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Effect of surface treatment on the mechanicalproperties of banana-Glass fibre hybrid composites

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Keywords : Glass fibre (20mm), Banana fibre (20mm), NaOH, Epoxy resin, hybrid composite.

Abstract. Natural fibre reinforced composites have attracted the attention of research community mainly because they are turning out to be an alternative to synthetic fibre. Various natural fibres such as jute, sisal, palm, coir and banana are used as reinforcements. In this paper, banana fibres and glass fibres have been used as reinforcement. Hybrid epoxypolymer composite was fabricated using chopped banana/glass fibreand the effect of alkali treatment was also studied. It is found that the alkali treatment improved the mechanical properties of the composite.

Introduction

Natural fibres are widely used as a replacement for synthetic fibres due to their ease of availability and eco-friendly nature. Among several natural fibres banana fibre is also used in industrial applications such as automotive and textile. Mechanical properties of short banana fibre reinforced natural rubber composites wereinvestigated [1-3].It is reported that as the fibre concentrations increases tensile strength is also increased. Treated Banana Fiber-PolyLacticAcid composite represent as a best reinforced composite with good flexural and impact properties [4-5]. Experiments on Hybrid composites proved that they are cost effective, recyclable and biodegradable and may replace or reduce utilization of synthetic fibres in different applications [6-7]. SEM studies showed that chemical treatmentof banana fibres changed the surface topography of the fibres [8-9]. Hence in this study surface treatment on the banana fibre is performed and its effect on mechanical properties of the banana-glass fibre hybrid composite is studied.

Experimental details.

Raw materials. Raw materials used for this experimental work are: Glass fiber (E-Glass), Natural fiber (Banana fiber), Epoxy resin(LY556) and Hardener(HY951). Glass fiber was obtained from M/S sakthifibre glass ltd. Banana fiber was obtained from ROPE internationals, Chennai. The fiber has better adhesion properties when it is in dry condition and poor adhesion in wet condition. Epoxy resin (LY556) used in this study was obtained from M/S sakthifibre glass ltd., Chennai.The hardener (HY951) is used in this study as per the required volume fraction with the resin.NaOH is used for surface treatment of banana fibre.

Fabrication of composite. Initially the banana fiber and glass fiber were chopped for a length of 15mm. Then the chopped fibers are thoroughly mixed with glass fiber with required volume proportion(table1).A wooden mold of dimension (300x300x3) mm was used for casting the composite sheet. For different volume fraction of fibers, a calculated amount of epoxy resin and hardener (ratio of 10:1 by weight) was thoroughly mixed with gentle stirring to minimize air entrapment. After keeping the mold on a glass sheet a thin layer of the mixture was poured. Then the required amount of mixed fibers was distributed evenly on the mixture. The remainder of the mixture was then poured into the mold. Care was taken to avoid formation of air bubbles

Chemical treatment. The required amount of banana fibres were then treated with 1% NaOH solution for 1 hour. The fibres are then washed thoroughly with distilled water. The washed fibres are then put in a oven for 24 hours at 70°C to removemoisture, and the composites were fabricated as per the procedure given above.

Fabrication and testing

The composites were prepared using hand layup method. The mould is cleaned and made dry, then release agent is laid up on the mould, Thenepoxy resin with hardner is poured in the mould. The The mixture of banana and glass fiber is placed on the resin present in the mould, another layer of resin is poured above the fibre and uniformly distributed using a roller. Then the mould is closed and a weight is kept above the mould and it is allowed to cure in room temperature for 24hrs. After the composite is fully cured it is separated from the mould and cut into required dimensions as per ASTM standards.Table 1 shows the specimen composition and labels.

Table 1: Composition and Designation of composite specimens

Composite label	Volume Fraction	Fibre Composition
A	20% volume fibre + 80% volume resin	100% Glass fibre(135g) + 0% Banana fibre
B		0% Glass fibre + 100% untreated Banana fibre(71g)
C		0% Glass fibre + 100% NaOH (1%)treated Banana fibre(71g)
D		50% Glass fibre(67.5g) + 50% untreated Banana fibre(35g)
E		50% Glass fibre(67.5g)+ 50% NaOH (1%) treated Banana fibre(35g)

Results and discussion

Tensile test. Tensile test specimens were prepared according to ASTM D - 638standard. The specimens with a gauge length of 250mm were tested on a tensile testing machine (Fig 1)at a cross head speed of 2.5mm/minute. Each specimen was loaded to failure. The force - extension curve was plotted automatically by the equipment software. The ultimate tensile strength and elastic modulus of the samples were there after determined from the graph generated (Fig 2). The test results are taken from the average of 5 samples. The values are tabulated in table 2.

Fig 1: Tensile Test

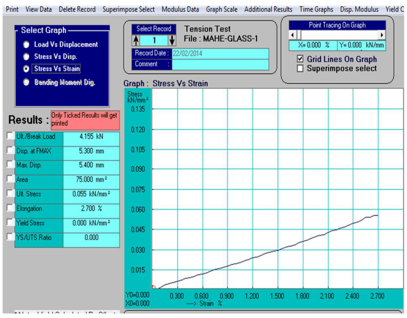

Fig 2: Stress Vs Strain for 100% (135 g) glass fibre

Table 2: Average tensile property of the various samples.

COMPOSITE	A	B	C	D	E
TENSILE STRENGTH (Mpa)	76.45	34.50	46.32	47.32	56.24
TENSILEMODULUS(Mpa)	1583.33	666.66	1000	1214.28	63.63

The above values clearly show that 100% glass fibre gives highest tensile strength. Also the surface treatment of banana fibre is increasing the tensile strength of hybrid fibre composite specimens.

Flexural strength. Flexural test specimens were prepared according to ASTM-D 790standard. The specimens with a gauge length of 100mm were tested on a flexural testing machine(Fig 3) at a cross head speed of 2.5mm/minute. Each specimen was loaded to failure. The force - extension curve (Fig 4) was plotted automatically by the equipment software. The test results are taken from the average of 5 samples.the values are tabulated in table 3.

Fig 3 : Flexural test

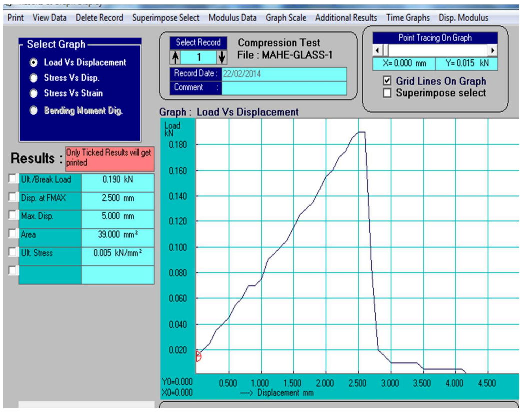

Fig 4: Load vsDisp graph for 100% (135 g) glass fibre

Table 3: Average Flexural strenght of the various samples.

Types of sample	A	B	C	D	E
Flexural Strength(Mpa)	133.20	32.54	43.29	35.54	76.72

The above table shows that the flexural strength is increased by the surface treatment of banana fibre.

Water absorption test. Water absorption test specimens were prepared according to ASTM D570-98. The detailed dimensions can be found in ASTM D570-98. The test results are taken from the average of 5 samples. The percent water absorbed till saturation is given in table 4.

Table 4: Average percent of water absorbed in various samples.

Types of sample	A	B	C	D	E
Percent Water absorbed till saturation	0.31	10.55	6.7	4.26	2.9

The percentage of water absorbed in the specimen is drastically reduced by surface treatment of banana fibre.

It is evident from Fig 5 and Fig 6 that the alkali treated fibre composites exhibit better tensile and flexural properties than untreated fibre composites.

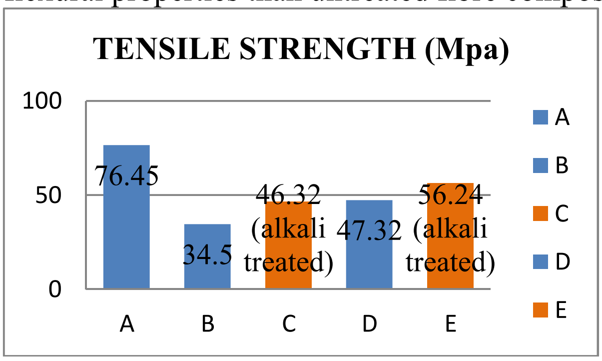

Fig 5.Varation of tensile strength for the samples

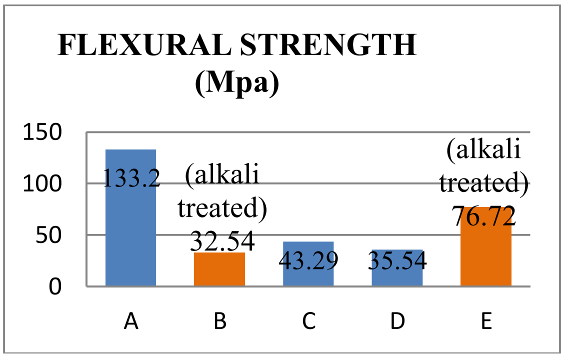

Fig 6.Variation of flexural strength for the samples

Conclusion

The test results showed that the tensile strength for treated banana fibrehybrid composite is 56.24Mpa. This is higher than untreated banana fibre and comparable with that of pure glass fibre composite. Also flexural strength of treated banana fibre hybrid composite is 76.72 Mpa, similarly the water absorption till saturation is reduced by alkali surface treatment of banana fibre. Hence proper alkali treatment of banana fibre will give better mechanical properties.

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