Design and Vibration Analysis of Composite Panels

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Abstract— Sandwich panels have high strength to weight ratios hence have been successfully used for many years in the aviation and aerospace industries, as well as in marine, and mechanical and civil engineering applications. Also they have attendant high stiffness. The use of the sandwich constructions in the aerospace structures can be traced back to Second World War when British De Havilland Mosquito bomber had utilized the sandwich constructions. In the early use, the sandwich structure was very simple in construction, with simple cloth, fabric or thin metal facings were used and soft wood were used as the core. The conventional sandwich construction comprises a relatively thick core of low-density material which separates top and bottom faceplates (or faces or facings) which are relatively thin but stiff. 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 is 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.

Key words: Vibration Analysis of Composite Panels, FEA Analysis of Existing Composite Panel

I. INTRODUCTION

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. Composite panels have high strength to weight ratios hence have been successfully used for many years in the aviation and aerospace industries, as well as in marine, and mechanical and civil engineering applications. Also they have attendant high stiffness. The use of the sandwich constructions in the aerospace structures can be traced back to Second World War when British De Havilland Mosquito bomber had utilized the sandwich constructions. In the early use, the sandwich structure was very simple in construction, with simple cloth, fabric or thin metal facings were used and soft wood were used as the core. The conventional sandwich construction comprises a relatively thick core of low-density material which separates top and bottom faceplates (or faces or facings) which are relatively thin but stiff. The materials that have been used in sandwich construction have been many and varied but in quite recent times interest in sandwich construction has increased with the introduction of new materials for use in the facings (e.g. fiber- reinforced composite laminated material) and in the core

II. LITERATURE REVIEW

Mr. Deshmukh P.V. Modal analysis of composite sandwich panel, Use of Sandwich construction for an aircraft structural component is very common to the present day. One of the primary requirements of aerospace structural materials is that they should have low density, very stiff and strong. Sandwich panels are thin-walled structures fabricated from two flat sheets separated by a low density core. We have investigated here is of aluminium honeycomb structure because of excellent crush strength and fatigue resistance. Sandwich panels have a very high stiffness to weight ratio with respect equivalent solid plate because of low density core. FEA modeling is developed by consideration of rotary inertia. The free vibration analysis of sandwich panels is studied. Four noded isoperimetric shell element is used for FEA.

G.D.Shrigandhi Modal Analysis of Composite Sandwich Panel: Use of Sandwich construction for an aircraft structural component is very common to the present day. One of the primary requirements of aerospace structural materials is that they should have low density, very stiff and strong. Sandwich panels are thin-walled structures fabricated from two flat sheets separated by a low density core. The core investigated here is of aluminium honeycomb structure because of excellent crush strength and fatigue resistance. Sandwich panels have a very high stiffness to weight ratio with respect equivalent solid plate because of low density core. Modeling is developed in FEA by consideration of rotary inertia.

Nikhil V Nayak Composite Materials in Aerospace Applications. Fiber-reinforced polymer composite materials are fast gaining ground as preferred materials for construction of aircrafts and space crafts. In particular, their use as primary structural materials in recent years in several technology-demonstrator front-line aerospace projects world-wide has provided confidence leading to their acceptance as prime materials for aerospace vehicles. This paper gives a review of some of these developments with a discussion of the problems with the present generation composites and prospects for further developments.

Rakesh vishwakarma Streses analysis of laminated composite plate using F. E. M, This work presents a stress analysis of Graphite/Epoxy laminated composite plates. In the present work the stress behavior of laminated composite plates under transverse loading using a four-node element with six degrees of freedom at each node: translations in the x, y, and z directions, and rotations about the x, y, and z-axes, based on first order shear deformation theory. The static stress analysis includes the all type of stress behavior in diagrammatic form and results are closed agreement with later work. In the present study the modeling is done in ANSYS 12.0 and results were closed to FEM code.

Piyoosh Thori An approach of composite materials in industrial machinery: advantages, disadvantages and applications, Carbon fiber Composites forecasts indicate several years of supply that will exceed the anticipated demand. Carbon fiber producers have used world leading technology to produce the most uniform and highest quality fiber. Carbon-fiber composites weight about one-fifth as much as steel, but can be similar or better in terms of stiffness and strength, depending on fiber grade and orientation.

D. Chandramohan A review on natural fibers. Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications. While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective.

III. MODAL ANALYSIS

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.

A. Analysis of composite panel (glass60%, epoxy40%)

For FEA analysis of this composite panel made of glass 60% and epoxy 40% nodes are 3844 and elements are 2700

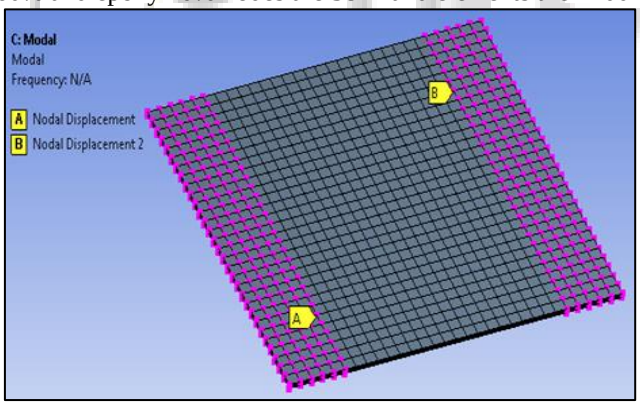

Fig. 1: Boundary Condition

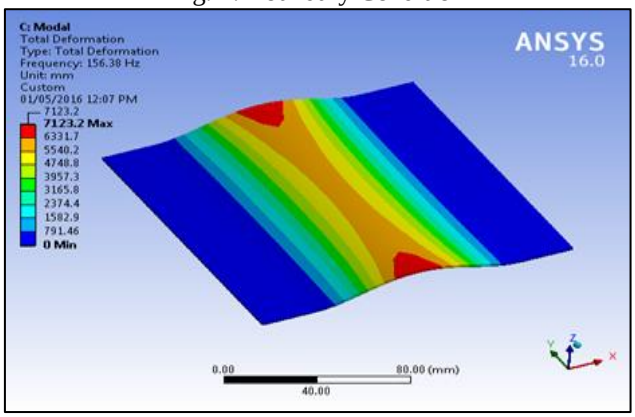

Fig. 2: Total deformation at mode1 (156.38Hz)

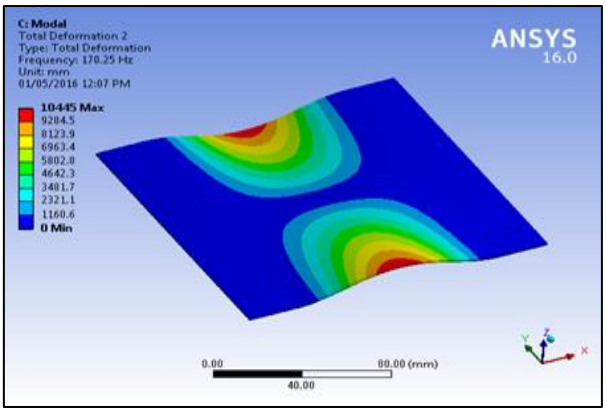

Fig. 3: Total deformation at mode2 (170.25Hz)

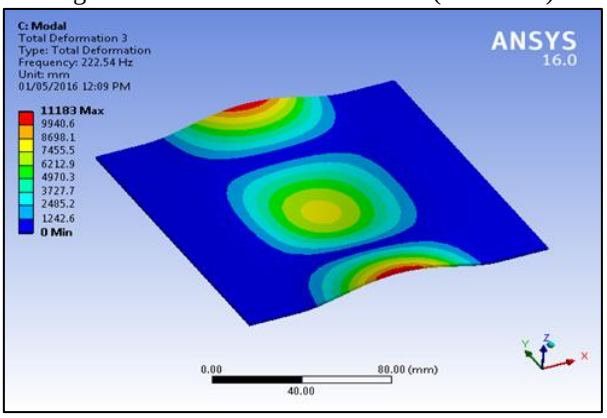

Fig. 4: Total deformation at mode3 (222.54Hz)

B. Natural Frequencies

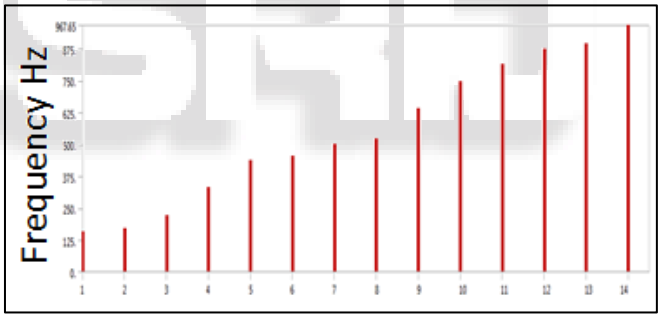

Fig. 5: Natural frequencies

C. Harmonic Response Analysis

Now we determine harmonic response of given model. For this the boundary conditions are having acceleration 9810 mm/s^2 and components are 0. ,0., 9810 mm/s^2. The boundary conditions are shaded in blue portion as shown in figure where we apply fixed support.

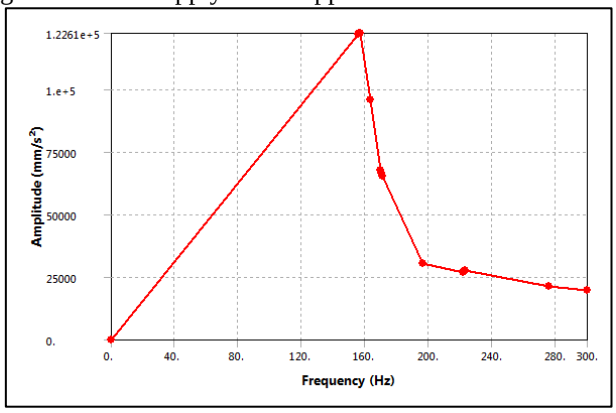

Fig. 6: Amplitude vs frequency graph

IV. EXPERIMENTAL ANALYSIS

A. Material Selection

In this work material selected is glass, epoxy, jute and ash. And composition of these composite materials is made. And fabrication of various composite panels is done. Epoxy is used for bonding of these compositions.

B. Selection of Fabrication Process of Composite

Fabrication of composite panels is effectively done by means of using epoxy as bonding with various compositions of materials such as glass, jute, ash. And composite panels made from these compositions are as shown in figures as shown below. Glass 60% and Epoxy 40% plate is fabricated having (150x150x2mm) dimensions. All the plates have same dimensions.

Fig. 7: Glass60%, poxy40%

Fig. 8: Jute60%, epoxy40%

Fig. 9: Glass30%,jute30%,epoxy40%

Fig. 10: Glass20%, jute30%, epoxy40%, ash10%

C. Testing Methodology

Mounting of electro dynamic vibration shaker.

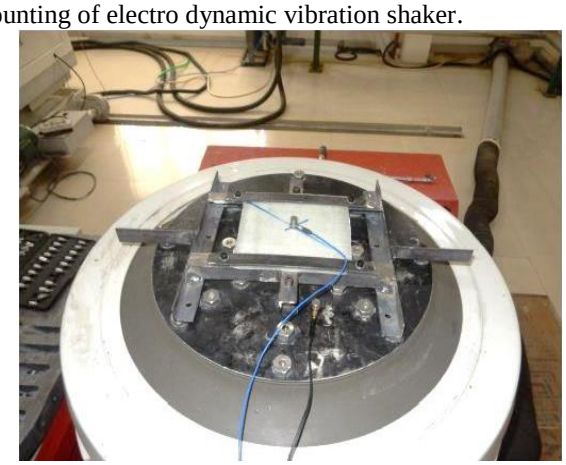

Fig. 11: Mounting of vibration shaker

V. RESULTS AND DISCUSSIONS

This are the various natural frequencies obtained from the FEA which can used to select the proper material according to required frequencies. By means of doing FEA of different compositions of different composite panels we can say that composite panel made of Glass20%, jute30%, epoxy40%, ash10% has better results as natural frequency of this composition is higher than other composite panels. Experimental results show correlation between results of harmonic response analysis using FEA and dynamic response analysis using vibration shaker and FFT analyzer.

Composition of composite panel	Mode number	Natural frequencies
Glass60%,epoxy40%	1	156.38
	2	170.25
	3	222.54
Jute60%,epoxy40%	1	111.69
	2	121.44
	3	158.35
Glass30%,jute30%,epoxy40%	1	204.06
	2	221.95
	3	289.69
Glass20%,jute30%,epoxy40% ,ash10%	1	295.5
	2	321.3
	3	418.96

Table 1: Natural frequencies of composite material

A. Experimental Results

For testing experimentally of different composite panels has test condition with following condition at that condition the vibration frequency range was 10 to 1000 Hz. And for vibration bed having acceleration was 1 g and sweep time was 10 minutes.

The given graph shows the FFT analyzer graph for different composition of composite panels.

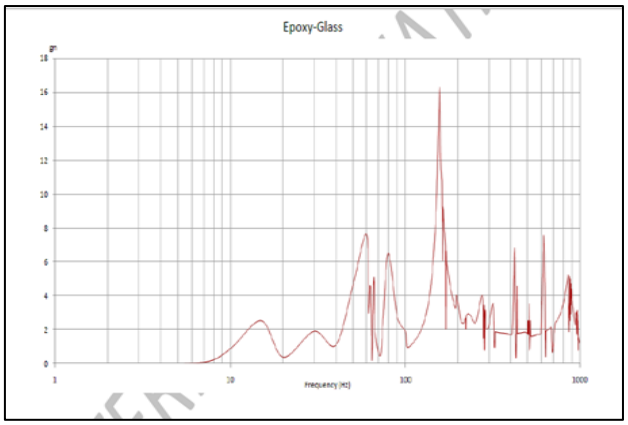

Fig. 12: Graph of the FFT analyzer for Epoxy-Glass composition

VI. CONCLUSION

Thus, by studying we can predict the behavior of composite panel made of different compositions of epoxy, glass, jute and ash. And with this conclusion composite panel can be used to appropriate application. By means of doing FEA of different compositions of different composite panels we can say that composite panel made of Glass20%, jute30%, epoxy40%, ash10% has better results as natural frequency of this composition is higher than other composite panels. By means of using above results we can easily correlate FEA analysis with experimental results which states that harmonic response analysis using FEA is nearly accurate because results have not more variations. 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.

A. Future Scope

While doing this work natural frequencies of composite panel which made of different composite materials proves that by means of using this work we can easily select the composite panels according to the desired frequency. It can be used in generators for perforation purpose by manufacturing composite perforated plates instead of steel or mild steel, as this composites can be sustain more vibrations.

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