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Vibration Characteristics Of Natural Fiber Reinforced Polymer Composites – A Review

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Abstract : *Natural fiber reinforced composites is an emerging area in polymer science. These natural fibers are stumpy cost fibers with low density and high specific properties. These are eco-friendly and non-abrasive. The natural fiber composites suggestion specific properties comparable to those of conventional fiber composites. Still, in development of these composites, the unsuitability of the fibers and poor resistance to moisture often reduce the potential of natural fibers and these draw backs become critical issue. These methods utilize finite element analysis techniques, together with experimental results, to detect damage. They locate and estimate damage events by comparing dynamic responses between damaged and undamaged structures. This paper reviews the various techniques of vibration analysis on natural fiber composites are finite element method, numerical simulations, frequency and time domain method, graphic technique and mathematical formula, etc.*

Keywords :*Finite Element Method, Mathematical Formulations, Natural fibers, Vibration analysis*

I. INTRODUCTION

Natural fibers have in recent times involved the consideration of researchers and mavens because of the advantages that these fibers make available over conventional reinforcement materials, and the advance of natural fiber composites has been a subject of concentration for the past few years. These natural fibers stand low-cost fibers with low density and high specific properties. These are decomposable and nonabrasive, unlike further reinforcing fibers. Also, they are freely available and their specific properties are like to those of other fibers used for reinforcements. But, certain drawbacks such as unsuitability with the hydrophobic polymer matrix, the inclination to form combinations during processing, also poor resistance to moisture critically reduce the potential of natural fibers to be recycled as reinforcement in polymers. According to the dynamic response parameters analyzed, these methods can be subdivided into modal analysis, frequency domain, and time area and impedance domain. Model-dependent methods are able to provide global and local damage information However, there are still many challenges and difficulties before these methods can be effected in practice. The stacking sequence of coconut sheath/coconut sheath/glass with alkali treatment of fibers delivers the optimum increase in mechanical strength and free vibration characteristics. X-ray diffraction and transmission electron microscope were performed to recognize the dispersion of nanoclay and it strengthening mechanism. Scanning electron microscopy was used for fractography analysis.[1]

II. SOFTWARE'S USED IN VIBRATION ANALYSIS

Jinshui Yang et al.[2] investigated the vibration and damping behavior of hybrid carbon fiber composite pyramidal truss sandwich panels with viscoelastic layers embedded in the face sheets with various thickness of viscoelastic layers and the samples were prepared using hot press molding technique. Analytical models based on modal strain energy approach have been developed by using ABAQUS software, which estimate the damping property of hybrid sandwich structures. Vibration and damping behavior of composite samples were investigated with/ without viscoelastic layers. The damping properties were analyzed different fiber orientations such as 0˚, 45˚ and 90˚. Seung-Chan Choi et al.[3] investigated the bending vibration control of the pre-twisted rotating composite thin-walled beam. The preparation is based on single cell composite beam are a warping function, centrifugal force, Coriolis acceleration, piezoelectric effect and pre-twist angle. The adaptive capability of the beam is realize when the negative velocity feedback control algorithm is applied.

Satyajit Panda et al.[4] investigated a patch of active constrained layer damping (ACLD) treatment by using integrating laminated composite plates with the geometrically nonlinear dynamic analysis of functionally graded (FG). The piezoelectric fiber reinforced composite (PFRC) material is considered the constraining layer of the ACLD treatment.Jeyaraj et al.[5] investigated a fiber-reinforced composite plate in a thermal environment and considering the inherent material damping property of the vibration and acoustic response characteristics in composite material. The pre-stress due to thermal environmental by considering the free and forced vibration analyses the critical buckling temperature uniformly 0˚to100 ˚C is obtained. Kapuria et al.[6] investigated by using an efficient as well as advanced layer wise plate theory piezoelectric fiber reinforced composite (PFRC) sensors and actuators plates are integrated with fiber metal laminate (FML) plates and active vibration suppression of hybrid composite plates The electrode surfaces of sensors was exactly satisfied and conveniently by using a different concept of electric node. Chortis et al.[7] investigated the nonlinear damping and vibration of laminated composite strips are large in-plane forces and existing a predicting theoretic agendas. Initial stress effects are formulated by new nonlinear damping, stiffness matrices and the governing equations of a viscoelastic composite are introduced by Nonlinear Green– Lagrange axial strains. A finite element damped beam was developed by nonlinear laminate mechanics.

III. STUDIES RELATED TO FREQUENCY AND TIME DOMAIN

Sarlin et al.[8] investigated the glass fibre reinforced epoxy composite were considered steel, rubber or epoxy adhesive for damping properties of laminated structures. The rule of mixtures provides a good average of the damping behaviour of the hybrid structure use of weight fractions as a substitute of volume fractions of composite materials. By using frequency and time domain test methods hybrid structures loss factors and the essential materials of composites a good estimate of the damping behavior of the hybrid structure provides the rule of mixtures in weight fractions as a substitute of volume fractions.

IV. STUDIES RELATED TO GRAPHIC TECHNIQUE

Zhifang Zhang et al.[9] investigated the poor inter-laminar fracture toughness of the matrix were potentially serious damage in delamination in normal polymer composites laminates. due to loss of stiffness in dynamic parameters are frequencies to detect and evaluate damages are finding using vibration based detection methods. by using measured frequency easily finding the damages presence in frequency shift. set of non-linear simultaneous equations are to solve the inverse problem in location and severity of damage after measured changes in frequency.

V. STUDIES RELATED IMPULSE TECHNIQUES

Buket okutan baba et al.[10] investigated the flexture strength and vibration behavior of sandwich composite beams and concluded that natural frequencies decrease due to the presence of debonds .This is due to the reduction in the stiffness with the presence of debond. The frequency response of sandwich beam is sensitive to curvature angle. The highest increase in damping loss factor was observed for second and fourth modes. With presence of bond, the damping variation for sandwich beam with curvature angle of 30° and 60° shows more sensitive results than that of sandwich beam with curvature angle of 15°and 45°.

VI. STUDIES RELATED TO IMPULSIVE EXCITATION METHODS

Ronald F. Gibson et al.[11] investigated the mechanical properties of fiber-reinforced composite materials and structures are used for modal vibration response measurements to illustrate quickly and accurately. Vibration can used to determine elastic moduli and damping factors of composites either a single mode or multiple modes under various environmental conditions.

VII. STUDIES RELATED TO MATHEMATICAL FORMULA

Della, et al.[12] investigated double delaminations have been solved analytically lacking resorting to numerical approximation in vibration of beams. Using the delaminations their boundaries the beam are analyzed as five interconnected beams. Each of the beams applied Classical beam theory vibration behavior of the beam are shown due to new slenderness ratio specific dominate of beam the slenderness ratios of the delaminated beams occur Global, mixed and local vibration modes vibration performances occur for different sizes, depths, spanwise locations and relative slenderness ratios of the delaminations.

Monsalve-Cano et al.[13] investigated an orthotropic singly symmetric 3D Timoshenko beam-column by generalized boundary conditions subjected an eccentric axial load. The stability and free vibration analyses buckling, natural frequencies and modal shapes are in classical manner. Gilbert et al.[14] investigated a non-plane time-harmonic wave are caused by two particulate composites in Small elastic vibrations. By using acoustic waves are rigorously analyzed for the adhesive interface and distinct periodic structures on the transmission and reflection. For the macro- and micromechanical effects on wave circulation was introduced a two-scale asymptotic expansion with interfacial correctors.

Sakiyama et al. [15] investigated the governing equation is formulated by the Rayleigh–Ritz method with algebraic polynomials in two elements was allowable displacement functions and the principle of virtual work is considered the Green strain tensor on the general thin shell theory. The free vibration of a laminated composite conical shell with twist for strain–displacement relationship. Aytac Arikoglu et al.[16] investigated the vibration analysis on three layered composite beam in Viscoelastic core. By applying Hamilton's principle the equations of motion have been derived govern the free vibrations of the sandwich beam. The frequency domain and equations are solved by using differential transform method (DTM). Viswanathan et al.[17] investigated Using spline function asymmetric free vibrations of annular cross-ply circular plates are estimated. The shear deformation and rotary inertia effect are using governing equations formulated. In terms of displacement and rotational functions are obtained to couple differential equations. Menghui Xu et al.[18] investigated the natural frequencies of composite sandwich beams were frame truss core in the combining the Bernoulli–Euler beam theory and Timoshenko beam theory. Using Hamilton's principle the governing partial differential equations of motion are derived. The natural frequencies are determined by analytical formulations. Thuc Phuong Vo et al.[19] investigated the analytical model applicable to flexural–torsional coupled vibration for thin-walled composite box beams by arbitrary lay-ups under constant axial force are obtainable The structural coupling coming from the material anisotropy based on the classical lamination theory.

VIII. CONCLUSION

The vibration analysis most of all focused in artificial fibers. Only few are concentrated in natural fibers.it is observed that many method used to find natural frequencies, mode shapes, load frequency.
By using finite element method are to vibration control effect and design parameters of beams such as rotating speeds, pre-twist angles and fiber orientations. In frequency and time domain method composites have a good estimate of the damping behavior of the hybrid structure provides the rule of mixtures in weight fractions as a substitute of volume fractions.

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