"A Review of Composite Material for Aligning It's Characteristics Behaviour to Enhance it's Use in Engineering Applications."

Nilesh S. Navagale   Dr. Rahul B. Barjibhe
Research Scholar   Research Guide
K.B.C.N.M.U.Jalgaon.   Prof. and Dean Academics
Jalgaon Shri. Sant Gadge Baba College
of Engg. And Tech.,Z.T.C.Bhusawal.

Abstract

Composite material is a material made from two or more constituent materials or Viscoelastic Materials (VEM) with significantly different physical or chemical properties that, when combined; produce a material with characteristics different from the individual components. Typical engineered composite materials include: Composite building materials, such as cements, concrete, Reinforced plastics such as fiber-reinforced polymer, Metal composites.

The use of composite material for advanced engineering applications makes it imperative to assess its behaviour in the scope and domain of NVH. In cases, where the occurrence of resonance is undesired for the function, the same needs to be negated by controlling the influential parameters leading to the characteristics of vibration for the component or the sub-assembly. The first mode and the others that follow indicate the natural frequencies at which the response of the material tends to be higher. The tendency to resonate over the operating frequency or working range could be controlled by altering the Eigen value by assigning a different level for control parameters. The mass, stiffness and damping could be varied to realize suitable Eigen value and Eigen vector for the function.

Keywords- *Composite Material, Viscoelastic Materials (VEM), Metal Composites, Damping, NVH.*

I. INTRODUCTION

The use of composite material for advanced engineering applications makes it imperative to assess its behaviour in the scope and domain of NVH. In cases, where the occurrence of resonance is undesired for the function, the same needs to be negated by controlling the influential parameters leading to the characteristics of vibration for the component or the sub-assembly. The tendency to resonate over the operating frequency or working range could be controlled by altering the Eigen value by assigning a different level for control parameters. The mass, stiffness and damping could be varied to realize suitable Eigen value and Eigen vector for the function.

The damping in metal structures is low, which results in high amplitudes of the vibrations. To reduce excessive amplitude of vibration structural damping is preferred. In structural damping, Viscoelastic Materials (VEM) are used as damping materials as they are capable of storing strain energy when deformed, and dissipate a portion of this energy through hysteresis.

II. PRESENT THEORIES AND PRACTICES

Literature survey (Previous Research Work) includes following points: Current performance enhancement technology, methodology for finding material damping properties at higher frequency and at relatively lower amplitudes, to find out modal loss factor in passive constrained viscoelastic material used in engineering structures, especially in automobiles for analyzing effective damping performance have also been surveyed.

i) D. Ngo-Cong, N. Mai-Duya, W. Karunasena, T. Tran-Cong, presented a new effective Radial Basis Function (RBF) collocation technique for the free vibration analysis of laminated composite plates using the First order Shear Deformation Theory (FSDT). Results obtained are compared with the exact solutions

ISSN: 2233-7857 IJFGCN

and numerical results by other techniques in the literature to investigate the performance of the proposed method.

ii) Sharayu U. Ratnaparkhi, 1 S.S. Sarnobat , presented extensive experimental works to investigate the free vibration of woven fiber Glass/Epoxy composite plates in free-free boundary conditions. An experimental investigation is carried out using modal analysis technique, to obtain the Natural frequencies. iii) A.S.Adkine, V.S.Kathavate, G.P.Overikar, S.N.Doijode, in their work an attempt was made to analyse the engine mounting bracket. Design includes the modelling of the engine mounting brackets by taking into account all packaging constraints.

iv) B. S. Ben, B. A. Ben, Adarsh K, K. A. Vikram and Ch. Ratnam ,presented the methodology for finding material damping properties at higher frequency and at relatively lower amplitudes. The method employs combined Finite element and frequency response for finding the damping characteristics of composite materials, which are used in high frequency applications.

v) S. K. Panda • B. N. Singh, analysed the nonlinear free vibration behavior of thermally post-buckled laminated composite spherical shallow shell panel. Effects of various geometries and material properties on the nonlinear free vibration frequencies are examined in detail and discussed.

vi) Kanak Kalita and Abir Dutta, presented different mode frequencies for free vibration of isotropic plates using the ANSYS computer package. The analysis for isotropic plate is carried out for uniform thickness and different aspect ratios.

vii) Pavan B. Chaudhari and Dr.D. R. Panchagade, analyses Finite Element Analysis of Engine mount bracket for optimizing Natural frequency by use of different lightweight materials.

viii) Ahmed Maher, Fawkia Ramadan, Mohamed Ferra, attempted to improve the convergence characteristics of the model within a wide range of frequencies for different code numbers at two levels of volume fraction. ix) Avinash Kadam, Prof. Pravin P. Hujare, devoted to find out modal loss factor in passive constrained viscoelastic material used in engineering structures, especially in automobiles for analyzing effective damping performance.

III. PROBLEM DEFINITION

Most of the structural components are generally subjected to dynamic loadings in their working life. Very often these components may have to perform in severe dynamic environment where in the maximum damage results from the resonant vibrations. Susceptibility to fracture of materials due to vibration is determined from stress and frequency. Maximum amplitude of the vibration must be in the limited for the safety of the structure. Hence vibration analysis has become very important in designing a structure to know in advance its response and to take necessary steps to control the structural vibrations and its amplitudes. Especially in applications such as the Automotive, Aerospace and Machine Tool Industry, the effort of the Design Engineer is to minimize or negate the occurrence of vibrations thereby improving the perception of comfort and or contributing to reduced levels of noise. The challenge is to minimize the effort and cost in doing so.

Research Gap:-

The Literature survey presented earlier reveals the following knowledge gap in the research reported so far,

1) Though much work has been done on static analysis of a engine components such as connecting rod, crankshaft or Engine Mounting Bracket

(EMB), very less has been reported on vibrational characteristics and it's control parameters.

2) A number of research efforts have been devoted to the comparative study of materials such as Aluminium (Al), Magnesium (Mg), Grey Cast Iron (C.I.) etc. used for engineering applications, but very less work has been done on utilization of composite materials for such engineering applications. 3) It is still needed to do the research work on investigating a new class of composite material with different Visco-Elastic Materials (VEM) to reduce the vibration characteristics.

ISSN: 2233-7857 IJFGCN

4) It is essential to analyze the effect of various factors such as No. of layers, aspect ratio, damping factor, vibration response amplitude, thickness of VEM, mode shapes etc. on the natural frequency.

Aims and Objectives:-

The knowledge gap in the existing literature review has helped to set the aims and objectives of this research work which are outlined as follows:-

1) To study the characteristics behaviour of existing material/composite material used in engineering applications such as connecting rod, crankshaft, Engine Mounting Bracket (EMB) and modification in structure for suitability to use in advanced engineering applications.

2) To design and investigate a new composite material with different ViscoElastic Materials (VEM) and check its suitability for particular application.

3) To evaluate the response of composite material in order to enhance it's use

for the intended function in engineering applications.

4) Determination of the vibrational characteristics of a composite material in the form of natural frequencies and mode shapes by using modal analysis. 5) To identify the significant control parameters for vibrational characteristics

and the effect of altering these parameters.

6) Formulate a reliable prediction on effective loss factor based on

accumulated data of Visco-Elastic Materials (VEM).

7) To find alternatives for composition of Visco-Elastic Materials (VEM), either in layers or a homogeneous matrix that would offer favourable response for countering the incidence of vibrations.

8) To analyse the effect of varying the thickness of viscoelastic materials on damping performance of composite material. So that significant amount of damping can be obtained with minimum impact on the total mass of the structure.

9) To identify the other related mechanical or automobile components where such composite material can be possibly suitable for engineering applications.

IV. METHODOLOGY

For case study of composite structure/plate, consider three (or more) layers of different materials i.e. base layer, constrained layer with VEM and constrained layer. Visco-elastic Material (VEM) is considered in conjunction with constrained layer. The base beam as well as the constraining layer is made of same or different materials such as aluminum. Some of the important Viscoelastic Materials (VEM) are:- 1) Polyethylene 2) Poly Methyl Methacrylate3) Polypropylene 4) Styrene Butadiene Rubber (SBR) 5) Nitrile 6) Butyl 7) Urethane etc.

The composite plate/structure size is decided as per ASTM Standard E 756-05. For example, the size of test beam is initially considered as the free length (L1) as 400 mm (approximately) and width as 50 mm (approximately). The thicknesses of various parts of beam will be varies from 1 to 3 mm.

i)Experimentation:-

Test Method for Measuring Vibration-Damping properties of materials was developed in order to determine damping factor. The common methods used to measure damping are the free vibration decay method, the resonant dwell method, the hysteresis method and the frequency response technique. The most suitable techniques for characterizing the material properties of CLD configuration in the medium frequency range (from 1 Hz up to several KHz) is the `Frequency Response' technique. This technique offers potential for rapid non-destructive evaluation of material and structures. In this technique the specimen is excited impulsively with a controlled impact hammer with a force transducer attached to its head. The specimen response is sensed by an accelerometer. The signals from the force transducer and the

ISSN: 2233-7857 IJFGCN

accelerometer are sent to a fast Fourier transform (FFT) analyzer which displays the frequency response spectrum.

In this work, experimental tests based on ASTM standard test method for measuring Vibration Damping properties of materials were developed in order to determine damping factor. The experimental program shall consider several layers of different viscoelastic materials whose properties are of interest. The symmetrical composite plate/structure is composed as per ASTM standard E756-05. It consists of two layers of same or different materials such as aluminum & the viscoelastic material in the core composed of a high strength acrylic double face adhesive. By analyzing the resonant peak for a particular mode, the loss factor, a measure of damping, is obtained from the real part of the response spectrum. The performance of constrained layer damping treatment depends to a large extent on the geometry and the type of constraining layer. The maximum amount of shear strain is usually accomplished whenever the constraining layer is of the same type and geometry as that of the structure to be damped.

ii) Computational Method:-

1) Prepare the CAD model of test specimen using the CAD software such as

CATIA, UGNX.

2) Pre-processing (meshing):- i)Importing the neutral format of CAD geometry in Pre-processor such Hyper Mesh. ii) Discretization of geometry

V. FUTURE SCOPE

1. Structural analysis of engine mounting bracket for effect of forces acting on it

2. Identifying scope for weight optimization using tools like Topology Optimization for a given application.

3. Deploying computational techniques to explore performance in the domain of Noise Vibration and Harshness analysis (NVH)

4. Identifying potential applications in the Automotive or Consumer Product industry for utilizing the findings of this research work.

REFERENCES

[1] Sharayu U. Ratnaparkhi, S.S. Sarnobat, ***Vibratio*n *Analysis of Composite Plate,*** International Journal of Modern Engineering Research (IJMER) www.ijmer.com Vol.3, Issue.1, Jan-Feb. 2013 pp-377-380 ISSN: 2249-6645

[2] A.S.Adkine, V.S.Kathavate, G.P.Overikar, S.N.Doijode ,***Static Behaviour of Engine Mounting Bracket***,International Advanced Research Journal in Science, Engineering and Technology,Vol. 2, Iss*ue 4, April 2015* pp-68-73 ISSN: 2393-8021.

[3] B. S. Ben, B. A. Ben, Adarsh K , K. A. Vikram and Ch. Ratnam ***Damping measurement in composite materials using combined finite element and frequency response method***, International Journal of Engineering Science Invention **(IJESI)** ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726 ***Using Constrained Layer Damping Treatment,*** Int. conference on advances in manufacturing and materials engineering AMME 2014,Procedia Materials Science 5(2014) pp-

and applying material properties and boundary conditions using Hyper Mesh.

www.ijesi.org ǁ PP.89-97 National Conference on "Advances In

726-733.

ISSN: 2233-7857 IJFGCN

3) Processing (Solver):-Meshed model submitted to solver to find out the Modeling And Analysis Of Aerodynamic Systems” National

natural frequencies Institute of Technology Rourkela (ODISHA)

and Mode shapes of test specimen using Radioss or MSC Nastran, etc.
[4] S. K. Panda • B. N. Singh, ***Nonlinear free vibration analysis of***

4) Post-processor:-Visualizing the results typically using Hyper View as post ***thermally post-buckled composite spherical shell panel,*** Int processor. Journal Mech Mater Des (2010) 6:175–188, DOI10.1007/s10999-

5) Comparing the results with benchmark model with variants.
010-9127-1 pp. 175 -188.

6) Identifying alternative material/s to reduce vibration of existing test piece.

[5] Pavan B. Chaudhari, Dr.D. R. Panchagade, ***Comparison of Magnesium, Aluminium and Cast Iron to obtain Optimum Frequency for Engine Bracket using Finite Element Analysis,***

International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 2, Issue 5, September- October 2012, pp.1016-1020.

[6] Avinash Kadam, Prof. Pravin P. Hujare, ***Finite Element Analysis of Damping Performance of VEM Materials Using CLD Technique,*** Int. Journal of Engineering Research and Applications, ISSN: 2248-9622, Vol. 4, Issue 7(Version 6), July 2014, pp.150-153.

[7] Pravin P. Hujare, Anil D. Sahastrabudhe, ***Experimental***

[8] Ramzan Muhammad, Bimlesh Kumar, Atul Chaskar, ***Modal***

Analysis of Nanoparticles Reinforced Natural Rubber, IOSR

Journal of Mechanical and Civil Engineering (IOSR-JMCE), eISSN: 2278-1684, p-ISSN: 2320-334X, Vol. 11, Issue 3,Ver.IV May-June 2014, pp.45-52.

[9] G.V.Mahajan, Prof.V.S.Aher, ***Composite Material :A Review Over Current Development and Automotive Application,*** Int. Journal of scientific and research publications, ISSN: 2250-3153, Vol. 2, Issue 11, Nov 2012.

[10] Gourav Gupta, Ankur Kumar, Rahul Tyagi, Sachin Kumar, ***Application and Future of Composite Materials:- A Review,*** Int. Journal of Innovative Research in Science, Engineering and

Technology (IJIRSET), ISSN(Online): 2319-8753, ISSN(Print):

2347-6710, vol. 5, Issue 5, May 2016, pp.6907-6911.

[11] Piyoosh Thori, Pawan Sharma, Manish Bhargava, ***An Approach of Composite Materials in Industrial Machinary, Advantages, Disadvantages and Applications,*** Int. Journal of Research in Engineering and Technology (IJRET), e ISSN: 2319-1163, p ISSN: 2321-7308, Vol. 2, Issue 12, Dec 2013, pp.350-355.

[12] Alen John, Sanu Alex, ***A Review on the Composite Materials Used for Automotive Bumper in Passenger Vehicles,*** Int. Journal of Engineering and Management Research (IJEMR), ISSN: 22500758, Vol. 4, Issue 4, August 2014, pp.98-101.

[13] P. Lakshmi Kala, V. Ratna Kiran, ***Modelling and Analysis of V6 Engine Mount Bracket,*** Int. Journal of Innovative Research in Science, Engineering and Technology (IJIRSET), ISSN(Online): 2319-8753, ISSN(Print): 2347-6710, vol. 4, Issue7, July 2015, pp.5907-5914.

7) Propose the best suitable composite material.

Fig.1 Potential Application of Composite Material: Engine Mount ***Investigation of Damping Performance of Viscoelastic Material***

ISSN: 2233-7857 IJFGCN