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INVESTIGATIONS ON DYNAMIC ANALYSIS OF JUTE FABRIC REINFORCED HYBRID POLYMER MATRIX COMPOSITES

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ABSTRACT

Recent trends practicing in the industries evidenced the use of the Natural fibers like jute, pine apple, Gongura etc instead of the synthetic fibers in the Fiber Reinforced Polymer matrix composites because of their superiority in mechanical properties and bio-degradability. Vibration characteristics of jute fabric reinforced hybrid polymer matrix composites are investigated in this paper. These fibers are reinforced in The Hybrid polymer resin of combination of 15% Cashew Nut Shell Liquid (CNSL) and polyester resin. An experimental modal test has been conducted on samples to get the natural frequency, damping and mode shape. Experimental values have been verified with the computational numerical model developed by using FEM package ANSYS and the natural frequency of jute fabric hybrid polymer matrix composite is determined under fixed condition.

***Keywords**: Jute fabric, Hybrid polymer matrix, Modal analysis, ANSYS*

1. INTRODUCTION

Jute fibers are composed primarily of the plant materials cellulose (major component of plant fiber) and lignin (major components of wood fiber). The fibers can be extracted by either biological or chemical retting processes. Given the expense of using chemicals to strip the fiber from the stem biological processes are more widely practices. Cashew Nut Shell Resin (CNSL) The synthesis of polymers from renewable resources has attracted considerable attention from polymer scientists throughout the world because of its potential attribute as substitute petrochemical derivatives. With petroleum production increasingly facing exhaustion, scientists and technologists focus their attention towards renewable resources because these materials may act as potential raw materials for the manufacture of polymers in the 21st century. In this paper the blend of CNSL and polyester is utilized. Because of the wide organize of properties common filaments are utilized as a part of numerous application like building and development (i.e. divider, entryway outlines, roof), away gadgets (i.e. bio gas tank, water tanks, and so on), furniture (like seat, apparatuses), electronic contraptions (cell telephone packaging), vehicles (like auto body, dust board), additionally in railroad mentors parts, toys, and so forth.

2. BACKGROUND

Clary investigated impacted of fiber orientation on the primary 5 flexural modes of rectangular, unidirectional, boron-epoxy panels and natural frequencies are verified. **Dutt** and **Shiva** studied the free vibration response of CF- F-F and C-F-C-F woven carbon composite laminates employing a FFT analyzer and compared with FEM tool ANSYS. This work presents an experimental study of modal testing of woven fiber jute/Epoxy laminated composite plates victimization FFT analyzer. **Cawley** and **Adams** used finite part methodology including transverse shear deformation to predict the natural modes of free-free CFRP plates. This methodology created improved accuracy for the theoretical results for orthotropic plates. **Jun et al** introduced a dynamic finite element method for free vibration analysis to evaluate the influences of Poisson effect, couplings among extensional, bending and torsional deformations, shear deformation and rotary inertia are incorporated in the formulation.

3. EXPERIMENT

3.1 MATERIALS

CNSL

CNSL, an agricultural by-product of the cashew nut processing industry and a renewable resource, is a source of a long chain, m-substituted phenol which promises to be an excellent monomer or polymer production. CNSL occurs as a reddish brown, viscous fluid in the soft honeycomb structure of the shell of cashew nuts. Many researchers have investigated on the chemistry and composition of its extraction. CNSL contains four major components: 3-pentadecenyl phenol (cardanol), 5-pentadecenyl resorcinol (cardol), 6-pentadecenyl salicylic acid (anacardic acid) and 2- methyl 5-pentadecenyl resorcinol (2-methyl cardol).

Jute fiber is 100% bio-degradable and recyclable and thus environmentally friendly. Jute fiber appears to be a promising fiber and constitutes large area of investigation due to its good mechanical properties compared with other natural fibers, such as sisal, coir, and ramie.

Table I: Properties of jute fibre

Density	1.46 g/cc
Poisson's ratio	0.34
young's modules	20 GPa
flexural rigidity	3 to 5 dynes .cm
elongation at break	1 to 1.8 %

3.2 SPECIMEN MAKING

In this work the Hybrid Polymer composite is made by the combination of General Purpose

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Resin and CNSL with Jute Fabric as reinforcement. 15% of CNSL mixture is used for making Hybrid polymer composite. Test samples were prepared as per the Tanguchi's Method using L9 Array with three parameters at two different levels. First parameter is fibre orientation with 0º, 45ºand 60º. Second parameter is number of layers with 5, 6 and 7 layers and Third parameter curing temperature with 80ºC.The L9 array of 9 samples is shown in table II.Fig.1-2 shows the specimen preparation.

K. X – Fibre Orientation
L. Y – No of layers
M. Z – Curing Temperature

Table II:Tanguchi's L9 array samples

Sl No	***Tanguchi's L9 Array***			***Fibre orientation***	***No of layers***
1	X1	Y1	Z1	0^0	5
2	X1	Y2	Z2	0^0	6
3	X1	Y3	Z3	0^0	7
4	X2	Y1	Z2	45^0	5
5	X2	Y2	Z3	45^0	6
6	X2	Y3	Z1	45^0	7
7	X3	Y1	Z3	60^0	5
8	X3	Y2	Z1	60^0	6
9	X3	Y3	Z2	60^0	7

Figure: 1 Preparation of specimen

Figure: 2 vacuum molding usage

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3.3 VIBRATION ANALYSIS

After curing the samples, they are placed on the setup of vibration test, which is shown below. A 50mm mark is made on one side of the sample to clamp it .Then 25mm space lines are drawn/ marked on each sample to conduct the test.

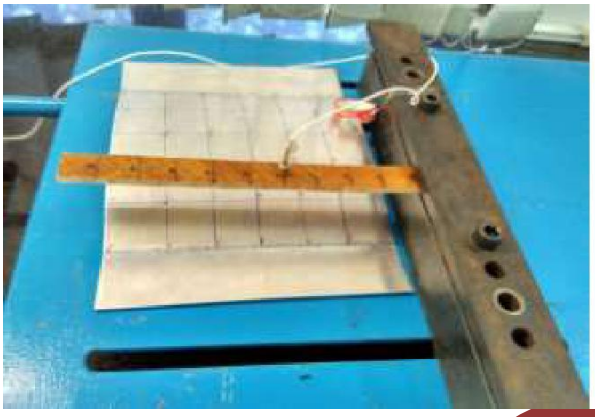

Figure: 3 Specimen position

Figure: 4 showing responses to vibration on one sample

The testing equipment is a setup of a holding device, an accelerometer (which measures the amplitude of vibration at the given node), a computer setup and a small hammer to give the initial displacement. The test specimens are marked completely for conducting the experiment. Firstly, the test specimen is clamped and fixed by bolt tightening. Now, the natural frequencies are recorded by giving small blows on the marking made.

3.4 FINITE ELEMENT ANALYSIS

Ansys package was used for modal analysis simulation of the composite beam. This composite beam is assumed to be a cantilever beam. A fixed supported is provided at one end, and the other end is free. Six number of modes are taken for the beam with uniform CNSL. Each mode gives one natural frequency. The figure in the below shows the behaviour of natural frequency of varying layers and orientations.

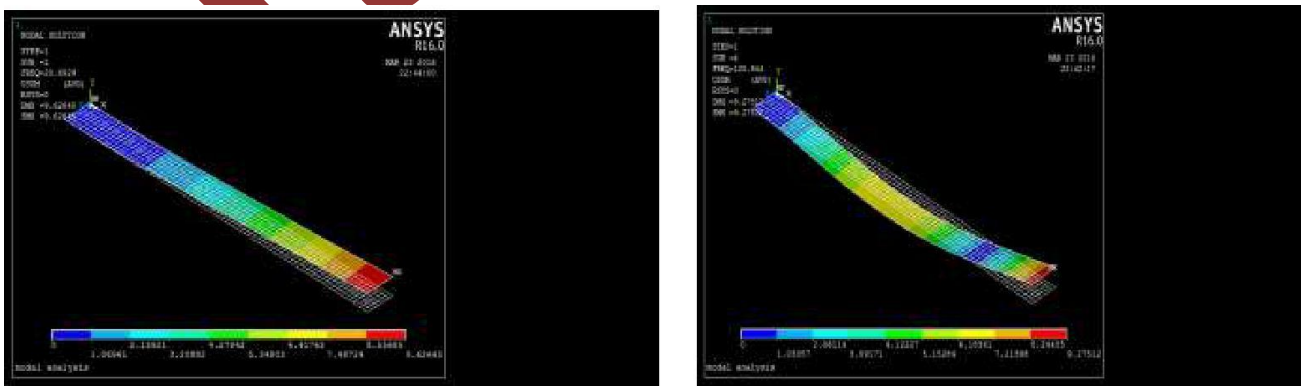

Figure : 5a and 5b are mode shapes of 5 layer specimen

4. RESULTS AND DISCUSSIONS

The experimental and numerical results of composite plates from vibration test are tabulated below. The validation with the formulation has also been made. The geometrical dimension of all the composite plates reflects with the following table-iii.

Table III: The dimensions of composite beam L=300mm W=25mm

Sl.No	***Sample***	***Thickness(h) m***	***Density(ρ) kg/m^3***
1	**5 layers**	**0.005**	**1099**
2	**6 layers**	**0.006**	**1146**
3	**7 layers**	**0.007**	**1244**

The formulation holds good for vibration analysis of composites panels with boundary conditions that are fixed- free, as shown in Table. The obtained values of three lowest non dimensional frequencies are compared with numerical solution.

Table IV: Values of natural frequency of experiment and numerical results with different number of layers

Sl.No	***Sample***	***Frequency in Hzs (Expt)***			***Frequency in Hzs (Ansys)***		
		Mode 1	***Mode 2***	***Mode 3***	***Mode 1***	***Mode 2***	***Mode 3***
1	6L 60^0	15.596	96.72	299.53	15.435	111.608	322.676
2	7L 45^0	22.691	131.54	450.22	23.83	140.101	429.6
3	7L 60^0	18.037	117.83	358.18	17.87	124.543	354.757

Three different types of laminate are fabricated, to examine the effects on number of layers that are made up of 5, 6 and 7 layers. For fixed-free boundary condition, natural frequencies for free vibration are obtained both experimentally and numerically. Below is the table which shoes the variations in natural frequencies with increasing layer of laminate.

4.1 CONCLUSIONS

In these work experimental and numerical study was carried out for hybrid polymer

Jutefabric/Polyester resin composite structure. The natural frequency value difference among numerical outcomes and experimental outcomes are due to are due to non uniformity in the specimens properties such as voids, thickness variation, smoothness of the surface and position of the accelerometers. The vibration test performed on composite beams and a simulation model has developed using ANSYS package. The following conclusions have given on the basis of investigation:

KK. The fundamental natural frequency increases with increases in the number of layers.
LL. The natural frequency is increases with increases in fibre volume.
MM. The natural frequency decreases with increases in fibre orientation.

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