

Experimental Study on Dynamic Behaviour of Hybrid Nano Composites Reinforced with Kenaf/Banana/Glass Fiber

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Abstract: Hybrid composite developed by various researchers by combining natural fibers/natural fiber and natural fibers/synthetic fibers with epoxy resin are well established. One the way to improve the mechanical properties of hybrid based composites is to produce hybrid composites by combining several types of reinforcement/filler such as nano filler with polymers. The present study deals with to fabricate the different types of hybrid nano composites laminates without filler, 0.5, 1 & 1.5wt % of graphene by using kenaf/banana/glass fiber as reinforcing materials with epoxy resin. In the analysis, a frequency domain model is used along with Frequency Response Function (FRF) measurements obtained from the plate. These measurements are made using a Fast Fourier Technique (FFT) based spectrum analyzer. Natural frequency, damping factor and mode shapes are obtained from the laminates.

Keywords: Hybrid nano composites, Damping factor, Mode shapes, Natural fiber.

I. INTRODUCTION

Natural fiber-reinforced polymer composites have established a huge attraction and concern as innovative material in several applications. Although, natural fiber-plastic composites have been commercialized, but their potentiality for use in many industries has been limited. Therefore, most studies in this area focus on improving the physical-mechanical properties and impact resistance of the composites[1].The natural frequencies and mode shapes of a number of graphite/epoxy and graphite/epoxy-aluminium, graphite/epoxy shells of cantilever specimens by forced vibration for various laminates and for different aspect ratios. Natural frequency and mode shapes results were compared with those calculated by a finite element analysis. The agreement between observed and calculated mode shapes was excellent[2]. The free vibrations of axially loaded composite beams using the dynamic stiffness matrix method by developing an exact dynamic stiffness matrix of composite beams taking into account the effects of an axial force, shear deformation and rotatory inertia[3]. The analytical method for evaluating the natural frequencies of laminated composite and sandwich beams using higher-order mixed theory and analyzed various beams of thin and thick sections[4].

II. EXPERIMENTATION

A. Fabrication of Nano Composite Laminates

The nano hybrid composites are prepared by hand lay-up technique using banana/kenaf/glass as reinforced materials and commercially available epoxy resin as a matrix material. Two types of composite laminates were prepared having dimensions of 150mmx150mmx4mm with addition of graphene filler (0, 0.5, 1, 1.5, wt. %).

- Kenaf/Glass/Graphene composites
- Banana/Glass/Graphene composites



Fig-1: Hybrid Nano Composites

B. Free Vibration Characteristics of Hybrid nano composites.

A rectangular symmetric plate of kenaf/Glass and Banana/Glass hybrid nano composites with different weight percentage of graphene of fiber oriented at [+90/0] hybrid Nano composites laminate is prepared.

The Experimental setup for modal analysis as shown in Figure 2. A grid of 5x6 (30 points) measurement points were marked over the surface of the test specimen. The specimen was clamped on test fixture and an impulse technique was used to excite the structure by impact hammer with force transducer built in to the tip to register the force input. The excitation signal was feed to the analyzer through amplifier unit. A piezoelectric accelerometer stuck on the desired measuring point of the specimen senses the resulting vibration response. The accelerometer signals were conditioned in the charge amplifier and fed to the analyzer. The analyzer in conjunction with Fast Fourier Transform (FFT) gives mathematical relation between time and Frequency Response Spectrum (FRS) and coherence functions are registered in the selected frequency range. At each grid point five measurements were made and their average was obtained. The output data of all 30 measurements was used as an input data for LABVIEW-2009 package to identify response frequencies. From the response frequencies natural frequencies, damping factor and mode shapes were obtained and animated.

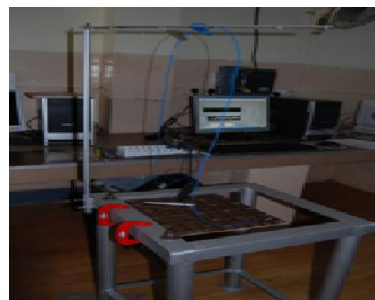


Fig-2: Experimental setup for modal analysis

III. RESULTS AND DISCUSSIONS

A cantilever test plates of hybrid nano composites having dimensions 150x150x4 mm were tested for input frequency of 250 Hz to obtain modal properties.

Table 1: Damping Factor Results

Composites Laminates	Wt% of Graphene	Damping Factor(%)
Kenaf/Glass	0	2.074
	0.5	2.590
	1	3.824
	1.5	3.049
Banana/Glass	0	3.029
	0.5	2.713
	1	2.848
	1.5	3.060

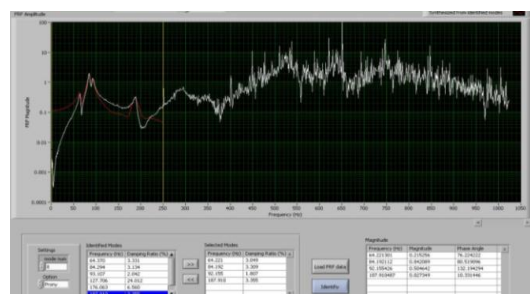
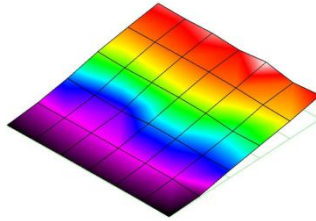
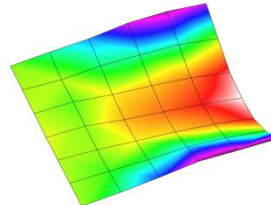


Fig-3: Magnitude – Frequency Response of Hybrid Nano Laminate

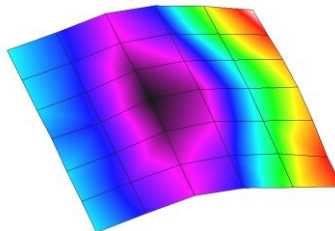
The fixed excitation is used here to obtain the response at various points on the specimen and results are also obtained at all points. Each peak from left to right of relates to corresponding mode shapes from 1 to 4 of hybrid nano composite laminate. The first four experimental mode shapes obtained for hybrid nano composite laminate plates are given in figure 4. The mode shapes give the information of dynamic behavior of plates under various natural frequencies. The mode-1 is called as fundamental mode in bending, mode-2 is in twisting and the rest of the modes are under combination of bending and twisting.



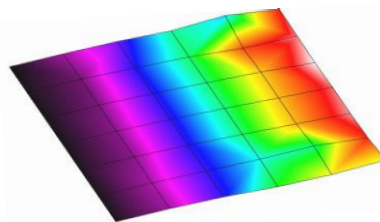
Mode : 1
Frequency : 24.00
Damping factor : 3.02



Mode : 2
Frequency : 48.76
Damping factor : 3.824



Mode : 3
Frequency : 126.46
Damping factor : 2.59



Mode : 4
Frequency : 142.67
Damping factor : 2.074

Fig-4: Mode shapes of Hybrid Nano Composites

IV. COMPARISON BETWEEN THE EXPERIMENTAL RESULTS OF KENAF AND BANANA REINFORCED NANO COMPOSITE LAMINATE.

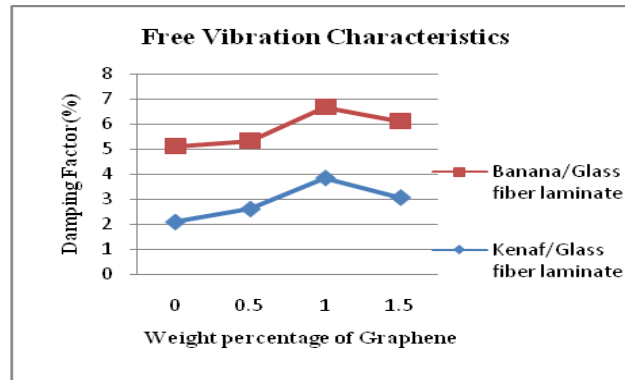


Fig-5: Damping Factor of Hybrid Nano Laminate

From the figure 5, it is observed that the average damping factor obtained for fundamental frequency of Banana/Glass fiber composites laminate is more than the kenaf/Glass fiber composites laminate. The variation in damping factor may be due to difference in flexural stiffness of hybrid nano composites

V. CONCLUSIONS

The main objective of the present work is on development, testing and characterization of hybrid nano composites reinforced epoxy composites to know their suitability and adaptability for various structural applications. Experimentally determined the natural frequency and mode shapes for hybrid nano composites laminate by using Fast Fourier Technique (FFT) analyzer.

- It is observed that the average damping factor obtained for fundamental frequency of Banana/Glass fiber composites laminate is more than the kenaf/Glass fiber composites laminate.
- Banan/glass fiber reinforced epoxy composites possess good damping factor as compared to kenaf/glass fiber composites. Therefore, these composites can be used as vibration absorbing materials in certain applications such as automobile industries, for house construction roofing material and for indoor applications.

VI. REFERENCES

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BIOGRAPHIES

Mr. Ramesh Kumar S C has obtained his B.E degree in Mechanical Engineering from VTU, Master degree in Machine Design. He pursuing his doctoral degree in the area of Nano Hybrid Composites from Bangalore University. He has teaching experience of over 08 years and industry experience of 01 year. He has published 3 technical papers 2 journals paper. He has handled various subjects such as Strength of Materials, Dynamics of Machines, Mechanical Vibrations, Tribology, Computer Aided Machine Drawing, Computer Aided Engineering Drawing and Design of Machine Elements. His areas of interests are Design of Machine Elements and Composites Materials. He is a life member of Institute of Engineers India.



Dr H K Shivanand working as Professor in Department of Mechanical Engineering from Bangalore university and he has obtained his B.E degree in Mechanical Engineering from VTU and also obtained Doctoral degree in the field of Metal matrix composites from VTU. He has 20 years of teaching experience. He has published 95 Number of Publications in National Journal, 66 Number of Publications in International Journal, Guided around 17 PhD students and also published two text books.



Dr Sumana B G has completed her Bachelor of Engineering in Mechanical Engineering from Malnad College of Engineering, Hassan, Masters in Machine Design from University Visveswaraya Collge of Engineering, Bangalore and Ph.D. from Bangalore University. Her research interests include fiber metal composites, fiber metal laminate cylindrical structures, autofrettage of fiber metal cylindrical structures. She has teaching experience of more than 18 years and presently is a teaching faculty at Government Engineering College, Hassan, a premier technical institution in the state of Karnataka, India. She has published more than 10 technical papers in reputed journals, national and international conferences.