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Development and Characterization of Hybrid Natural Fiber Reinforced Composites based on Poly- propylene Resin

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Abstract: Recently natural fibers have been receiving considerable attention as substitutes for synthetic fiber reinforcements in plastics due to their low cost, low density, acceptable specific strength, good thermal insulation properties, reduced tool wear, reduced thermal and respiratory irritation and renewable resources. The development of natural fiber usage in India has now reached an appreciable stage. The present project work is taken up to develop a Natural Fiber Reinforced Composite material to get desired mechanical properties so that it can replace the existing Synthetic Fiber Reinforced Composite material for a suitable application.

Studies on natural fiber reinforcement phases are extremely rare. In this work, Hibiscus Cannabinus(kenaf) fiber are used as the reinforcing material, since they are abundant in nature and have minimal effect on the environment because of their biodegradable properties and the polypropylene resin is used as matrix phase for this work. The composite is prepared by using compression technique. The prepared composites are tested as per ASTM standards for different mechanical properties of composite.

Keywords: Natural Fiber Composite, Reinforcement, Matrix and Poly propylene Resin.

1. Introduction:

1.1 Composite:

A composite is combination of two materials in which one of the materials, called the reinforcing phase, is in the form of fibers, sheets, or particles, and is embedded in the other materials called the matrix phase. The reinforcing material and the matrix material can be metal, ceramic, or polymer. 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, tribological, and environmental applications.

1.2 Classification of Composites:

According to the type of reinforcing material composites can be classified as

1) Fibrous Composites
2) Particulate Composites

According to the type of matrix material composites can be classified as

1) Metal Matrix Composites (MMC)
2) Ceramic Matrix Composites(CMC)
3) Polymer Matrix Composite(PMC)

1.3 Classification of Natural Fibers:

Natural fibers are subdivided based on their origins, whether they are derived from plants, animals, or minerals. Natural fibers can be classification shown in Fig.1.1

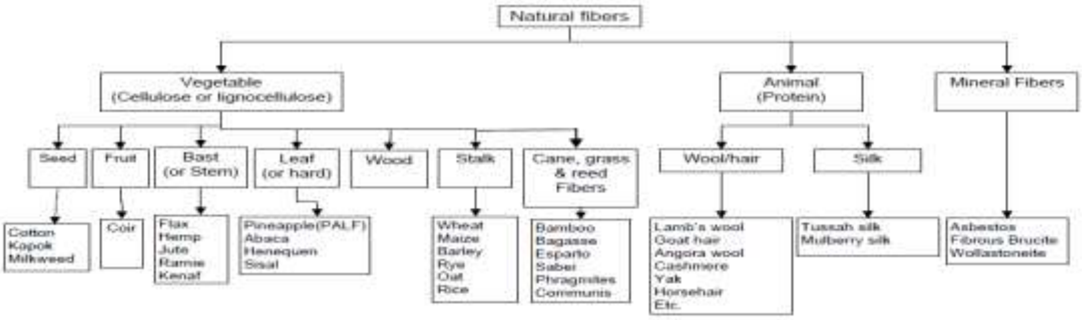

Fig.1.1: Classification of natural fibers.

1.4 Types of Resins:

1) Thermoplastic Resins
2) Thermo set resins
3) Unsaturated polyester resins
4) Epoxy resins
5) Vinyl ester resins
6) Phenolic resins
7) Polypropylene Resins
8) Bio resins

2. IDENTIFICATION AND EXTRACTION OF FIBRE:

Kenaf or its scientific name Hibiscus Cannabinus composite is a warm season annual fiber crop , Kenaf grows almost in all areas of South India. Kenaf has a single, straight and branchless stalk. Kenaf stalk is made up of an inner woody core and an outer fibrous bark surrounding the core. The fiber derived from the outer fibrous bark is also known as bast fiber and it has has superior flexural strength combined with its excellent tensile strength. Stalk of age over 6months- One year are procured from the local market and dried for about two weeks. It is then sliced in to thin pieces and soaked in water for 2 weeks. Then fiber is extracted from the slices manually.

3. Treatment of Fiber:

In order to develop composites with better mechanical properties and good environmental performance, it is necessary to impart fibers by chemical treatments. 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 3.1, and then the fibers are washed thoroughly with distilled water to remove the final residues of alkali.The extracted fibres treated, untreated and chopped fibres are as shown in Figures3.2 & 3.3.

Fig.3.1: Treatment of Fiber in 2% NaOH solution.

Fig.3.2 Showing Treated, Untreated Fibers

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Fig.3.3 showing short fibers

4. Fabrication of Composites:

The fabrication of composites is done by Compression molding Technique.The subsequent fabrication process consisted of first putting a releasing film on the mould surface. Next a polymer coating was applied on the sheets. 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 molding at the temperature of 180^0c for half an hour for curing temperature. The composites are prepared by compression molding technique are shown in Figures.

Fig.4.1: Polypropylene Resin.

Fig.4.2: Iron plates

Fig4.3: compression molding machine setup

Fig 4.4: 15% Kenaf fiber composite

Fig 4.5: 25% Kenaf fiber composite

5. SPECIMEN PREPARATION AND TESTING:

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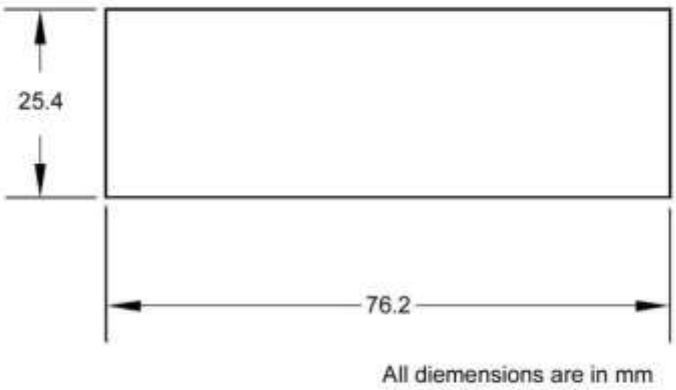
5.1 Flexural Test Specimen:

ASTM – D790 Flexural Test Specimen Details.

5.2 Water Absorption Test Specimen:



ASTM - D570 Water Absorption Test specimen Details.

5.3 Mechanical Tests:

a) Flexural Test: Flexural test was done by compression testing machine supplied by Hydraulic and Engineering Instruments, New Delhi, with a cross head speed of 1.25 mm/minute at standard laboratory atmosphere of 23°C ± 2°C (73.4°F ± 3.6°F) and 50 ± 5 percent relative humidity. There were two important parameters being determined in the flexural test, they are flexural strength and tangent modulus of elasticity in bending.

Flexural Strength: Flexural strength is the ability of the material to withstand bending forces applied perpendicular to its longitudinal axis or it is the maximum stress in the outer specimen at the moment of break.This stress can be evaluated for any point on the load deflection curve using equation [28].

$$\sigma_f = \frac{3PL}{2bd^2} \text{-------------------------------(1)}$$

Where σ_f = Stress in the outer specimen at midpoint, MPa

P = Load at a given point on the load deflection curve, N

L = Support span, mm

b = width of beam tested, mm

d = depth of beam tested, mm

Flexural Modulus: Flexural modulus or Modulus of elasticity is a measure of the stiffness during the initial of the bending process. curve and the value can be calculated using equation

$$E_B = \frac{mL^3}{4bd^3} \text{ ----------------- (2)}$$

Where E_B = modulus of elasticity in bending (MPa)

L = support span (mm)

m = slope of the tangent to the initial straight line portion of the load deflection curve of deflection (N/mm)

b = width of beam tested (mm)

d = depth of beam tested (mm)

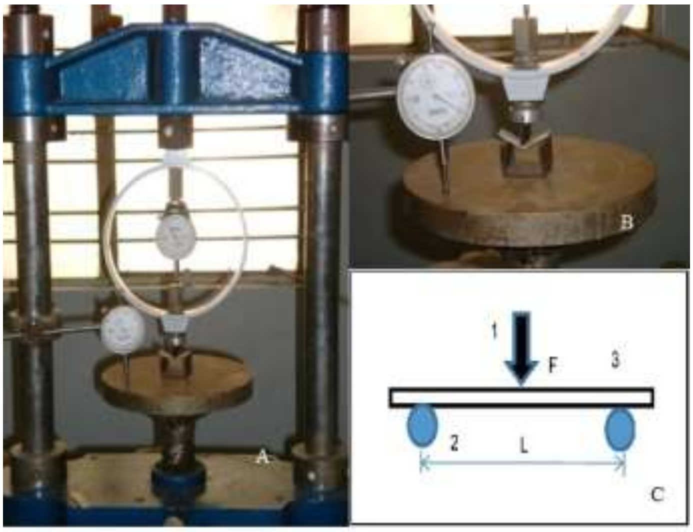


Fig: Flexural Test Setup.

b) Water Absorption Test:

This test method covers the determination of the relative rate of absorption of water by fiber when immersed. The specimens are placed in oven at 50 ± 3oc for 24 hr to evaporate any water particles in specimen and weight (conditioned) of specimen is noted .The conditioned specimens shall be placed in a container of double distilled water maintained at a temperature of 23 ± 1 o C and shall rest on edge and be entirely immersed. After 24 hr the specimens shall be removed from water, all surface water wiped off with a dry cloth, and weighed immediately, and again the specimens are kept in oven for 24 hours for reconditioning, and weight (reconditioned) of specimen is noted

$$\text{Increase in weight (\%)} = \frac{\text{Wet weight} - \text{Conditioned weight}}{\text{Conditioned weight}} X\ 100$$

$$\text{Soluble matter lost (\%)} = \frac{\text{Conditioned weight} - \text{Reconditioned weight}}{\text{Conditioned weight}} X\ 100$$

The percentage of water absorbed, which is the sum of the % increase in weight and soluble matter lost.

6. RESULTS:

6.1 Flexural Testing:

Table: Flexure Test observations for Kenaf fiber 15% Weight ratio composite

Deflection (mm)	Load(N)		
	Specimen 1	Specimen 2	Specimen 3
0.5	6	5	6.5
1.0	10	9	10.5
1.5	13	12	13
2.0	15	14	15
2.5	16.5	15	16.5
3.0	-	16	17

Table: Mean values of flexure test observations for Kenaf fiber 15% Weight ratio composite.

Deflection (mm)	Mean Load (1Div=3.75N)	Flexural stress (N/mm^2)	Standard Deviation

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0.5	5.8333	12.0733	10.1036
1	9.8333	22.2604	17.0318
1.5	12.666	28.6743	21.9393
2	14.6666	33.2019	25.4034
2.5	16	36.2204	28.5744
3	16.5	37.2523	23.3345

Table: Flexure Test observations for fiber 25% Weight.ratio composite

Deflection (mm)	Load(N)		
	Specimen 1	Specimen 2	Specimen 3
0.5	7	6	6
1.0	13.5	12	11
1.5	18	19	15
2.0	21	22	18
2.5	24	25.5	20.5
3.0	-	-	23

Table: Mean values of flexure test observations for 25% Weight.ratio composite.

Deflection (mm)	Mean Load (1 Div=3.75N)	Flexural stress (N/mm^2)	Standard Deviation
0.5	6.3333	14.3371	10.9696
1	12.1666	27.5425	21.0733
1.5	17.3333	39.2387	30.0222
2	20.3333	46.0301	35.2183
2.5	23.166	52.4440	40.5581
3	23	52.0669	-

Table: Flexure Test observations for Kenaf fiber 35% Weight ratio 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: Mean values of flexure test observations for Kenaf 35% Weight ratio composite

Deflection (mm)	Mean Load (1 Div=3.75N)	Flexural stress (N/mm^2)	Standard Deviation
0.5	6	13.5826	10.3923
1	10.8333	24.5242	18.7639
1.5	14.8333	33.5793	25.6942
2	17.6666	39.9932	30.599
2.5	20.3333	46.0301	35.2183
3	22.8333	51.6895	39.5485
3.5	25.75	58.2923	36.4159

Table: Flexure Test observations for fiber 45% Weight ratio 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: Mean values of flexure test observations for fiber 45% Weight ratio composite.

Deflection (mm)	Mean Load (1 Div=3.75N)	Flexural stress (N/mm^2)	Standard Deviation
0.5	5.666	12.8265	9.8155
1	14.8333	33.5793	25.6921
1.5	19.333	43.7663	33.4863
2	23.5	53.1988	40.7031
2.5	26.83	60.7446	46.4767
3	28.8333	65.2722	49.9408

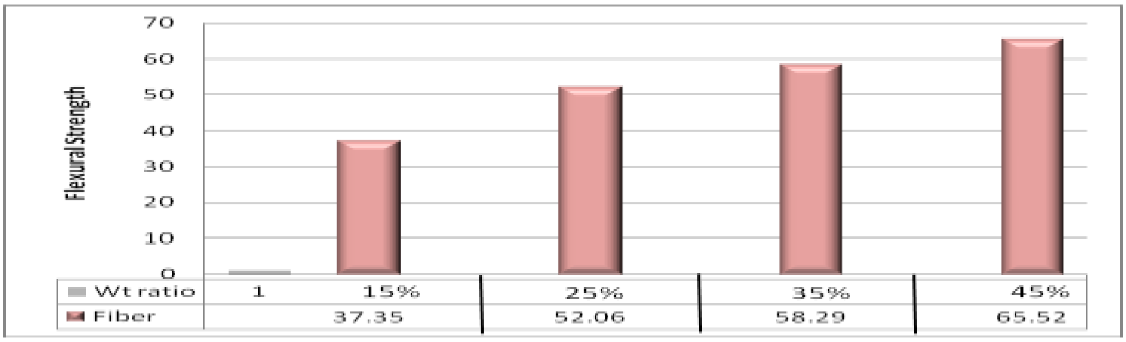

Fig: Flexural Strength for Different composites

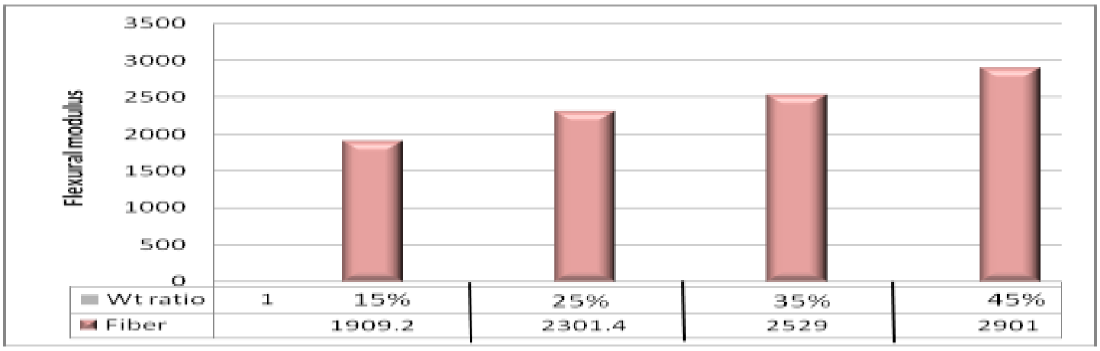

Fig.: Flexural Modulus for Different composites.

6.2 Water Absorption Test:

Table: . The percentage loss of soluble matter

Sl.No	**Typeof composite**	**% increase in wt of specimen**	**% amount of soluble matter lost**	**% of water absorbed**
1	15%	0.93	2.83	0.699
2	25%	0.97	1.25	0.759
3	35%	2.3	1.39	0.768
4	45%	2.688	3.26	2.975

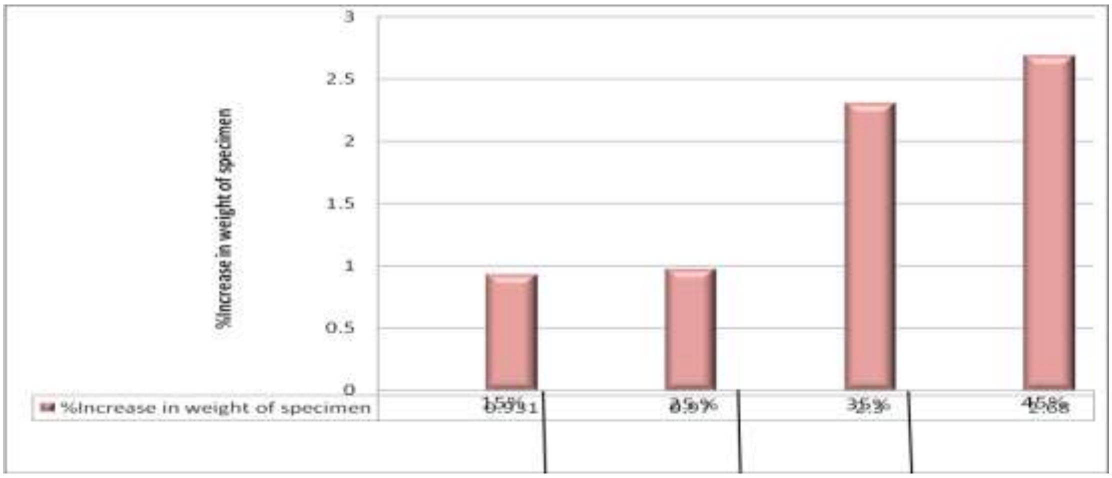

Fig.: % of Moisture Absorption in 24 hr.

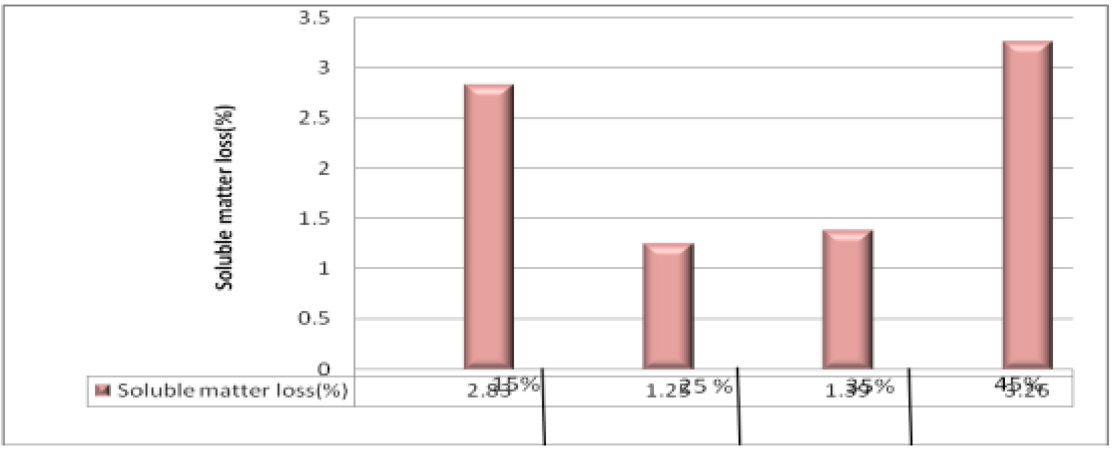

Fig.: % of Soluble Matter Lost.

7. Conclusions:

The kenaf fibers were successfully used to fabricate composites with different composition of fiber to Resin and these fibers are bio degradable and highly crystalline with well aligned structure. So it has been known that they also have higher tensile strength than other synthetic composites and in turn it would not induce any serious environmental problem like in synthetic fibers. The variation of mechanical properties like Flexural strength and Water Absorption of polypropylene based kenaf lampas composites has been studied as function of fiber to resin weight ratio. It is observed that 45% fibers to resin composites are observed optimal flexural strength than of all composites. The effect of alkali on the flexural properties has also been studied. It is found that the treated composites have considerable effect on increasing in above said mechanical properties. These composites may find applications as structural materials where higher strength and cost considerations are important

8. References:

1. K. V. Arun, S. Basavarajappa, B.S. Sherigara, Damage characterization of glass textile fabric polymer hybrid composites in sea water environment. *Materials and Design* 31 (**2010**), pp 930 – 939.
2. Yi Zou, Shah Huda, Yiqi Yang, Lightweight composites from long wheat straw and polypropylene web.
3. Bioresource Technology 101 (**2010**), pp 2026–2033.
4. Supranee Sangthong, Thirawudh Pongprayoon, Nantaya Yanumet, Mechanical property improvement of unsaturated
5. polyester composite reinforced with admicellar-treated sisal fibers. Composites: Part A 40 (**2009**), pp 687–694.
6. P. Threepopnatkul, N. Kaerkitcha, N. Athipongarporn, Effect of surface treatment on performance of
7. pineapple leaf fiber–polycarbonate composites. *Composites: Part B* 40 **(2009**), pp 628–632.
8. Y-Xu, S.Kawata, K.kawai and S.Kuroda Thermomechanical properties of the silanized-kenaf/polystyrene

composites eXPRESS Polymer Letters Vol.**3**, No.10 **(2009)** 657–664

9. Byoung-Ho Lee, Hyun-Joong Kim, and Woong-Ryeol Yu Fabrication of Long and Discontinuous
10. Natural Fiber Reinforced Polypropylene Biocomposites and Their Mechanical Properties Fibers and
11. Polymers **2009**, Vol.**10**, No.1, 83-90
12. Mehdi Jonoobi.; Jalaludin Harun.; Alireza Shakeri.;,Manjusri Misra and Kristiina Oksman.;
13. Chemical,Crystallinity, and Thermal degradation of Bleached and Unnleached Hibiscus cannabinus
14. pulp and Nanofibers, *BioResources*, **2009,** vol 4(2), pp 626-639.
15. Singha A.S.; and Vijay Kumar Thakur; Grewia optiva Fiber Reinforced Novel, Low Cost Polymer
16. Composites, **2009,** vol 6(1), pp 71-76.