STUDIES ON MECHANICAL BEHAVIOR OF PINE APPLE FIBERS REINFORCED HYBRID POLYMER MATRIX COMPOSITE

T.Santh Prasad, G. Venkatachalam. B. Vignesh

School of Mechanical Engineering, VIT University, Vellore-632014, India.

ABSTRACT

In a view to reduce environment pollution due to synthetic polymers, research is focusing to develop materials made from natural resource. Natural fiber reinforced composites have been widely used in the variety of applications. Natural fiber composites may suffer when the material is exposed to adverse environments for long period of time. This work will focus on pineapple fiber which is an extremely valuable natural fiber with robust mechanical properties. Pineapple fiber reinforced with hybrid polymer composites will be subjected to tensile and flexure & vibration test. The fiber used in composite is treated by immersing pineapple into three different chemicals like NaoH, KMnO4&KOH solution. Simulation results will be obtained from FEA and compared with experimental results. The influence of different parameters vibration, fracture, tensile and flexural properties of composites will be evaluated using ANOVA and significant changes in both strength and modulus will be observed.

Keywords: *ANOVA Technique of Optimization. Surface Treatment, Hybrid Polymer Matrix (CNSL/Isotholic Polyester), Vibration Testing, FEA-ANSYS, Design Of Experiment,*

INTRODUCTION

Pineapple fiber is effectively accessible and extremely taken a toll proficient. Pineapple fiber has great mechanical properties contrasted with other common fiber like coir, jute, abaca, bamboo and so on. Pineapple fiber can be utilized as fortification with common gum or manufactured gum or with hybridization of both gums. Hybridization gives better bio-degradability. Pineapple fiber with crossover polymer gives better bio-degradability and better mechanical property as manufactured polymer offers great mechanical quality and characteristic polymer gives better bio-degradable properties. Treatment of fiber likewise influences the mechanical properties and it is financially savvy property change method. Conventional composites produced using manufactured strands are not environment well disposed. in this case Pineapple fiber offer great mechanical properties alongside bio-degradability. Daudet et al[1] studied the properties of pina fiber. 1% of sodium hydroxide has been treated with the fiber. Scanning Electron Microscope (SEM) analysis shows that the condensed arrangements of fibers will get strong fiber.Isuwaet et al[2]have studied the property of Kenaf/PALF (Pineapple Leaf Fiber) Reinforced HDPE (High Density Polyethylene) Composite. Tensile properties and water absorption behavior was discussed briefly.
Modification was carried out on the fibre‟s surface using Vinyltri. Treated fiber has good results as it absorbs less water than normal one. Therefore the treated fiber has more advantage than the

normal one. Nanthaya et al[3] have studied about the Fresh pineapple leaves, which contain about 85% water, are chopped into small pieces and ground into paste. Resin type used here are Polypropylene reinforcement. The PALF (Pineapple Leaf Fiber) the energy required to produce 2.27 MJ/kg.95.4 MJ/kg and 100 MJ/kg are the energies required for the production of PP and glass fiber. Yuliatiet et al[4] studied the different types of resins. Pineapple leaf fibre MDF seems to be suitable for building construction materials. MDF specimens measuring 20 x 15 x 20 mm were obtained from MDF boards and exposed to the subterranean termites. Sipiaoet et al [5] have studied pineapple fiber and discussed in various types of testing methods. Such as Scanning Electron Microscopy (SEM), X-ray diffraction (XRD) &Thermal analysis (TGA). In Chemical treatments alkaline and distilled water has been used. The treated fibers are dried with the help of oven. Treated pineapple fiber has increased high impact strength of 14% than the untreated fiber.Chikkolet et al [6] have studied different properties of fiber reinforced composites and it had been enhanced through fiber surface modification. Alkali treated fiber have good mechanical properties than the untreated one. Lignocellulose fibers offer several advantages over their synthetic fibers.Threepopnatkul et al[7] have studied the modified pineapple leaf fibres composite produces high Young"s modulus as is the case of the PALF/NaOH composites. The PALF/Z-6011 composites showed the highest tensile strength and impact strength. leo et al [8]have studied pine fibres where compared with different wood specimen. The tensile and flexure property are higher at perpendicular to the grain direction, The review of a literature carried out for the present study reveals that there is very less amount of research in field of pineapple fibre with hybrid matrix composite

EXPERIMENTAL DETAILS

Pineapple fiber which is obtained from pineapple leaves used as reinforcement . CNSL and isotholic polyester are natural and synthetic resins respectively used in the hybrid polymer which is the matrix used. The pineapple fiber was treated for 12 hours with three alkali solutions which were prepared from 1% sodium hydroxide (NaOH), Potassium hydroxide (KOH), and Potassium permanganate (KMnO4) respectively. Fiber is then dried under room light to remove moisture. Pineapple Hybrid polymer was prepared with 85% of Isotholic polyester and 15 % of CNSL. The mould was manufactured with stainless steel with a specimen size of 300×30×4 mm. After inserting fiber and pouring of resin in the mould, the specimen was kept in oven for curing of composite. Fig.1 shows the prepared specimen. Nine such samples were prepared according to table 1 by varying parameters such as fiber treatment, various fiber volumes and various curing temperature. Table 1 is based on TAGUCHI"s design of experiment.

Table 1: optimization method

Sr. No.	*Fibre Treatment*	*Curing Temperature*	*Fibre volume (%)*
1	***NaOH***	***Room Temperature***	***5***
2	***NaOH***	***60 °C***	***10***
3	***NaOH***	***90 °C***	***15***
4	***KOH***	***Room Temperature***	***10***
5	***KOH***	***60 °C***	***15***
6	***KOH***	***90 °C***	***5***
7	***KMnO4***	***Room Temperature***	***15***
8	***KMnO4***	***60 °C***	***5***
9	***KMnO4***	***90 °C***	***10***

FIG 1. SPECIMEN

Vibration test (figure 2) was conducted at VIT university using Vibration testing machine in vibration lab with the help of DEWESoft version 7.11 (Figure-3), Vibrations of specimen were generated by using impact hammer. And the frequency where noted.

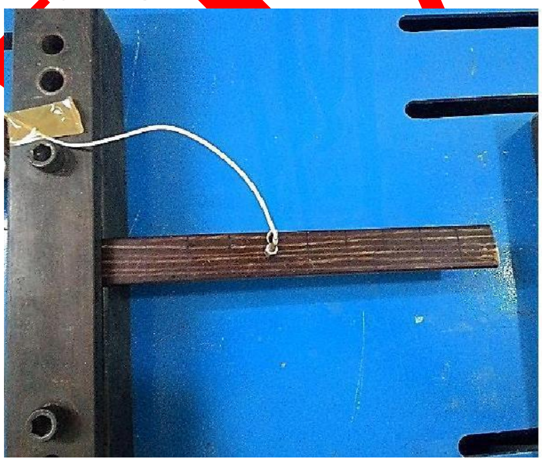

FIG 2. Viberation testing sample

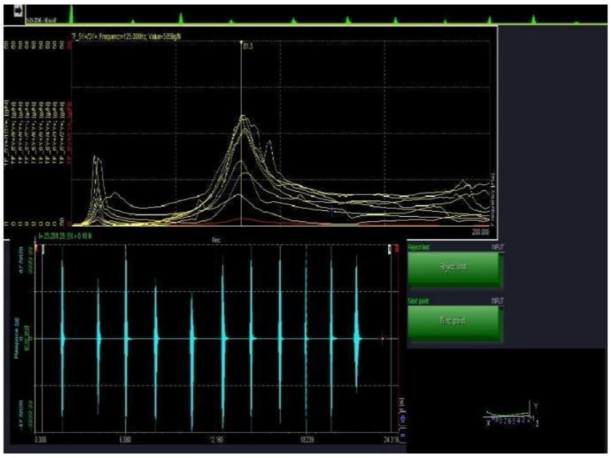

FIG3. dewesoft image

FINITE ELEMENT ANALYSIS.

Using Finite Element Analysis software (ANSYS) method The vibration analysis was carried out.

The properties of fibre and matrix properties used in the finite element analysis are presented in Table 2. Figure 4 and 5 show the geometry and meshing of the vibration sample. The boundary condition for the ANSYS is one end fixed and other end free & we used sweep meshing to generate the result.

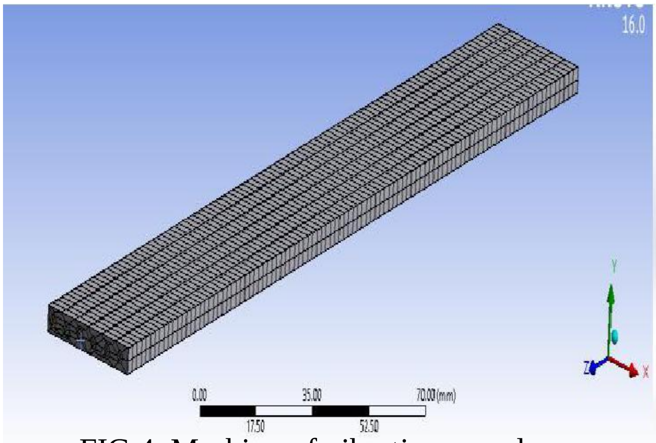

FIG 4. Meshing of vibration sample

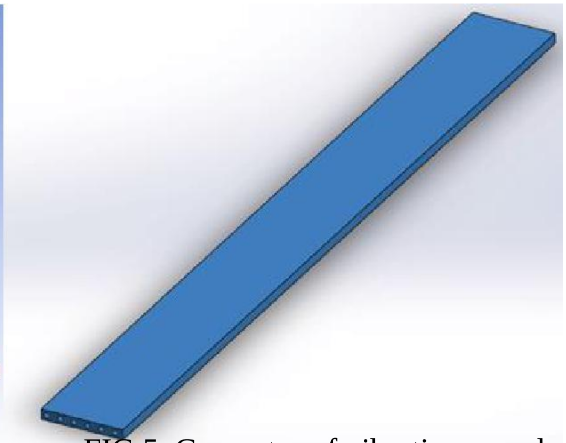

FIG 5. Geometry of vibration sample

TABLE 2: Property of Fiber and Matrix

Sr. No.	*Properties*	*Young modulus*	*poisson's*
1	*NaOH Fibre Treatment*	*9536.887*	*0.3*
2	*KOH Fibre Treatment*	*8535.123*	*0.3*
3	*KMnO4 Fibre Treatment*	*4890.893*	*0.3*
4	*Hybrid Matrix Room*	*195.89*	*0.33*
5	*Hybrid Matrix at 60 °C*	*163.23*	*0.33*
6	*Hybrid Matrix at 90 °C*	*123.53*	*0.33*

RESULTS AND DISCUSSIONS

To legitimize the results obtained from finite element analysis, experiments were carried out on three samples as shown in Table-3. This shows the natural frequency obtained from experimental analysis and numerical analysis. Good correlation has been found between and experiments and numerical analysis.

Table 3; Natural Frequency From Experimental and Numerical Results

Sr. No.	*Sample*	*Frequency*	*Experimenta (Hz)*	*Numerical (Hz)*	*Error*
1	*1*	*1st Natural*	*9.83*	*9.2215*	*13.25*

		2nd Natural	*55.27*	*64.792*	*13.58*
		3rd Natural	*191.28*	*212.9*	*10.15*
2	*2*	*1st Natural*	*11.235*	*12.562*	*18.71*
		2nd Natural	*36.78*	*45.287*	*12.844*
		3rd Natural	*220.23*	*248.41*	*13.32*
3	*3*	*1st Natural*	*12.375*	*14.475*	*4.50*
		2nd Natural	*82.298*	*86.658*	*5.092*
		3rd Natural	*249.65*	*286.54*	*12.93*

Numerical analysis was carried out using ANSYS16. Figure 6-8 show natural frequency obtained from ANSYS16. It is evident from figures that the fiber treatment and fiber volume play major role for dynamic stiffness of any natural composite structure.

Table-4 Shows the results of first three natural frequencies obtained from ANSYS16. Curing temperature also affect the damping parameter as shown in table-4. In this design of experiment the best natural frequency is obtained for sample number 7 because of more fiber and curing temperature

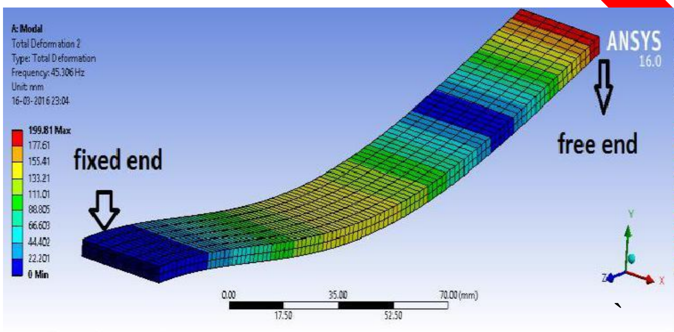

FIG6 . 1ST mode

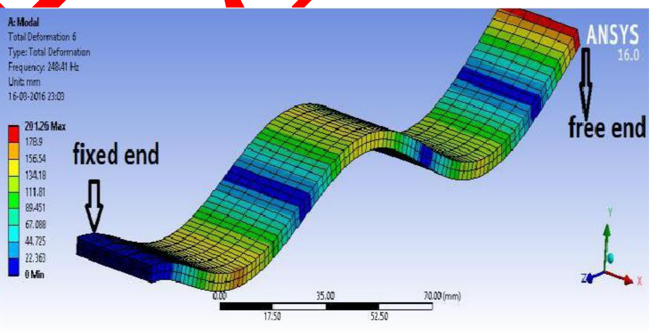

FIG7 . 2st mode

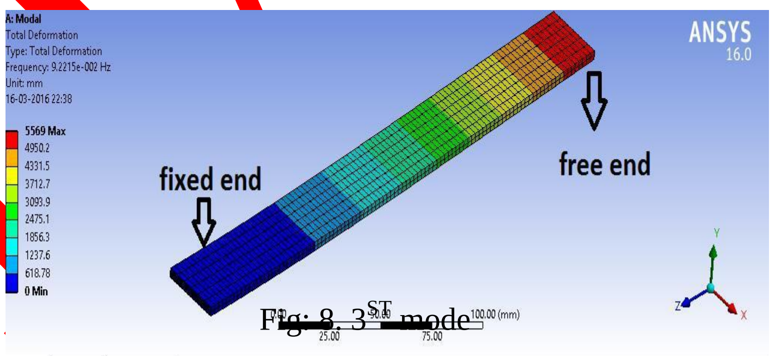

Fig: 8. 3ST mode

Table 4 : NATURAL FREQUENCY OBTAINED FROM ANSYS

Sr. No.	*Fibre Treatmen*	*Curing*	*Fibre volume (%)*	*1st frequency (Hz)*	*2nd frequency (Hz)*	*3rd frequency (Hz)*
1	*NaOH*	*Room Temperature*	*5*	*12.254*	*66.906*	*172.08*
2	*NaOH*	*60 °C*	*10*	*15.167*	*93.702*	*222.31*

3	*NaOH*	*90 °C*	*15*	*9.120*	*62.792*	*229.95*
4	*KOH*	*Room Temperature*	*10*	*16.364*	*92.9610*	*258.44*
5	*KOH*	*60 °C*	*15*	*11.532*	*79.287*	*225.31*
6	*KOH*	*90 °C*	*5*	*7.448*	*41.233*	*189.35*
7	*KMnO4*	*Room Temperature*	*15*	*13.475*	*79.658*	*295.54*
8	*KMnO4*	*60 °C*	*5*	*7.6385*	*36.965*	*143.47*
9	*KMnO4*	*90 °C*	*10*	*7.8815*	*61.76*	*158.06*

ANOVA (Analysis of Variance) is employed to find the influence of different parameters on response i.e. natural frequency. MINITAB software is used to carry out ANOVA. The influence of different parameters on first natural frequency is given in figure 9. From the figure it is seen that the Noah fiber treatment gives higher natural frequency. The curing temperature is also the major effect on the stiffness, as increasing curing temperature decrease the stiffness of the specimen. Room temperature (30°C) gives better result. As per the findings from the available literature, it is evident that increasing fibre volume percentage increases the stiffness of the specimen and fibre treatment with NaOH offers best results.

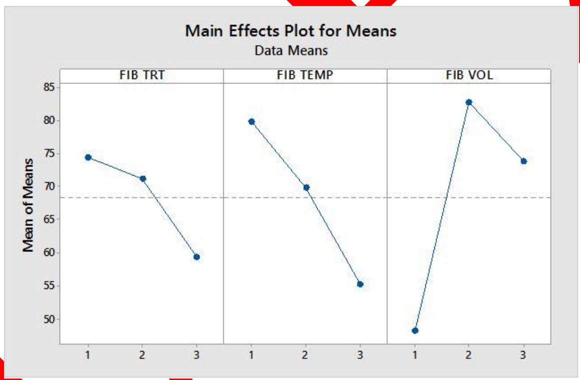

Fig 9. anova graph

Contour plot is shown in figures 10-11 which gives inter-relation between fiber treatments, curing temperature, and fibre volume percentage. The abscissas of Figures 10-11 shows the contour plot results 1, 2 and 3 represent the regression equation of the treated fiber. In figure-10, fibre treated with NaOH with curing temperature at 30 °C offers best result, as increase in curing temperature decrease the 1st natural frequency

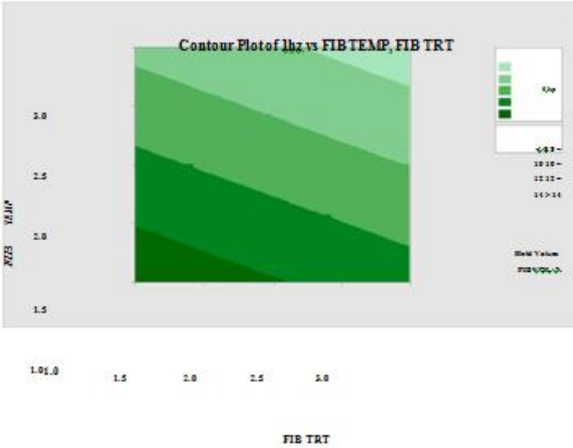

FIG 10. fiber temo vs fiber treatement

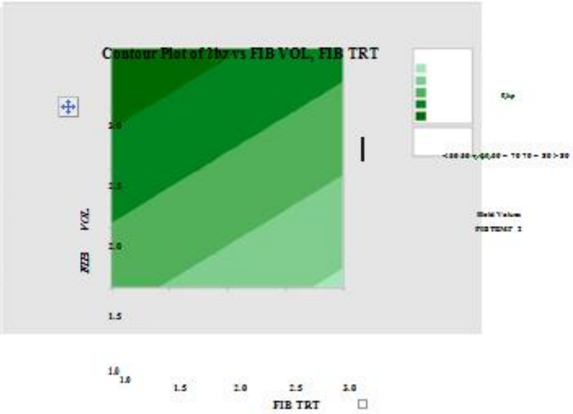

FIG11. fib volume vs fiber treatement

1hz = 17.34 - 1.258 FIB TRT - 2.941 FIB TEMP + 1.131 FIB VOL (1)

2hz = 82.4 - 7.55 FIB TRT - 12.29 FIB TEMP + 12.82 FIB VOL (2)

3hz = 187.2 - 4.5 FIB TRT - 24.8 FIB TEMP + 41.0 FIB VOL (3)

CONCLUSIONS

Based on the present work, we can concluded that fibre treatment influences the surface & stifness properties of composite and compared to all this chemicals NaOH fibre treatment gives best result. Curing temperature also plays the major effect on stiffness properties and increasing in curing temperature reduce the stiffness of hybrid composite. By increasing fibre volume percentage the dynamic load carrying capability of hybrid composite increases hence stiffness also increases. As per the present study, the $KMnO_4$ with the curing temperature 30 °C (Room Temperature) and 15 % fibre volume gives higher natural frequency.

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