ELASTIC PROPERTY EVALUATION OF FIBRE REINFORCED GEOPOLYMER COMPOSITE USING SUGARCANE BAGASSE FIBRE

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Abstract - *The natural fibers have attracted substantial importance as potential structural material. Natural fibers are replacing the traditional man made fibers as reinforcements. They have many advantages over man made fibers . Natural Fibers are low in cost and have high mechanical properties. Natural fiber is a good renewable and biodegradable . Availability of natural fibers and ease of manufacturing have tempted many researchers to try locally available fibers and to study their feasibility of reinforcement purposes. Geopolymer composites were prepared from neat and alkali-treated sugarcane bagasse fibers. The results proved that alkali treatment leads to an increase in stiffness and strength of composites . In this study, epoxy based composites has been reinforced with sugarcane bagasse fiber and are fabricated. Bagasse is a by-product of the milling process after production of sugar. Bagasse is mainly used as a burning raw material in the sugar cane mill furnaces.*

Keywords: Natural Fibres, Miliing Process, Geopolymer composite, Biodegradable, Bagasse Fibre.

1. INTRODUCTION

Composites are also known as Fiber-Reinforced Polymer composites, are made from a polymer matrix that is reinforced with man-made or natural fiber or other reinforcing material. The matrix protects the fibers from environmental and external damage. Matrix transfers the load between the fibers. The fibers provide strength and stiffness to reinforce the matrix and also help to resist cracks and fractures. Composite materials are also called composition materials or shortened to composites. Composite materials are materials made from two or more constituent materials with significantly different physical or chemical properties. When we combined these materials, produce a material with different characteristics from the individual components. Composites are materials that comprise strong load carrying material is known as reinforcement. Reinforcement provides stiffness and strength, helping to support structural load . Bio-based composites possess a wide range of end-of-life possibilities such as incineration, recovery/recycling and composting . The interactions, between filler and the epoxy matrix, results in the increase of mechanical strength. NaOH treatment results in improvement of strength of the fibre.

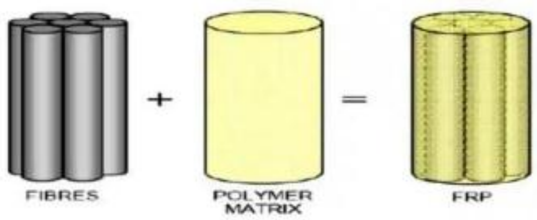


Fig.1.1. Fiber Reinforced Polymer (FRP)

Fig.1.2. Sugarcane Bagasse

Fig.1.3. Sugarcane Bagasse Fibre

2. MATERIALS AND METHODS

2.1 Treatment of Sugarcane Fibres

Sugarcane stalk is composed of an outer rind and inner pith. The outer layers of bagasse is hard fibrous substance and inside is soft material. The experiment was initiated from the preparation of the sugarcane bagasse. A chemical treatment was performed on the bagasse fibers. The fibers were submerged in 30 ml NaOH for 4 hours at temperature of 80 deg C . Then they were rinsed with distilled water to remove excess NaOH from the surface then and then dried up in an oven at temperature of 20° for 3 seconds.

Fig. 2.1 (a) Chemical treatment of bagasse

Fig. 2.1 (b) Oven Dry of bagasse Fibre

2.2 Epoxy Resin and Hardner

The Epoxy Resin used in this experiment is Epoxy Resin LY556 and Hardner is HY951. The viscosity of conventional epoxy resins is higher and they are more expensive compared to polyester resins. The cured resins have good mechanical and thermal properties.

Fig. 2.2 Epoxy Resin LY556 and Hardner HY951

2.3 Preparation Of Composites

Four wooden molds of dimension 250x250x10 mm were use for casting the composites. The samples were casted with 0, 2, 5 and 7 % volume fraction of fibers. For different volume fraction of fibers, a calculated amount of epoxy resin and hardener in the ratio of 10:1 weight was thoroughly mixed in a jar and stirred well. Here shear mixing is done in this experiment. It is then placed in a hot water to remove air bubbles that got introduced. After that mixture was poured in the mould and allowed to cure at room temperature for 24 hrs. After 24 hrs the samples were taken out of the mold and it is then cut into desired shapes for the corresponding test. The samples for tensile test and Vibration test were prepared in the following volume fractions:-

Sl No.	Compositions
1	Epoxy + 0% Sugarcane Bagasse Fibre
2	Epoxy+ 2% Sugarcane Bagasse Fibre
3	Epoxy+ 5% Sugarcane Bagasse Fibre
4	Epoxy+ 7% Sugarcane Bagasse Fibre

Fig. 2.3 (a)Epoxy and Hardner mixing

Fig. 2.3 (b) Shear mixing

Fig. 2.3 (c) Casting of Sample

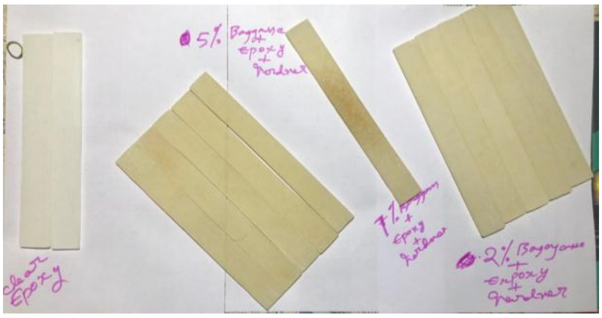


Fig. 2.3 (d)Sample Composites

3.COMPOSITE TESTING AND RESULTS

3.1 Vibration Test

Modal analysis of epoxy/bagase Nanocomposite

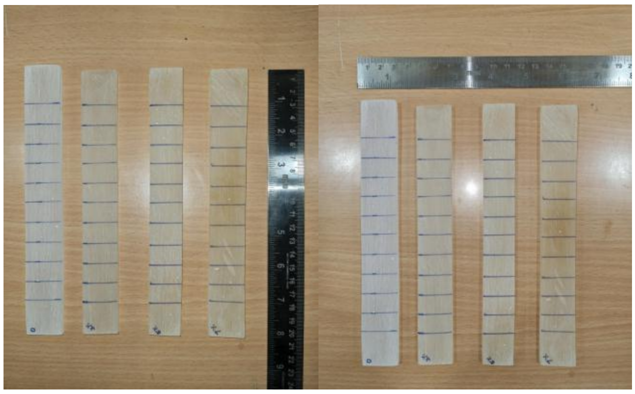
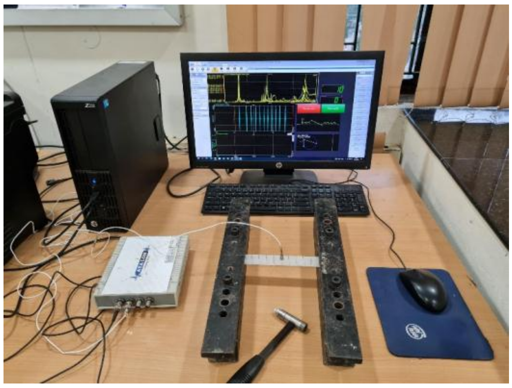
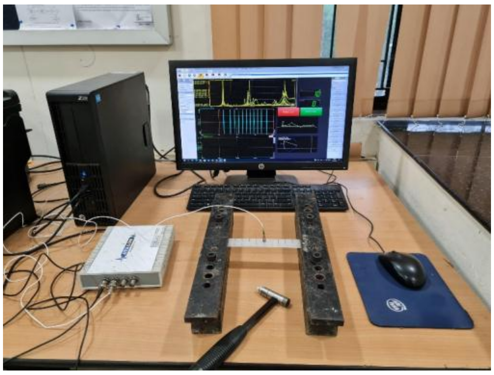


Fig 3.1 (a) various bagasse samples prepared for dynamic analysis

The modal analysis of the polymer composite is demonstrated by performing an experiment on a miniature model of bagasse reinforced polymer composite beam with 200mm in length, 25mm in width, and 4mm in thickness under cantilever end condition as shown in figure . The polymer composite beam is fabricated using DGEBA epoxy resin and hardener to carry out the experimental test. First, the bagasse reinforced polymer composite beam is fixed on the CFCF end condition followed by CFFF, then the data acquisition system (DAQ) was connected to the computer system and the other end of the DAQ was connected to the accelerometer and the impact hammer. The impact hammer was employed to excite the bagasse reinforced polymer composite beam, and the sensor was mounted at the top layer of the composite beam, which could get the response signals due to the excitation. The DAQ was used to convert the response signal to frequency response function and can be seen in the display unit of Dewesoft software.



(b)



(c)

Fig 3.1 Modal analysis test set up (b) Epoxy composite (c) bagasse reinforced composite.

Table 3.1 (a) Natural Frequencies of the various bagasse reinforced composites in CFCF boundary condition.

Wt%	Natural Frequencies (Hz)		
	Mode 1	Mode 2	Mode 3
0	312.5	906.3	1725.0
2	328.1	964.1	1773.4
5	300.0	870.3	1595.2
7	270.3	778.9	1540.5

Graph 3.1 (a) Natural Frequencies of the various bagasse reinforced composites in CFCF boundary condition.

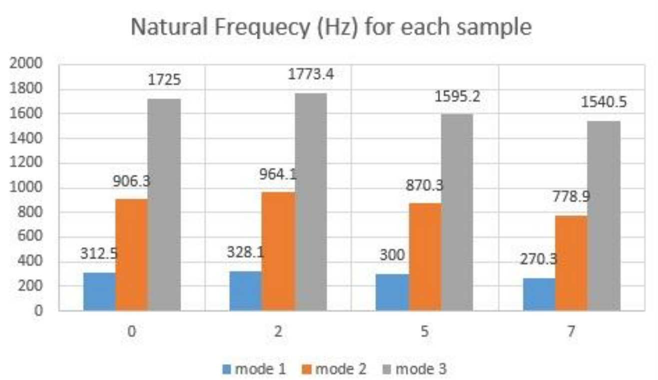


Table 3.1 (b) Damping factors of the various bagasse reinforced composites in CFCF boundary condition.

Wt%	Damping Factors		
	Mode 1	Mode 2	Mode 3
0	0.013	0.032	0.004
2	0.009	0.001	0.006
5	0.017	0.023	0.001
7	0.011	0.025	0.005

Graph 3.1 (b) Damping factors of the various bagasse reinforced composites in CFCF boundary condition.

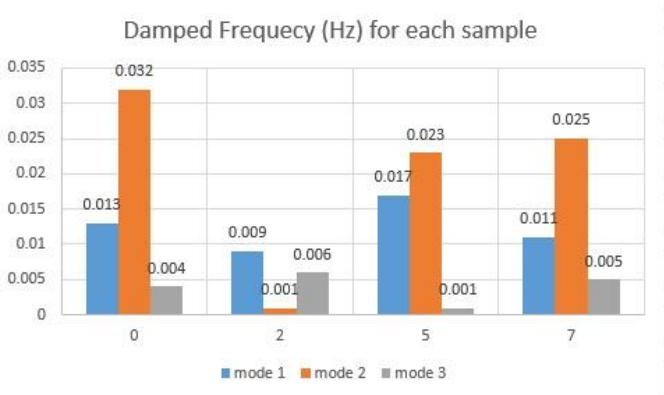


Table 3.1 (c) Natural Frequencies of the various bagasse reinforced composites in CFFF boundary condition.

Wt%	Natural Frequencies (Hz)		
	Mode 1	Mode 2	Mode 3
0	70.3	393.8	1109.4
2	71.9	406.3	1332.0
5	64.1	379.7	1132.8
7	62.5	356.3	1081.3

Graph 3.1 (c) Natural Frequencies of the various bagasse reinforced composites in CFFF boundary condition.

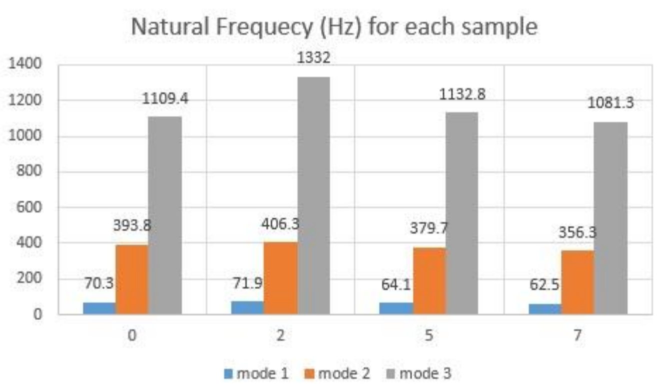
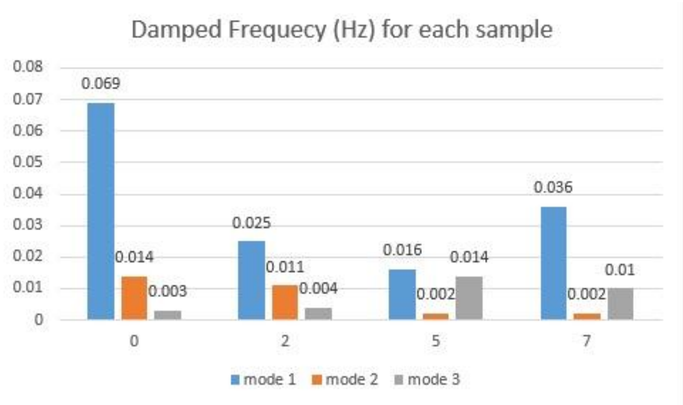


Table 3.1 (d) Damping factors of the various bagasse reinforced composites in CFFF boundary condition.

Wt%	Damping Factors		
	Mode 1	Mode 2	Mode 3
0	0.069	0.014	0.003
2	0.025	0.011	0.004
5	0.016	0.002	0.014
7	0.036	0.002	0.01

Graph 3.1 (d) Damping factors of the various bagasse reinforced composites in CFFF boundary condition.



CFFF- Clamped Free Free Free
CFCF- Clamped Free Clamped Free

3.2 Tensile Test

The common specimen for tensile test is based on ASTM D3039. It is constant rectangular cross section of 4mm thick, 25 mm wide and 250 mm long. Specimens are placed in the grips of a Universal Test Machine at a specified grip separation and pulled until failure. For ASTM D3039 the test speed can be determined by the material specification . A typical test speed for standard test specimens is 2 mm/min.

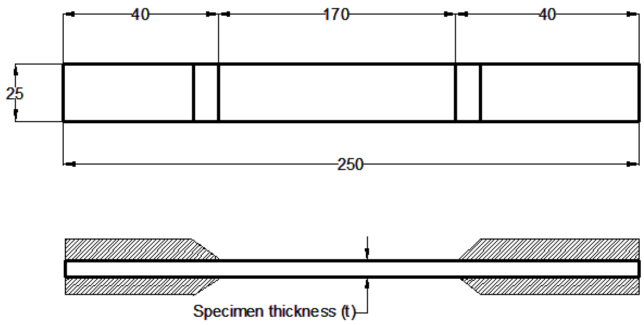
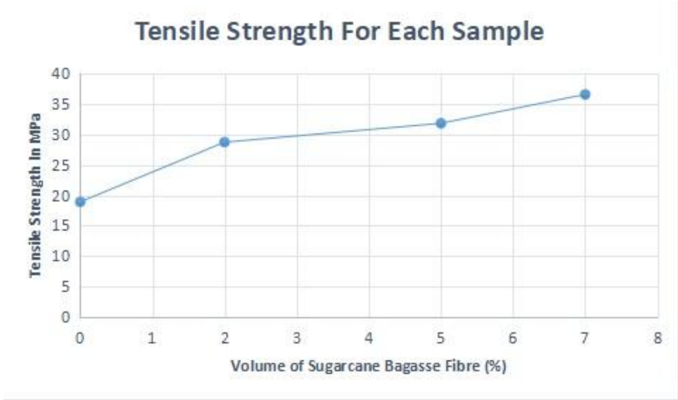
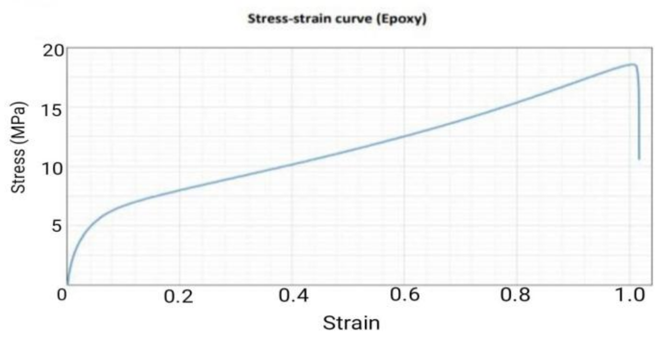


Fig 3.2 (a) Dimensions of Tensile Test Sample

The experimental results of composite testing of different fiber content in Table 3.2.

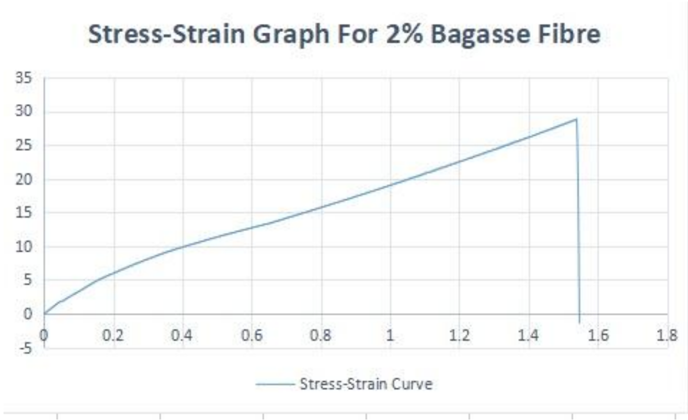


Graph 3.2(a) Variation of tensile strength with different of sugarcane bagasse fiber

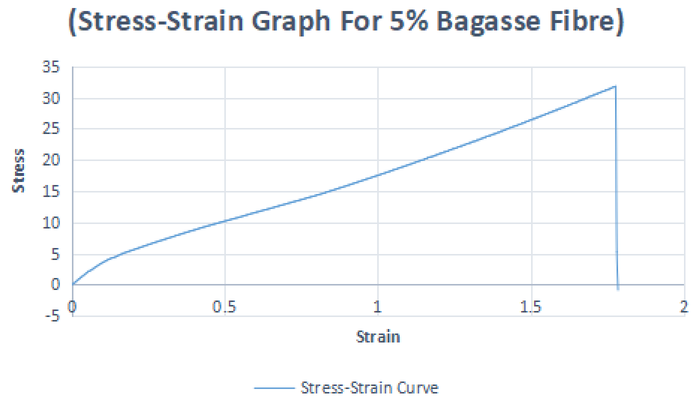


Graph 3.2(b) Stress-Strain Curve for 0% Sugarcane BagasseFibre.

Sl No.	Fibre Content (%)	Tensile Strength (MPa)
1.	0	18.92
2.	2	28.70
3.	5	31.80
4.	7	36.53



Graph 3.2(c) Stress-Strain Curve for 2% Sugarcane Bagasse Fibre.



Graph 3.2(d) Stress-Strain Curve for 5% Sugarcane Bagasse Fibre.

5. CONCLUSIONS

The natural frequencies of the various weight percentages (0, 2, 5, 7%) of bagasse reinforced polymer composite beams under CFCF and CFFF boundary conditions are tabulated in Table 3.1(a), 3.1(b),3.1 (c) and 3.1(d). From the experimental results it can be seen that the polymer composite beams with 2wt% of bagasse reinforcement has higher natural frequency than those of the other composite beams. This might be because the significant interaction between the bagasse and epoxy composite's intermolecular polymer chain increases the natural frequencies of the composite beam. The increase in natural frequency of the composite beam according to the increase in the weight concentration of the bagasse fibre is shown in graph 3.1 (a) and 3.1(c). The fluctuation in the damping factors of the composite beam under various weight percentages of bagasse fibre is under CFCF and CFFF is shown in table 3.1(b) and 3.1(d). By plotting the graph under various conditions it is seen that composite beams having 0wt% is having higher damping factor than other composite beams under various wt%.

From graph 3.1 (a), (b), (c) and (d) it is observed that the composite beams having higher weight concentration of bagasse fibre is not having the highest value of natural frequency or damping factor. This is because the structure got stiffer or the distribution of the filler got concentrated in different areas of the composite which is the reason for the decreased damping and natural frequencies. The amplitude of the resonance peak decreases at a lower frequency. From this experiment we can conclude that when natural frequency of the composite increases, corresponding damping factor decreases.

The sugarcane bagasse fiber composite material has a much higher tensile strength and modulus of elasticity than the other materials having 0% concentration of fibre. From graph 3.2 (b), (c) and (d) we can see that the ultimate strength or the breaking point of the material increases with increase in the concentration of the bagasse fibre. Composite containing 7% of bagasse fibre has higher ultimate strength or higher breaking point than 5% and the composite containing 5% of bagasse fibre has higher ultimate strength than 2% and so on . Therefore we can conclude from the result that the tensile strength of a composite increases with increase in the concentration of the fibre present in the composite.

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[7] International Journal of Composite Materials 2017, 7(5): 150-154 DOI: 10.5923/j.cmaterials.20170705.04 A Study on the Vibration Characteristics of Bagasse-Banana Fibre Hybrid Composite Pavana Kumara B. * , John Paul Vas, Shreeranga Bhat, Karthik Madhyastha N