REVIEW ON SANDWITCH COMPOSITE PANNEL

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Abstract- ***The investigations carried out in the area of combination of polyurethane foam and natural cork as core inserts in the multilayer hybrid composite materials. For the estimation of modal parameters like modal frequency and modal damping characteristics of the materials, the general approach is more frequently used are experimental techniques such as Fast Fourier Transformation [FFT]. Polyurethane foams of different densities are combined with higher damping capability materials like natural cork to form multilayer hybrid cored sandwich panels [HSW], and their performance for vibration is carried through experimental FFT analyzers & by FEA. In FEA (modal analysis) 3D part modeling of composite panels is done and assembly also carried out then proper material selected. After that meshing of parts carried out and number of modes shapes selected on which analysis takes place and results are collected by using FEA. Such that experiment can be carried out by using FFT analyzer in which hammering is done on the composite panel and the hammer has input signal of excitation. And output signal is given to the accelerometer, after those readings are recorded by FFT and data is collected.***

1. INTRODUCTION

Advances in analytical techniques, combined with the availability of newer and more efficient materials, have facilitated the design of lighter and more flexible structures. These advanced structures are known to be much more responsive to dynamic loadings than their solid predecessors. As a consequence, it has become more important to accurately assess dynamic properties, such as damping and natural Frequencies. In particular, damping which is a measure of energy dissipation in vibrating systems plays a major role in the assessment of serviceability limit states. The damping ratio is a parameterusually that characterizes the frequency response of a second order ordinary differential equation. Sandwich panels are designed to take higher shear loads and also bear the characteristics of higher vibration damping capacity. The sandwich panels absorb large a mounts of energy; they are also often used as a “cushion” against external loads. These materials are lightweight, have good shear properties and higher strength. 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 (e.g. solid foams). 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. 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.

In the light of the above, undoubtedly very meager information is available on the investigations carried out in the area of combination of polyurethane foam and natural cork as core inserts in the multilayer hybrid composite materials. For the estimation of modal parameters like modal frequency and modal damping characteristics of the materials, the general approach more frequently used are experimental techniques such as Fast Fourier Transformation [FFT] and shaker testing techniques. However research in the area of estimating the damping ratio of the material from their elastic and physical constants is very scanty & scarce. Hence in this work an attempt has been made to evaluate damping ratio of sandwich composite through elastic constants. Polyurethane foams of different densities are combined with higher damping capability materials like natural cork to form multilayer hybrid cored sandwich panels [HSW], and their performance for vibration damping is carried through experimental FFT analyzers. In the search for designing and fabricating sandwich panels with higher damping capability, efforts have been made to vary the volume fraction of the core material of the sandwich and to evaluate the damping capacity of these materials(1).

A. Sandwich Structure Types:

Detailed treatment of the behavior of honeycombed and other types of sandwich panels can be found in monographs by Plantema and Allen. These structures are characterized by a common feature of two flat facing sheets, but the core takes many generic forms; continuous corrugated sheet or a number of discrete but aligned longitudinal top-hat, zed or channel sections. The core and facing plates are joined by spot-welds, rivets or self-tapping screws.

B. Construction of Sandwich:

Sandwich construction 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. 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.

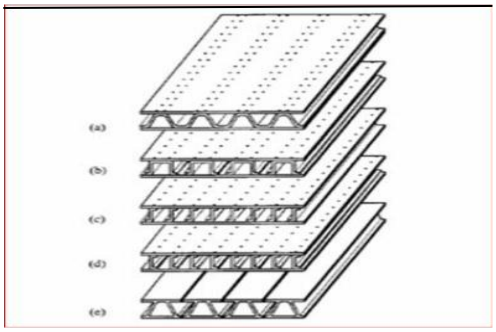

Fig.1.1 Sandwich Panel With (A) Continues Corrugated-Core (B) Top-Hat Core (C) Zed-Core (D) Truss-Core (2)

Because of the separation of the core, face sheets can develop very high bending stresses. The core stabilizes the face sheets and develops the required shear strength. Like the web of a beam, the core carries shear stresses. Unlike the web, however, the core maintains continuous support for the face sheets. The core must be rigid enough perpendicularly to the face sheets to prevent crushing and its shear rigidity must be sufficient to prevent appreciable shearing deformations. Although a sandwich composite never has a shearing rigidity as great as that of a solid piece of face-sheet material, very stiff and light structures can be made from properly designed sandwich composites(2).

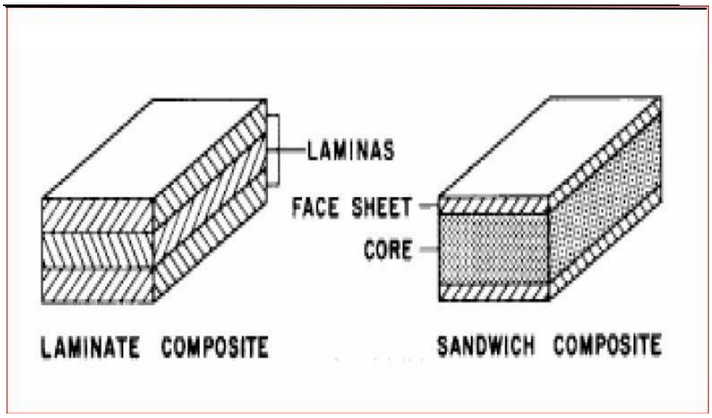

Fig.1.2 laminates and sandwich composites.

C. Face Sheets:

The face sheets provide the flexural rigidity of the sandwich structure. It should also possess tensile and compressive strength.

D. Cores:

The purpose of the core is to increase the flexural stiffness of the panel. The core in general has low density in order to add as little as possible to the total weight of the sandwich construction. The core must be stiff enough in shear and perpendicular to the faces to ensure that face sheets are distant apart. In addition the core must withstand compressive loads without failure

2. LITERATURE REVIEW

Sourabha Havaldar, Uday N Chate [1] 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 prediction of them at the des ign stage, especially in the case of light-weight structures is very desirable. Unfortunately, damping parameters cannot be deduced deterministically from other structural properties and recourse is generally made to data from experiments conducted on completed structures of similar characteristics. Such data is scarce but valuable, both for direct use in design and for furthering research into the phenomenon and modelling of damping. Till date, no work has been reported on the estimation of the damping rat io of the material purely from its elastic and physical constants. In this work, an effort has been made to obtain modal damping ratio for the fundamental mode of the structure from both analytical and experimental technique. The damping propertiesof PURE materials such as Aluminium, Polyurethane foam, Cork material, and of laminated composites (GFRP materials), are determined by classical modal analysis and also from their respective shear modulus and density constants. These theoretical developments in line with classical modal analysis, give impetus towards understanding damping mechanisms in Hybrid composite systems.

M.M. Venugopal1, S K Maharana, K S Badarinarayan [2] Finite element evaluation of composite sandwich panel under static four point bending load. The sandwich composites are multilayered materials made by bonding stiff, high strength skin facings to low density core material. The main benefits of using the sandwich concept in structural components are the high stiffness and low weight ratios. These structures can carry in-plane and out-of-plane loads and exhibit good stability under compression, keeping excellent strength to weight and stiffness to weight characteristics. In order to use these materials in different applications, the knowledge of their static behavior is required and a better understanding of the various failure mechanisms under static loading condition is necessary and highly desirable. The objective of this study is to develop a modeling approach to predict response of composite sandwich panels under static bending conditions. Different models including 2D and 3D with orthotropic material properties were attempted in advanced finite element (FE) software Ansys. Comparison of FE model predictions with experimental data on sandwich panel bending properties helped in establishing appropriate modeling approach. Analytical solutions were also used to verify the some of the mechanical properties such as bending stress and shear stress with the FEM results.

Bo Cheng Jin, Xiaochen Li, Rodrigo Mier, Adarsh Pun, Shiv Joshi, Steven Nutt [3] Parametric modeling, higher order FEA and experimental investigation of hat-stiffened composite panels. Sizing of hat-stiffened composite panels presents challenges because of the broad design hyperspace of geometric and material parameters available to designers. Fortunately, design tasks can be simplified by performing parameter sensitivity analysis a priori and by making design data available in terms of a few select parameters. In the present study, we describe parametric modeling and design sensitivity analyses performed on hat stiffener elements for both single and multiple-hat-stiffened panels using parametrically defined scripting finite element analysis (FEA) models and an idealized analytical solution. We fabricated a composite skin panel and 4 hat stiffeners using out of autoclave and vacuum bag only techniques. The stiffeners were subsequently bonded to the skin to form a multi-hat-stiffened panel. To validate the FEA and analytical solutions, multi-point deflections were measured using different loading conditions. The analytical solution provided upper and lower bounds for the center-point deflections of the panels, values potentially useful for hat-stiffened composite panels. The detailed FEA results accurately revealed the design sensitivities of relevant geometric parameters of hat-stiffened composite panels. The findings constitute a first step towards a structural and scripted FEA framework to speed the development and qualification of composite aircraft structures. The framework has the potential to reduce design cost, increase the possibility of content reuse, and improve time-to-market.

3. OBJECTIVE

1) To study and estimate damping properties of composite panels.
2) Replacing different composite materials in layers of sandwich composite panels to improve the performance of composite panels.
3) Design good composite panels with better efficiency.
4) Obtain highly efficient composite panels having good environmental and structural properties.
5) To design sandwich panels have higher shear loads and also bear the characteristics of higher vibration damping capacity.

4. 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.

5. METHODOLOGY

Steps in FEA (modal analysis)

[A] Introduction:

The Finite Element Method is essentially a product of electronic digital computer age. Though the approach shares many features common to the numerical approximations, it possesses some advantages with the special facilities offered by the high speed computers. In particular, the method can be systematically programmed to accommodate such complex and difficult problems as nonhomogeneous materials, nonlinear stress-strain behavior and complicated boundary conditions. It is difficult to accommodate these difficulties in the least square method or Ritz method and etc. an advantage of Finite Element Method is the variety of levels at which we may develop an understanding of technique. The Finite Element Method is applicable to wide range of boundary value problems in engineering. In a boundary value problem, a solution is sought in the region of body, while the boundaries (or edges) of the region the values of the dependent variables (or their derivatives) are prescribed.

Advantages of FEM:

1) The advantages of finite element method are listed below:
2) 1. Finite element method is applicable to any field problem: heat transfer, stress analysis, magnetic field and etc.
3) 2. In finite element method there is no geometric restriction. The body or region analyzed may have any shape.
4) 3. Boundary conditions and loading are not restricted. For example, in a stress analysis any portion of the body may be supported, while distributed or concentrated forces may be applied to any other portion.

Limitations of FEM:

5) The limitations of finite element method are as given below:
6) To some problems accurate results are not obtained to the approximations used
7) For vibration and stability problems the cost of analysis by FEA is prohibitive.
8) Stress values may changes from fine mesh to its counterpart.

B. 3D Part Modeling

In 3D part modeling design of various parts of the composite panels is done accurately such that modeling is done three dimensional. Various parts therefore precisely designed.

C. Assembly

In this step of FEA the detailed assembly of the parts that are design in 3D modeling is done very efficiently. By assembling parts one panel is created in FEA.

D. Material selection

Material selection for the composite panel done in this step of FEA such that by studying different properties of different materials and by taking this different properties of materials into consideration the materials are selected such as polyurethane and natural cork. This core material should selected have low density.

E. Discretization

This step gives meshing of the composite panel created in FEA of certain material.

F. Boundary condition

This step consists of selection of different loads on the composite panels and also selection of constraints.

G. No. of modes shapes

After that mode shape are selected such that for finding different stresses and strains occurs on the composite panel analysis by the loads.

H. Solver

The stresses and strains can be solved in this step and high stresses can be easily minimize in FEA.

I. Results of mode shape

Then results of mode shapes can be calculated by FEA

J. Conclusion

By following above whole procedure of FEA we can easily conclude from the results about composite panels.

STEPS IN EXPERIMENTAL ANALYSIS OF COMPOSITE PANELS

Following are steps in experimental analysis:

1. Glass fiber type, matrix type

In this step the composite type such as either glass fiber type or matrix type is choose and then we can easily goes towards fabrication of composite panels.

2. Selection of Fabrication process of composite

Then fabrication process i.e. way of fabrication of composite panel is selected and fabrication of composite panel is done.

3. *Varying length-width, no. of layers*

After fabrication of composite panel's lengths and widths varying of composite panels. And number of layers of natural cork and polyurethane are inserted in sandwich composite panel.

4. Testing methodology

At this step the fabricated composite panel is taken under the test and testing is carried out of sandwich composite panels.

5. Mounting of FFT analyzer

FFT analyzers are then mounted for testing of composite panels fabricated. FFT analyzer gives natural frequency of vibrations produced in fabricated composite panels. A signal which is represented an equation or a graph or a set of data points where frequency is dependent variable, by using Fourier Transform. This instrument converts the input signal with time as independent variable into frequency spectrum and displays in graphical form.

6. Input signal of excitation by Impact hammer

Input signal of excitation is given by impact hammer by hammering on composite panel and input of hammer i.e. applied load by hammer is noted.

7. Output signal by accelerometer

And output signal we obtained on the accelerometer. Accelerometer is used to determine vibration in rotating machinery.

8. Readings & visualization of vibration

Readings and visualization is carried out in this step such that by using FFT analyzer and accelerometer.

9. *Data collection*

Thus data can` be easily collected using accelerometer.**6.**

6. EXPECTED OUTCOMES

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