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Review Article

FLEXURAL PROPERTIES OF A KENAF FIBER REINFORCED IN POLYPROPYLENE RESIN

Shanker Banothu, Kranthi kumar Guduru, Ramesh babu. M., Swathi, P. and Vivak Tennyson

Asst. Professor, Mechanical Engineering department CJITS-Warangal

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ABSTRACT

Natural Composites typically have a fiber or particle phase that is stiffer and stronger than the continuous matrix phase and serve as the principal load carrying members. The matrix acts as a load transfer medium between fibers, and in less ideal cases where the loads are complex, the matrix may even have to bear loads transverse to the fiber axis. In this research the kenaf fiber is treated with NaOH solution and the fibers are properly reinforced with polypropylene resin in a matrix form to prepare hybrid composite laminates of 6mm thicknesses thereafter to determine the mechanical properties like flexural strength flexural modulus with suitable specimens. So the matrix also serves to protect the fibers from environmental damage before, during and after composite processing. When designed properly, the new combined material exhibits better strength than would each individual material. Composites are used not only for their structural properties, but also for electrical, thermal, and eco-friendly environmental applications.

INTRODUCTION

The interest in natural fiber-reinforced polymer composite materials is rapidly growing both in terms of their industrial applications and fundamental research. They are renewable, cheap, completely or partially recyclable, and biodegradable. Plants, such as flax, cotton, hemp, jute, sisal, kenaf, pineapple, ramie, bamboo, banana, etc., as well as wood, used from time immemorial as a source of lignocellulosic fibers, are more and more often applied as the reinforcement of composites. Their availability, renewability, low density, and price as well as satisfactory mechanical properties make them an attractive ecological alternative to glass, carbon and man-made fibers used for the manufacturing of composites.

The aim of present work is to prepare the laminas using the Hibiscus Cannabinus, lampas short fiber polyester composites fiber using general purpose unsaturated polypropylene resin by compression moulding process .The fibers without chemical treatment and with chemical treatment with sodium hydroxide (NaOH) are considered in the work. The composites are prepared using NaOH treated & untreated short fibers with polyester matrix at room temperature between two thick iron plates. To evaluate Flexural properties These properties are evaluated as per ASTM standards (Arun *et al*., 2010; Yi Zou *et al*., 2010).

***Corresponding author: Kranthi kumar Guduru,**
Asst. Professor, Mechanical Engineering department CJITS-Warangal.

Properties of natural fibers

Natural fibers have always found wide range of applications from the time they gained commercial recognition. Their versatility is based on the following desirable material properties.

- Plant fibers are a renewable raw material and their availability is more or less unlimited.
- Very good mechanical properties, especially tensile strength.
- Very good heat, acoustic and electrical insulating properties.
- Combustibility: products can be disposed of through burning at the end of their Useful service lives and energy can simultaneously be generated.
- Biodegradability: as a result of their tendency to absorb water, natural fibers will biodegrade under certain circumstances through the actions of fungi and/or bacteria.
- The abrasive nature of natural fiber is much lower compared to that of glass fiber, which leads to advantages in regard to technical, material recycling or processing of composite materials in general.

Advantages

- These are environmentally superior
- Less weight
- Availability from renewable sources
- Excellent price-performance
- Low density

- Can be thermally recycled (posses a good calorific value)
- Good specific properties
- Give less problem concerning health and safety of workers
- Good thermal and acoustic properties

Limitations

- Moisture Adsorption
- Dimension instability
- Swelling leads to micro-cracking
- Fluctuation in quality, price and availability
- Restricted processing temperature

MATERIALS AND METHODS

Kenaf or its scientific name Hibiscus cannabinus composite is a warm season annual fiber crop closely related to cotton and jute. Historically, Kenaf grows almost in all areas in A.P. It is used in many ways in rural areas both in crude form and in sliced form kenaf has been used as a cordage crop to produce twine, rope and sackcloth. Nowadays, there are various new applications for kenaf including paper products, building materials, absorbents and animal feeds (Supranee Sangthong *et al*., 2009; Threepopnatkul *et al*., 2009; Mehdi Jonoobi *et al*., 2009).

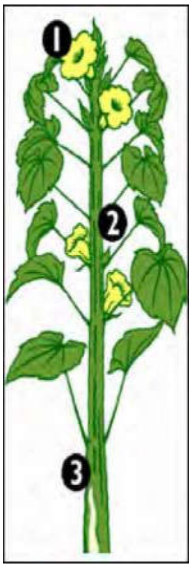


Fig.1 Kenaf plant

Fig.2. Kenaf Bast and Core parts

From the Fig. 1 is shows the light yellow color of kenaf's flower. The stalk of the kenaf plant consists of two distinct fiber types. The outer fiber is called bast and comprises roughly 40% of the stalk's dry weight. The refined bast fibers measure 2.6 mm and are similar to the best softwood fibers used to make paper as shown in the Fig .2 while the whiter, inner fiber is called core and comprises 60% of the stalk's dry weight (Xu *et al*., 2009; Byoung-Ho *et al*., 2009; Mat Taib1 *et al*., 2008).

Fiber treatment

The quality of a fiber reinforced composite depends considerably on the fiber-matrix interface because the interface acts as a binder and transfers stress between the treatments of fibers using chemical agent like sodium hydroxide (NaOH)**.** For treatment process water by volume is taken along with 2% of NaOH. The fibers are soaked in the water for 24 hours as shown in Fig .3 and then the fibers are washed thoroughly with distilled water to remove the final residues of alkali. Good bonding is expected due to improved wetting of fibers with the matrix. In order to develop composites with better mechanical properties and good environmental performance, it is necessary to impart fibers by chemical treatments. The extracted fibres treated , untreated and chopped fibres as shown in Fig.3&4.

Fig .3 Treatment of Fiber in 2% NaOH solution

Fig.4 Showing Treated, Untreated Fibers

Fabrication of Composites

The fiber piles were cut to size from the Kenaf and Glass lampas. The appropriate numbers of fiber plies were taken: two for each. Then the fibers were weighed and accordingly the resin weighed. Because the air bubbles were trapped in matrix may result failure in the material. The subsequent fabrication process consisted of first putting a releasing film on the mould surface. Next a polymer coating was applied on the sheets (Arun *et al*., 2010; Morsyleide *et al*., 2009; Singha, 2009).

Fig. 5. Polypropylene pallets

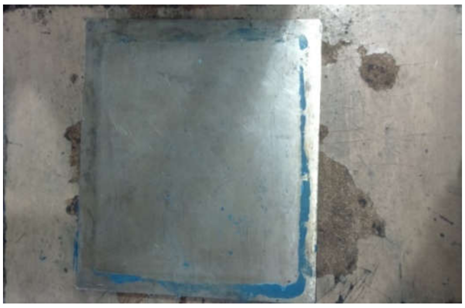


Fig.6. Iron plates

Fig.7. Compression moulding machine setup

Then fiber ply of one kind was put and proper rolling was done. Then resin was again applied, next to it fiber ply of another kind was put and rolled. Rolling was done using cylindrical mild steel rod. This procedure was repeated until eight alternating fibers have been laid. On the top of the last ply a polymer coating is done which serves to ensure a god surface finish. Finally a releasing sheet was put on the top and the iron plates were kept in the moulding at the temperature of 180^0c for half an hour for curing temperature. The composites are prepared compression moulding technique.

Specimen preparation and testing

Specimens for flexural test are cut from laminas as per ASTM D790 standards. The standard dimensions for test specimen are shown in the Fig .8and the actual specimens are shown in Fig .9

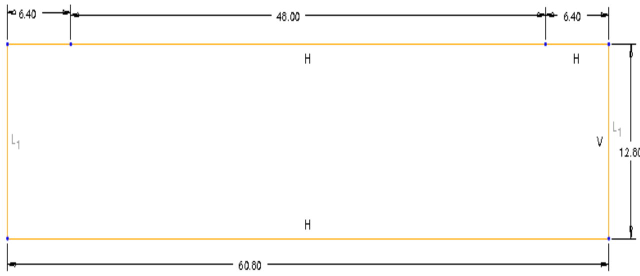


Fig.8. ASTM – D790 Flexural Test Specimen

Fig.9. Flexural Test Specimens

RESULTS AND DISCUSSION

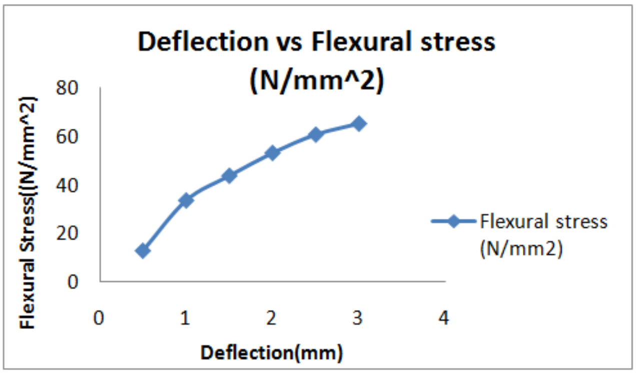
From the tested samples and the observations, the deflection of specimen with minimum load 4N and deflection 0.5mm (Table: 1) by the treated 6mm composite. By these readings minimum flexural stress is $12.82 N/mm^2$ and maximum $65 N/mm^2$ (Table: 2).

Table 1. Flexure Test observations for *fiber 6mm treated* composite

Deflection (mm)	Load(N)		
	Specimen 1	Specimen 2	Specimen 3
0.5	4	4	9
1.0	16.5	12	16
1.5	20	16	22
2.0	24.5	19.5	26.5
2.5	28	23	29.5
3.0	30.5	24	32

Table 2. Mean values of flexure test observations for fiber *6mm treated* composite

Deflection (mm)	Mean Load (1 Div=3.75N)	Flexural stress (N/mm2)
0.5	5.666	12.8265
1	14.8333	33.5793
1.5	19.333	43.7663
2	23.5	53.1988
2.5	26.83	60.7446
3	28.8333	65.2722



Graph 1. Mean values of flexure stress by deflection for fiber *6mm treated* composite

Table 5.3. Flexure Test observations for Kenaf *fiber 6mm untreated* composite

Deflection (mm)	Load(N)		
	Specimen 1	Specimen 2	Specimen 3
0.5	6	6	6
1.0	10	12	10.5
1.5	13.5	17	14
2.0	16	20	17
2.5	18	23	20
3.0	21	25	22.5
3.5	-	26.5	25

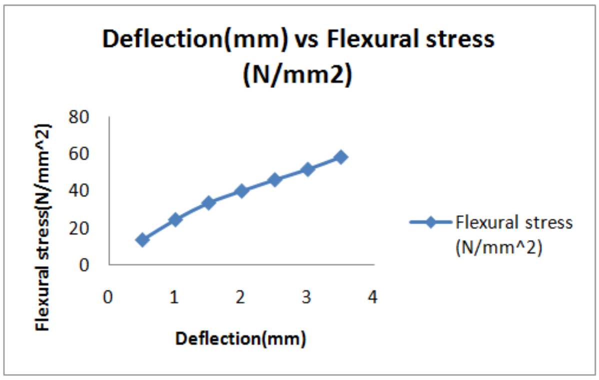
Table 3. Mean values of flexure test observations for Kenaf *6mm-untreated* composite

Deflection (mm)	Mean Load (1 Div=3.75N)	Flexural stress (N/mm^2)
0.5	6	13.5826
1	10.8333	24.5242
1.5	14.8333	33.5793
2	17.6666	39.9932
2.5	20.3333	46.0301
3	22.8333	51.6895
3.5	25.75	58.2923

Table 4. Flexural strength and Flexural Modulus for different composites

Fiber	Length	Flexural Strength (MPa)	Flexural Modulus (MPa)
Alkali treated	6mm	65.52	2901
Un-treated	6mm	51.68	2529

The graph.1 reveals the peaks at higher deflections as 3mm. From the tested samples and the observations, the deflection of specimen with minimum load 6N and deflection 0.5mm (Table: 4) by the treated 6mm composite. By these readings minimum flexural stress is $13.1/mm^2$ and maximum $52N/mm^2$.



Graph 2. Mean values of flexure stress by deflection for fiber *6mm untreated* composite

(Table: 4). the graph.2 reveals the peaks at higher deflections as 3mm.

Conclusion

The kenaf fibers with 6mm thickness was successfully used to fabricate composites with 30% fiber and 70 % resin, these fibers are bio degradable and highly crystalline with well aligned structure. So it has been known that they also have higher flexural strength than other natural and synthetic composites and in turn it would not induce any serious environmental problem like in synthetic fibers. The effect of alkali on the flexural properties also been studied. It is found that the treated hybrid composites have considerable effect on increasing in compare with untreated fibers on mechanical properties. These composites may find applications as structural materials where higher strength and cost considerations are very imperative.

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