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Analysis of the effect of thickness of constrained layer in sandwich panel

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Abstract - *The damping of structural components and materials is often a significantly overlooked criterion for a good design. Lots of research has been done to suppress vibration and to reduce the mechanical failures. Sandwich panels can be effectively employed for controlling the damping effect. Sandwiched structural components like sandwich panels, sandwich beams etc are gaining acceptability in construction field, aerospace and automobiles as they are light in weight, high strength, and less expensive. Normally Sandwich construction includes a relative thick core of low density material, sandwiched between the bottom and top face sheets (face layers) of relatively thin in size. In this study, vibrational analysis of sandwich panels by varying core layer thickness is conducted and the effect on frequency damping is observed.*

Key Words: Sandwich panel, finite element analysis, Modal analysis, Core layer, Face layer, Constrained layer.

1. INTRODUCTION

Vibration mainly influences the life of engineering structures and their performance. Vibration damping is a main aspect of structural behavior. Many types of damping mechanisms have been developed over time to control the undesired vibration of structures. Passive damping treatment is one of the ways to control the vibration and noise in structures. The structure borne and airborne noise and vibration are frequent in most systems. Sandwiched structural components like sandwich panels, sandwich beams etc are becoming more and more popular in construction industry due to their widespread structural applications in both commercial and residential building systems. There has been a constant need for the light weight and high strength materials for various applications like aerospace and automobiles. The sandwich structures are relatively lighter in weight and less expensive. Normally Sandwich construction includes a relative thick core of low density material, sandwiched between the bottom and top face sheets (face layers) of relatively thin in size. Faces are usually steel and the core materials are made of polyurethane, expanded polystyrene, extruded polystyrene, phenolic resins or mineral wool. Core layer is the constrained layer

1.1 Finite element analysis of sandwich panels

Fessel Kpkey et al [1] proposed in their study, vibration modeling of sandwich structures with soft core using solid shell finite elements. In this work, an alternative method is proposed by considering a recently developed linear hexahedral solid–shell element. Numerical tests, including various cantilever sandwich beams as well as a simplified pattern of rail on sleepers, are performed to show the efficiency of the proposed approach.

W. Larbi et al [2] in their study, an original finite element modeling to investigate the effects of a viscoelastic layer on the sound transmission through double-wall sandwich panels is presented. This formulation is obtained from a coupled fluid–structure variational principle taking into account the frequency dependence of the viscoelastic material. An efficient and inexpensive finite element for a sandwich plate with viscoelastic core is developed. Various results are presented in order to validate and illustrate the efficiency of the proposed finite element formulations.

M. Khanjani et al [3] In this work, nonlinear dynamic analysis of a cylindrical sandwich panel with embedded SMA wires in the face sheets is performed taking into account the instantaneous and spatial martensite phase transformation. A new finite-element-based procedure is proposed and Newmark time integration method is used to solve the finite element equations. The results show a gradual decrease in the amplitude of vibration as long as the SMA wires do not reach a fully elastic condition. Finally, the effect of various parameters such sector angle, operating temperature, wire volume fraction, through the thickness location of the wires and different boundary conditions on the vibration amplitude and loss factor is investigated.

1.2ANALYSIS OF SANDWICH PANEL

The sandwich panel considered for this study includes FRP (Fiber reinforced polymer) sheets as facing sheets and PUF(polyurethane foam) as the core or constrained layer. The material properties are as shown in table. The panel is of dimensions 3 m x 3 m. The facing sheets are of 2mm thickness.

Table -1: Material properties (Satyjith P. Shettigar et al)

	Core	Face
Material	PUF	FRP
Young's modulus	105.45 MPa	15620 MPa
Poisson's ratio	0.44	0.3
density	200 kg/m^3	1610 kg/m^3

The modal analysis was conducted by varying the core layer thickness of the sandwich panel with clamped-clamped boundary condition. Thirteen sets of vibrational analysis were conducted for thirteen core layer thickness keeping the face layer thickness constant. The core layer thickness was varied from 20 mm to 250 mm and the frequency values of each mode for different core layer thickness' are shown in fig 1.

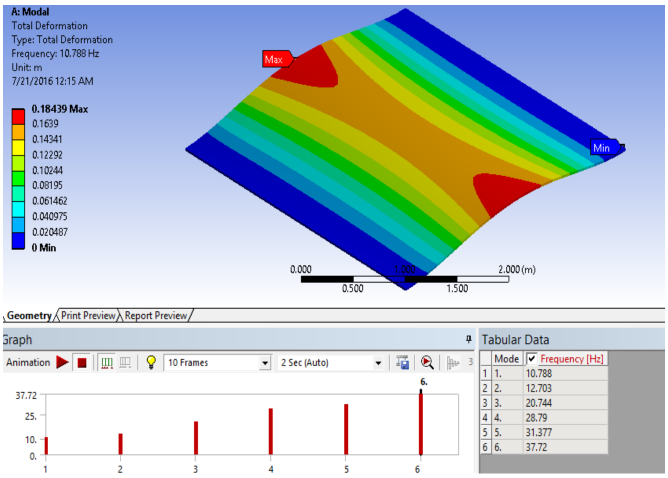

Fig -1: Frequency modes of 20 mm core layer thickness

3. RESULTS

The frequency mode variation with the variation in core layer thickness is shown in table-1.

Table -1: Material properties (Satyjith P. Shettigar et al)

Mod es	Core layer thickness								
	20	30	60	90	120	150	200	230	250
1	10.7	14.2	22.0	27.6	32.0	35.6	42.6	40.3	31.2
2	12.7	16.7	25.6	32.0	37.0	40.9	48.8	46.2	35.2
3	20.7	27.2	41.6	51.8	59.8	66.2	79.1	74.9	56.7
4	28.7	37.5	56.1	68.4	77.3	84.1	94.4	92.9	75.6
5	31.3	40.8	60.8	74.1	83.7	91.1	104.	100.	80.7
6	37.7	49.3	74.8	92.5	105.	115.	119.	124.	94.0

The variation is graphically shown in fig-2.

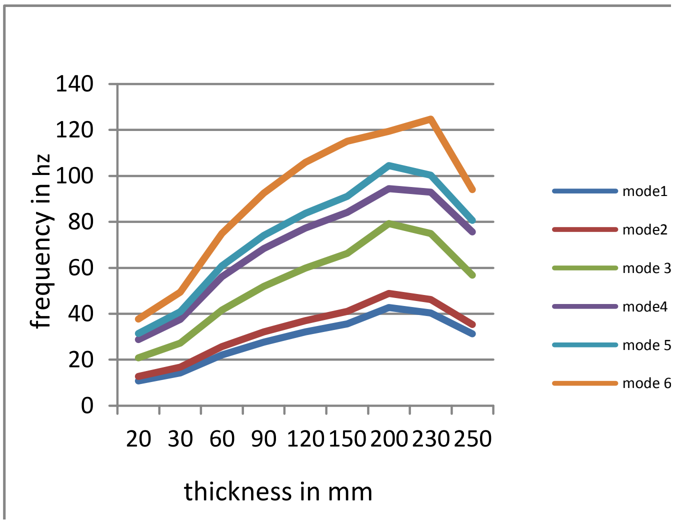

Fig -2: Frequency values of each mode for different core layer thickness

The core layer thickness was increased up to 250 mm from 20 mm and it was observed that the frequency values of each mode increased till 230 mm and then started decreasing.

4. CONCLUSIONS

Sandwich structures are used in vibration control of civil engineering structures. Sandwich panel has a prominent role in constrained layer damping technique. The effect of various parameters on the frequency damping property of sandwich panel is analysed in this study. The core layer thickness is increased from 20 mm to 250 mm and vibrational analysis was conducted. An average increase of 71.66% was there in the frequency values of each mode from 20 mm to 200 mm. then an average decrease of 5% was noticed in the frequency values of 230 mm thickness and a further decrease of 20% noticed for 250 mm core layer thickness. There is an increase in damping effect or vibration control only after a peak point.

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