Design and Vibration Analysis of Composite Panels

Mr. Vijaykumar S. Ghorade[1] Prof. G.A. Kadam[2] Prof. Anup M. Gawande[3] Prof. Arun M. Patokar[4]
[1]P.G. Student [2]Professor [3]Assistance Professor [4]Researcher
[1,2,3]Department of Mechanical Engineering
[1,2]SKNSITS, Lonavala [3,4]STC SERT Khamgaon

Abstract— Composite panels are used largely in aerospace and aviation industries, marine and civil engineering applications because of its properties such as light weight, high strength, high stiffness and good shear properties. Thus it is essential to improve the properties of composite panels. Composite materials may have big advantages over steel in automobile manufacturing. Composites are used to make safer, lighter and more fuel-efficient vehicles. A composite is composition of a high-performance fiber (e.g. carbon or glass) in a matrix material (epoxy polymer) that when combined provides desired properties compared with the individual materials. From vibration point of view composites absorbs more vibrations as compared to metals. Because composites dissipate the energy of vibrations, non-elastic, for making the composite material well suited for applications ranging from equipment mounts to athletic shoe insoles. So in this project we are trying to find out best composition of composite for vibration. For this specimens will be prepared for vibration testing. FFT analyzer used to get dynamic response at particular frequencies & results will be correlate with FEA. FEA of composite panels is done using CATIA V5R20 and ANSYS R15.0

Key words: epoxy glass fiber, FFT analyzer, FEA analysis, composites, etc

I. INTRODUCTION

Improvements in analytical techniques, combined with the availability of newer and more efficient materials, important to design of lighter and more flexible structures. These improved structures are thus much more Responsive to dynamic loadings than the solid predecessors. It has become more important to accurately assess dynamic properties, such as damping and natural frequencies. Fordamping which is a measure of energy dissipation in vibrating systems plays a essential consideration in the assessment of serviceability limit states of composites. The damping ratio is a parameterusually that defines the frequency response of a second order ordinary differential equation. Composite panels are designed to take higher shear loads and also follow characteristics of higher vibration damping capacity. The composite panels absorb large amounts of energy as the composites are also used as a cushion against external loads occur which are undesirable. Composite materials with high stiffness, lightweight, good shear properties and good damping properties and higher strength and stiffness.Composite panels have high strength to weight ratios thus they have been most widely used for many years in the aerospace and aviation industries, in marine, and also in mechanical and civil engineering applications widely. Also they have attendant high stiffness.In design and vibration analysis of composite panels firstly the FEA analysis of existing composite panel made from epoxy glass fiber is done and after that by means of using FFT analyzer, testing of composite panel which made from epoxy fiber glass is done. And results obtained form it are compared with the FEA analysis. If results are varying then by changing different compositions in composite material and again testing of new composite panel with changes made. And we have to repeat this until we get the satisfied results.

II. LITERATURE REVIEW

1) Sourabha Havaldar, Uday N Chate Estimation of modal damping ratio from specific shear modulus for monolithic materials and hybrid cored multilayer composites. Damping properties are of significant importance in determining the dynamic response of structures, and accurate result of them at the design stage, especially in the case of light-weight structures is largely desirable. But damping parameters cannot be deduced easily from other structural properties and recourse. Thus data from experiments were conducted on completed structures of same characteristics. Such data is scarce but very valuable, both for direct use in design andmodeling of damping
2) M.M. Venugopal1, S K Maharana, K S Badarinarayan Finite element evaluation of composite sandwich panel under static four point bending load. The sandwich composites are multilayer materials with different layers of materials which made by bonding stiffness, high strength and low density core material. The main advantage of using the sandwich concept in structural components are very high stiffness and low weight ratios in real applications. These structures can carry in the plane and out of plane loads and gives good stability under compression, excellent strength to weight and stiffness to weight. Different models of composites such as 2D and 3D with orthotropic material properties were attempted in advanced finite element analysis (FEA) software ANSYS. Comparison of FE model results with experimental data on sandwich composite panel bending properties occurs helped in establishes modeling. Analytical solutions were used to verify the mechanical properties such as bending stress and shear stress with the FEM results.
3) Bo Cheng Jin, Xiaochen Li, Rodrigo Mier, Adarsh Pun, Shiv Joshi, Steven Nutt Parametric modeling, higher order FEA and experimental investigation of hat-stiffened composite panels. Sizing of hat-stiffened composite panels presents because of the design hyperspace of geometric and material contents available to designers. The solution provided for different upper and lower bounds for the center-point deflections of the panels, values i.e. obtained were useful for hat-stiffened composite panels. TheFEA results easily give the design geometric contents of hat-stiffened composite panels. The results give a first step towards a structural and

scripted FEA models to give the development and of composite aircraft structures. The results have the large capacity to reduce design cost, increase of content reuse, and improve time.

III. OBJECTIVES

– To study and estimate damping properties of composite panels.
– Replacing different composite materials in composite panels to improve the performance of composite panels.
– Design good composite panels with better efficiency.
– Obtain highly efficient composite panels having good environmental and structural properties.
– To design composite panels have higher shear loads and also resist the characteristics of higher vibration damping capacity.

IV. SCOPE

The present work having the following scope:

– Improve properties of composite panels such as shear strength and resist high damping ratios such that the composite panels can be used in aircrafts.
– Performance of composite panels can be improved.
– Improve the efficiency of composite panels and also increase life of composite panels.

V. METHODOLOGY

A. *FEA (Modal Analysis):*

Introduction:Finite element analysis of composite panel is done using software's CATIA V5R20 and ANSYS R15.0.The Finite Element Method has more importance in a product of electronic digital computer.This approach shares many features common to the numerical approximations; it gives some advantages in the additional facilities offered by the high speed computers. The method can be systematically programmed to complex and difficult problems as nonhomogeneous materials, complicated boundary conditions and nonlinear stress-strain behavior. The Finite Element Method is used largely for wide range of boundary value problems in engineeringstream for various applications.

B. *Cad Modeling:*

CAD model designs with conventional and composite materials of composite panels are created in CATIA V5 R20 which contains special tools in generating typical surfaces, which are used largely toconvert into solid models. Composite panel having length 150mm, width 150mm and 2mm thickness is as shown in the figure.

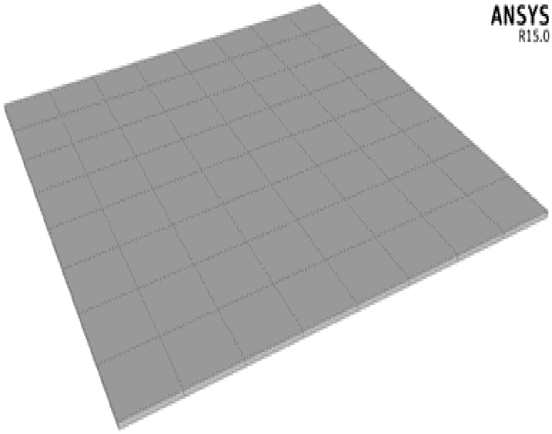

Fig. 1: CAD model of composite panel (150×150×2)

C. *Boundary Condition:*

Boundary condition of composite panel is fixed at one end as shown in figure.

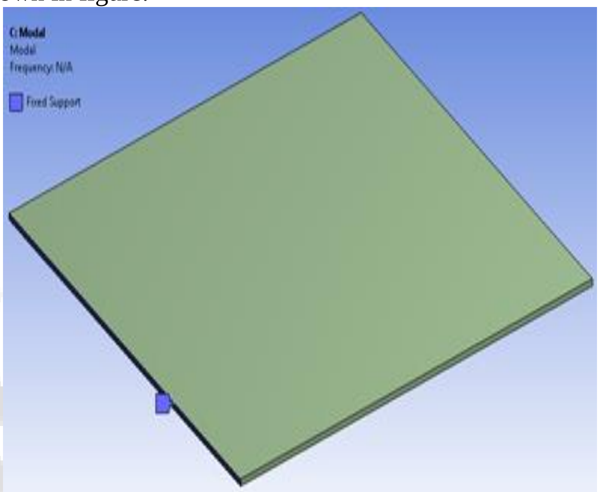

Fig. 2: Boundary Condition

D. *Discretization:P*

Meshing is done after the boundary conditions are given to the CAD model. Meshing is the step in the analysis in which the CAD model is discretized into very small parts known as elements. It is also known as piecewise approximation or distribution.

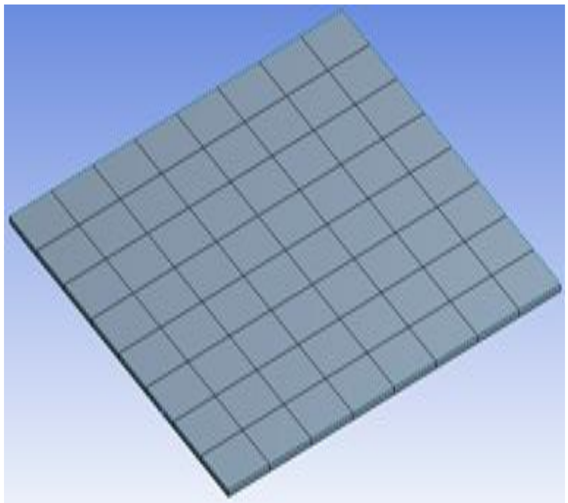

Fig. 3: Discretization of composite panel

E. Reference Direction:

Reference direction is as shown in figure

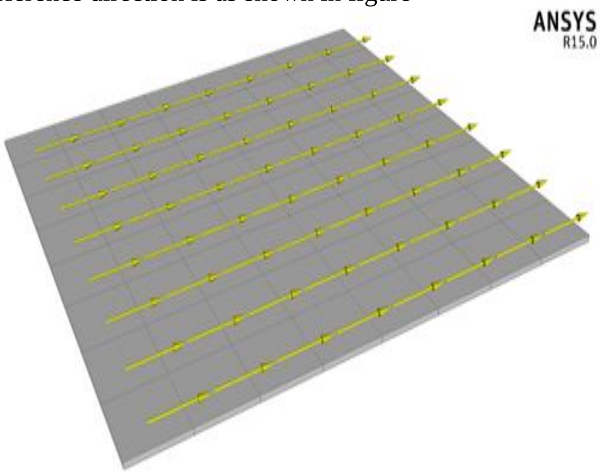

Fig. 4: Reference direction of composite panel

F. Fiber Direction:

Fiber direction is as shown in figure.

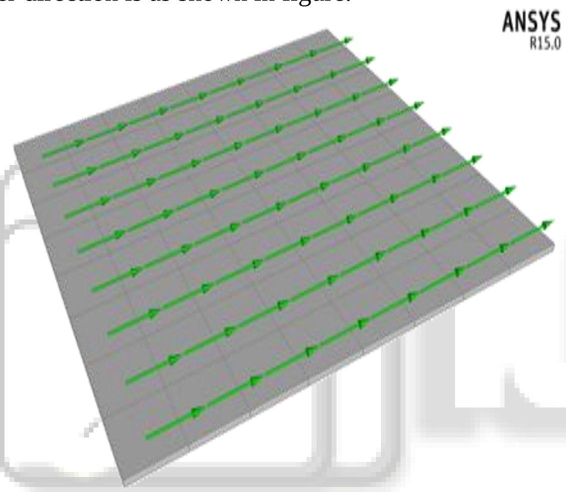

Fig. 5: Fiber direction of composite panel

G. Normal Direction:

Normal direction is as shown in figure.

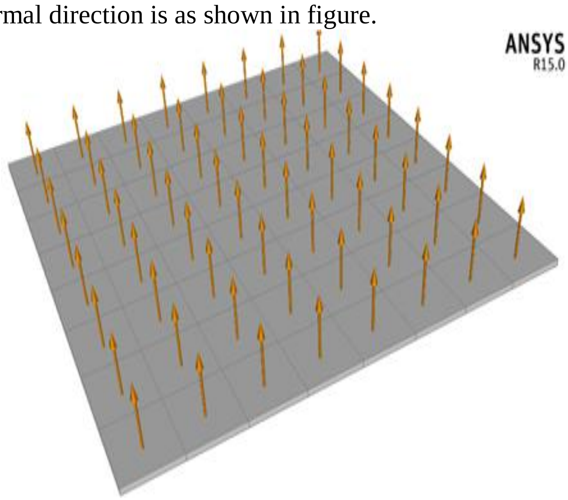

Fig. 6: Normal direction of composite panel

H. Orientation Direction:

Orientation direction is as shown in figure.

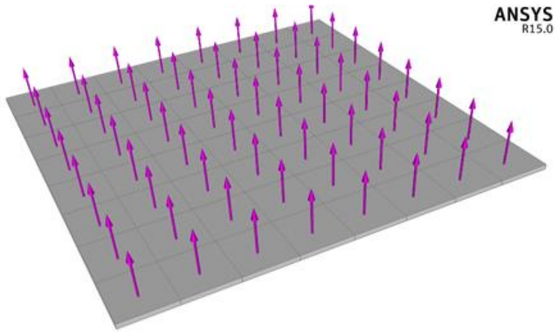

Fig. 7: Orientation direction of composite panel

VI. Modal Analysis of Composite

A. Material Specification:

Material	Epoxy Glass Fiber (Orthotropic)
Young's Modulus	9000-35000 MPa
Poisson's Ratio	0.28-0.4
Density	1850 kg/m^3

Table 1:

B. Results:

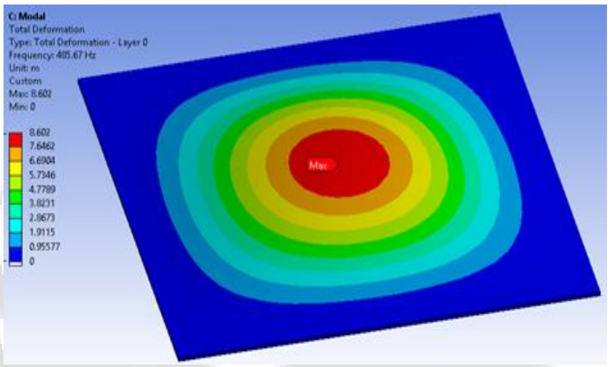

Fig. 8: Total deformation at mode1 (485.67Hz)

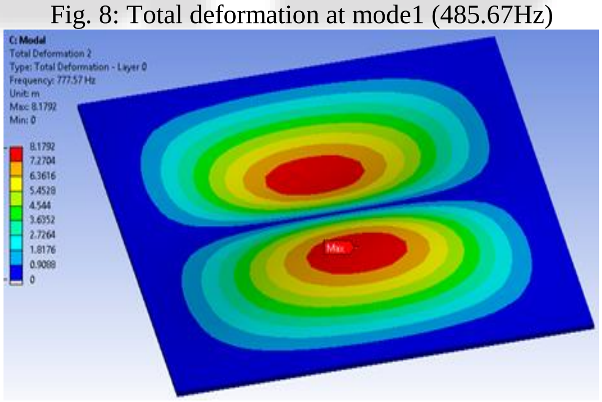

Fig. 9: Total deformation at mode2 (777.57Hz)

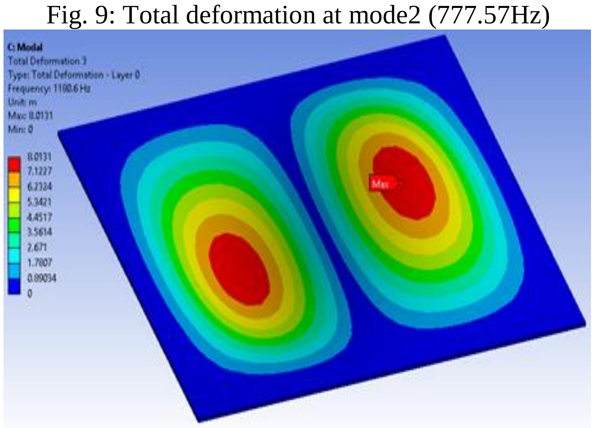

Fig. 10: Total deformation at mode3 (1180.6Hz)

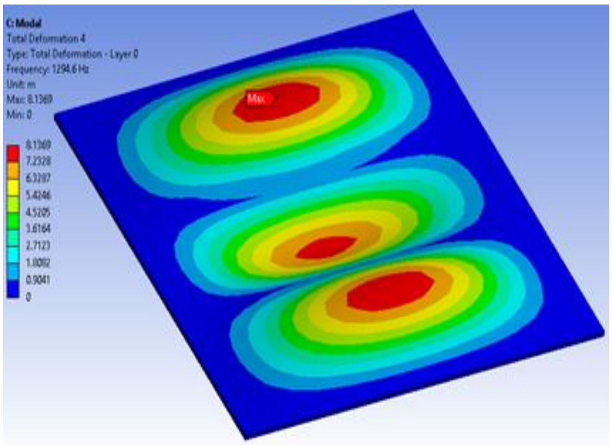

Fig. 11: Total deformation at mode4 (1294.6Hz)

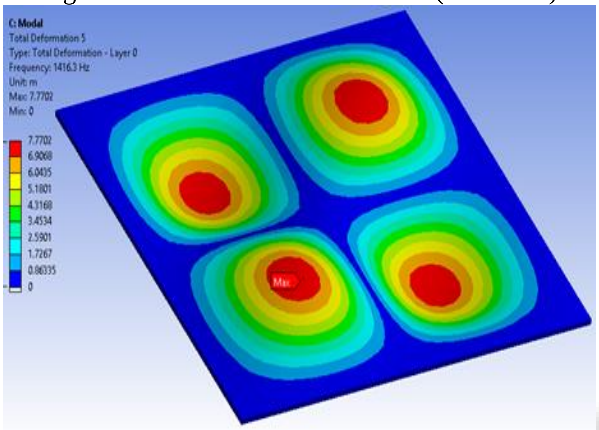

Fig. 12: Total deformation at mode 5 (1416.3Hz)

VII. RESULTS AND DISCUSSION

Mode number	Frequency(Hz)
1.	485.67
2.	777.57
3.	1180.6
4.	1294.6
5.	1416.3

Table 2:

A. Harmonic Response Analysis:

Now we determine harmonic response of given model at 484 Hz. For this the boundary conditions are having acceleration 49810 mm/s2 and components are 0. ,0., 9810 mm/s2. The boundary conditions are shaded in blue portion as shown in figure where we apply fixed support.

Fig. 13: Fix support boundary condition

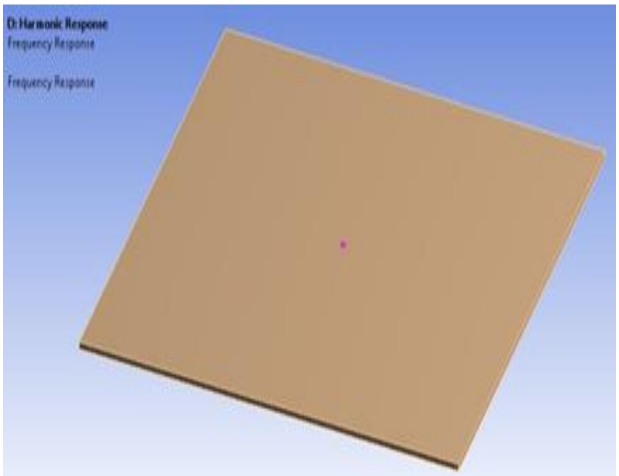

Fig. 14: Loading point for harmonic response

B. Response Location:

The location where harmonic response is derived is shown in figure.

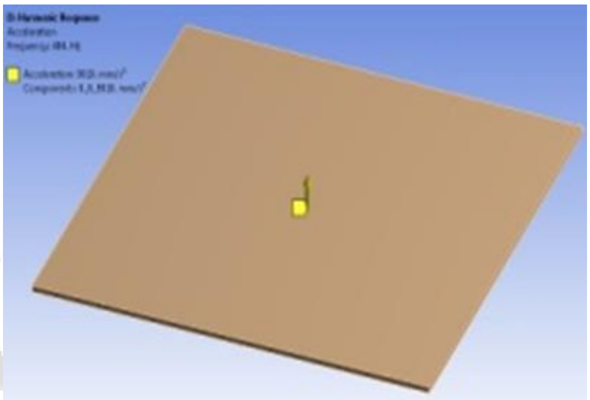

Fig. 15: Harmonic Response location

C. Frequency Responseplot:

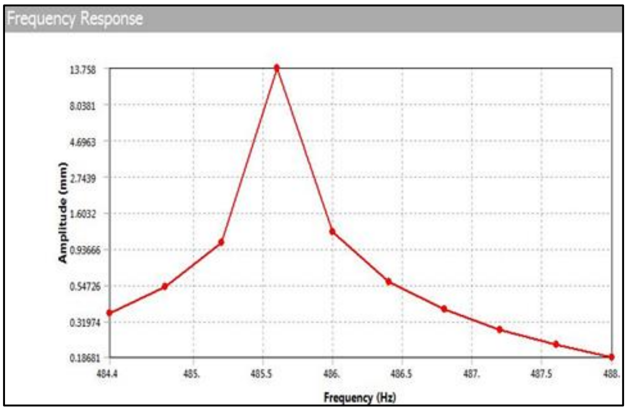

Fig. 16: Frequency response plot

In given graph of frequency response of composite panel is shown where the amplitude is maximum at frequency range near about 485.5 approximately.

VIII. CONCLUSION

In this way by doing design and vibration analysis of composite panels we can easily improve the properties of composite panels and also increased the efficiency of composite panels by changing compositions of composite material used in the composite panels. And also improve properties like strength, stiffness, etc.

REFERENCES

[1] Estimation of modal damping ratio from specific shear modulus for monolithic materials and hybrid cored multilayer compositites. SourabhaHavaldar, Uday N Chate 2nd International Conference on Nanomaterials and Technologies (CNT 2014).
[2] Finite element evaluation of composite sandwich panel under static four point bending load. paper presented by M.M. Venugopal1, S K Maharana, K S Badarinarayan, JEST-M, Vol. 2, Issue 1, 2013
[3] Parametric modeling, higher order FEA and experimental investigation of hat-stiffened composite panels. Bo Cheng Jin, Xiaochen Li, Rodrigo Mier, Adarsh Pun, Shiv Joshi , Steven Nutt, Composite Structures 128 (2015) 207–220 Composite Structures 128 (2015)207–220.
[4] Modal analysis of composite sandwich panel. Mr. Deshmukh P.V., ISSN: 2394-3696 volume 2, issue - 10, oct.-20155.
[5] Modal Analysis of Composite Sandwich Panel,G.D.Shrigandhi and PradipDeshmukh, E-ISSN 2277 – 4106, P-ISSN 2347 – 5161, Special Issue-4 (March 2016)
[6] Composite Materials in Aerospace Applications, Nikhil V Nayak, International Journal of Scientific and Research Publications, Volume 4, Issue 9, September 2014 ISSN 2250-3153
[7] Streses analysis of laminatedcomposite plate using F. E. M, 4847 Rakesh vishwakarma (IJAIEM)Volume 4, Issue 1, January 2015 ISSN 2319
[8] An approach of composite materials in industrial machinery, PiyooshThori, ISSN: 2319-1163 | pISSN: 2321-7308
[9] Coir fiber reinforcement and application in polymer composites: A Review D. Verma, J. Mater. Environ. Sci. 4 (2) (2013) 263-276 ISSN: 2028-2508 CODEN: JMESCN
[10] A review on natural fibers, D. Chandramohan, IJRRAS August 2011.

