi^2}$

DISCUSSION:

Experimental and analytical results are shown in Table (5.1). The damping factor⍰ = 0.09, is very small. Therefore, it can be seen from the values of experimental data, the variation in the damped frequencies and natural frequencies is very small.

Sr. No	Experimental Damped Freq. (Hz)	Experimental Natural Freq (Hz)	Analytical Frequencies (Hz)
1.	42.53	42.7	55.14
2.	392.25	393.8	397.92
3.	789.22	792.42	805.1
4.	1364.5	1370.06	1387.1
5.	1989.6	1997.7	2004
6.	2263.71	2272.93	2310.7

Analytical frequency data is compared with the corresponding matching experimental value. It can also be observed that the experimental frequencies are comparable with the analytical frequencies. This shows the accuracy of using higher no of degree of freedom and more no. of nodes for a particular finite element.

It is evident from the finite element formulations that, if higher no of nodes is introduced in the formulations, it increases the accuracy of the approximate solution and the solution approached the exact solution. But at the same time, if increases complexity of the formulation and limitations to the numerical computations. As discussed in chapter (2), many formulations have been proposed to achieve the desired accuracy of the finite element formulations. The presented formulation and the finite element model satisfactorily give the results with sufficient accuracy.

CONCLUSIONS:

These finite element formulations qualify to serve in vast types of core constructions i.e. viscoelastic, truss, honeycomb etc. with relative ease and accuracy. The analytical solutions based on these formulations attain comparable accuracy of results with the experimental values, thus the reliability of this new developed finite element with 54 DOF per element satisfactorily.

This new finite element formulation, having higher DOF and triangular geometry serve this very well. Use of cubic Hermite interpolation functions for a triangular element results in best continuity with respect to slopes in all the three geometric co-ordinates of the element and the triangular geometry offers best possible geometric approximation eliminating maximum possible errors

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