

Mechanical characteristics of chicken feather teak wood dust epoxy filled composite

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Abstract. Now a day rapidly growing interest in natural fiber reinforced composites is due to its light weight, low price, wide availability, renewability, low density & satisfactory mechanical properties replacing glass, carbon & manmade fiber composites. In addition to that Chicken feather fiber commonly described waste product possesses hydrophobic properties ,thermal insulation & teak wood dust having excellent wear characteristics, strengthening properties so both can be advantageously used as reinforcing material. So in this paper Composite specimens are prepared referring to ASTM standard by pouring the mixture of epoxy matrix and natural fiber Teak wood dust of particular size and using different percentage of weight and chopped chicken feather into metallic mould. Specimen so developed tested in UTM for Tensile strength to determine which specimen reinforcement having highest tensile strength. From the water absorption test in 24 hours the weight gain is very little and negligible hence composites can perform well in moist atmosphere.

1. Introduction

Combination of dissimilar materials at microscopic level which are not soluble in each other produces material which is better suited for specific application than individual material is called composite. The structured material consists of two or more constituents called reinforcing phase and the other is called matrix phase, which give shape to the composite, protect the reinforcement and transfer load. Composite materials are highly chemical resistant and manufactured at a lower cost as compare to steel and concrete hence an alternative to engineering materials economically. But Growing environmental awareness forced researchers to look for recyclable, biodegradable, low density and low cost green composites also known as natural fiber composites, although mechanical properties of these fibers are low but stiffness is comparable to synthetic fibers. In the literature review mechanical properties of different combination of natural fibers composites are discussed but very limited work is been done on chicken feather and teak wood fiber reinforced epoxy composite. Chicken feather which is commonly described as a waste material contributing to environmental pollution possesses desirable properties like-hydrophobic nature, high thermal insulation and non-abrasive behaviour and lowest density among all natural and synthetic fibers containing 91% protein(keratin) 1% lipid and 8% water. Aim of this paper is to systematically review literature on natural conduct tensile and water absorption test of chicken feather, teak wood dust epoxy filled composite. The research paper structured as follow. Section 2 reviews literature on natural fiber composites. Section 3 set objective of the paper where as section 4 discusses Theoretical analysis, Section 5 highlights Experimental Investigation Section 6 discusses result of the experiment & Section 7 concludes paper.

2. Literature Review

A good amount of research is reported in the area of composite but in this paper we reviewed journal



papers related to natural fiber reinforced composites only due to its light weight, low price, wide availability, renewability, low density & satisfactory mechanical properties. A composite of polyethylene matrix with keratin fiber reinforcement was prepared by Justin and Walter where fiber were of same diameter and varying aspect ratio mixed into the matrix. It was found that the density of the composite is not increased rather reduced by 2% due to keratin feather fiber [1]. Tensile and flexural strength of coconut spathe-fiber reinforced composite specimen were determined using INSTRON material testing system. From the test Sapuan et al concluded that tensile strength of the composite ranged from 7.9 to 11.6 MPa. The higher strength is due to coconut fiber reinforcement [2]. In bio-based jute epoxy composites rate of water absorption and swelling depends on volume fraction of fiber. With 40% fiber Masoodi and Pillai measured epoxy matrix swelling capacity was 19% & for bio-epoxy matrix it was 24% [3]. A study is carried out on the behavior of polymer composites reinforced with short fiber obtained from poultry feather fabricated by hanging-up technique by Anandrao et al [4].

Mechanical and thermal characteristics of polymeric composite reinforced with keratin bio fiber from chicken feather are thoroughly analyzed by Martinez Harnandez et al [5]. Wear behavior of wood based carbon epoxy filled composite was studied by Vefaeneezhad et al using Artificial Neural Network (ANN). Compression tests were performed. Tests revealed that higher temperature not only improved carbon strength and but also wear rate [6]. Work reported on mechanical characteristics of human hair reinforced polypropylene composites. From this Study Chaudhury and Pandey revealed the decrease in tensile and flexural strength was due to increase in fiber percentage. Further concluded that tensile strength could be increased with human hair fiber with different resin [7].

Natural fiber are reinforced in matrix for engineering application by Cheun et al by mixing of natural fiber with biodegradable and bio reasonable polymer for joints and fixtures [8]. Chicken feather fiber/ Poly lactic acid bio composite was prepared by Lam et al. Flight and down feathers were separated from the chicken feather and added to the PLA matrix to fabricate composite [9]. Cement bonded composite using 10% Chicken feather fiber reinforcement was done by Acda. Tests showed that there was significant decrease in elastic modulus, rigidity modulus and dimensional stability when reinforcement of fiber was more than 10% [10].

3. Objective

The objectives of the paper have been set as follows.

- Development of a suitable die for casting ASTM standard
- Preparation of composite of Teak wood dust with (varying size) with weight fraction of 10, 15 and 20% with 5% chicken feather and epoxy.
- Determine tensile strength and water absorption capacity of each composite specimen.

4. Theoretical analysis

Basing upon weight fraction or volume fraction of fibres composites are prepared where as density and other properties are found by rule of mixture..[10]

$$\text{Weight fraction of reinforcement } w_r = W_r \times \left(\frac{1}{W_r + W_m + W_f} \right) \times 100$$

$$\text{Weight fraction of Matrix } w_m = W_m \times \left(\frac{1}{W_r + W_m + W_f} \right) \times 100$$

$$\text{Weight fraction of chicken feather } w_f = W_f \times \left(\frac{1}{W_r + W_m + W_f} \right) \times 100$$

Where, W_r = weight of reinforcement, W_m = weight of matrix, W_f = weight of chicken feather

$$\text{Hence weight of composite } W_c = W_r + W_m + W_f$$

$$\text{Density of the composite } \rho_c = \rho_m v_m + \rho_r v_r + \rho_f v_f \dots (1)$$

$$\text{Further } v_r = V_r \times \left(\frac{1}{V_r + V_m + V_f} \right) \times 100$$

$$v_m = V_m \times \left(\frac{1}{V_r + V_m + V_f} \right) \times 100$$

$$v_f = V_f \times \left(\frac{1}{V_r + V_m + V_f} \right) \times 100$$

Assuming modulus reinforcing efficiency as unity and as per rule of mixture
 Modulus of elasticity of composite $E_c = E_r V_r + E_m V_m + E_c V_c \dots (2)$

Table1. Properties of Teak wood dust.

Properties	Value
Density (g/cc)	0.8
Young's Modulus (GPa)	10.5
Tensile Strength (Mpa)	95

Table2. Properties of Epoxy.

Properties	Value
Density (g/cc)	1.2×10^3
Young's Modulus (Gpa)	20
Tensile Strength (Mpa)	75

Table3. Properties of Chicken.

Properties	Value
Density (g/cc)	0.89
Young's Modulus (GPa)	3
Tensile Strength (MPa)	70

Table4. Properties of composite with 450 micron teak wood dust and 5% chicken feather.

Type of compsite	Density (g/cc)	Modulus of Elasticity (GPa)	Strength (MPa)
SP-A 10%	1.13	17.89	77.19
SP-B 15%	1.11	17.46	78.22
SP-C 20%	1.10	17.08	79.14

5. Experimental Investigation

5.1 Specimen Preparation

Teak wood dusts of particular size 150 micron separated out of the collected sample (from Sharma furniture) by sieve shaker depending upon the mesh size (450 micron) were considered as reinforcing fibre. The chicken feathers (collected from Mayurbhanj District of Odisha) were separated from the stem (quill) using scissor. Different sizes of chicken feather dusts have been prepared by grinding. Epoxy (supplied by Hindustan ceiba Geigy Ltd.) has been used as matrix. Metallic mould was prepared out of Aluminum for casting specimen as per ASTM standard. Dimensions of the standard specimen are represented in table no. 6. Mixture of teak wood dust, chicken feather and epoxy in required proportion poured into die to cast specimen.

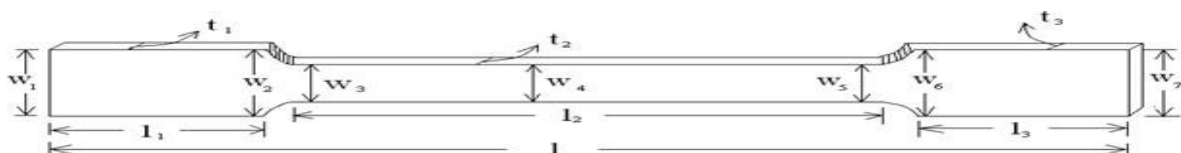


Fig. 1 Standard size of specimen.**Table5.** comparison of the dimensions with respect to standard.

Specimen Nomenclature	l_1	l_2	l_3	l	w_1	w_2	w_3	w_4	w_5	w_6	w_7	t_1	t_2	t_3
Standard	42	100	42	204	25	25	13	13	13	25	25	13	-	13
Cast Specimen	41.5	100	40.5	204	25.5	25.1	13.9	13.1	13.3	25.3	25.2	13.1	13	13.1
Deviation	-0.5	-	-1.5	-	0.5	0.1	0.9	0.1	0.3	0.3	0.2	0.1	-	0.1

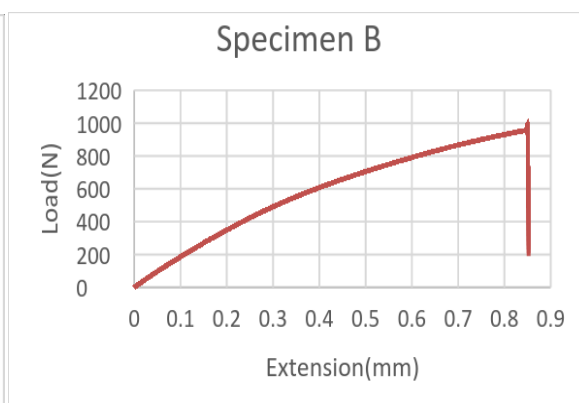
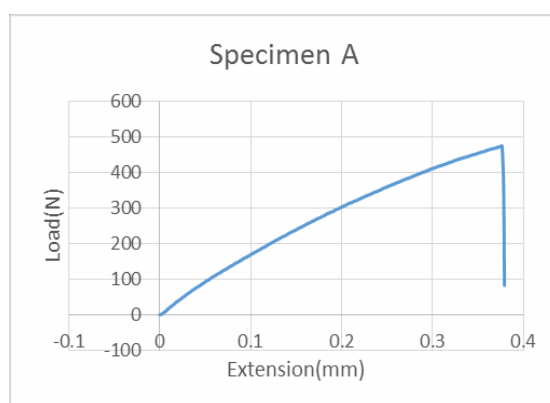
**Fig. 2, 3 and 4** metallic mould for specimen, mould with specimen and ejected specimen

5.2 Tensile Test:

Prepared standard tensile test specimen were tested in universal testing machine (TINIUS OSLEN , Model no- H50KS 50KN) capacity. Result of the tensile test shown in the below table and stress strain curves are plotted for specimen A, B and C. A superimposed curve compared the stress-strain ratio of three specimen.

Tabl6. Tensile stress strain, Area, Length and Max load for specimen A, B and C.

SL No	Specimen	Rate (mm/min)	Width (mm)	Thickness (mm)	Area (mm ²)	Length (m)	Max Load (MPa)	Tensile Stress	Extension at break	Tensile Strain at break (%)
1	A	2	13.8	8.7	120.06	115	474	3.95	0.35	0.33
2	B	2	14.4	7.45	107.28	115	958.17	8.93	0.85	0.74
3	C	2	14.3	8.95	127.98	115	1070.29	8.36	0.88	0.77
	Mean	2	14.17	8.37	118.44	115	834.15	6.44	0.7	0.61

**Fig. 5 and 6** extension vs load diagram For Specimen A and B.

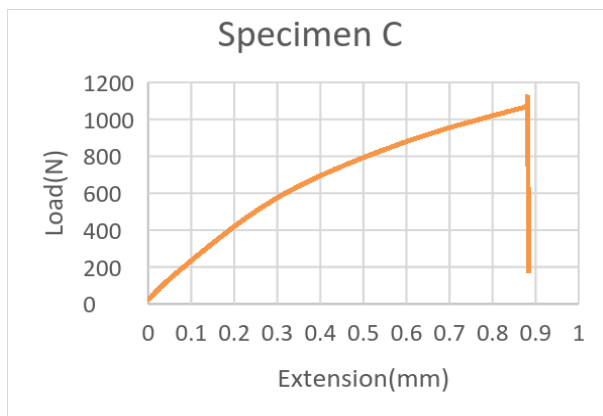


Fig. 7 extension vs load diagram For Specimen C.

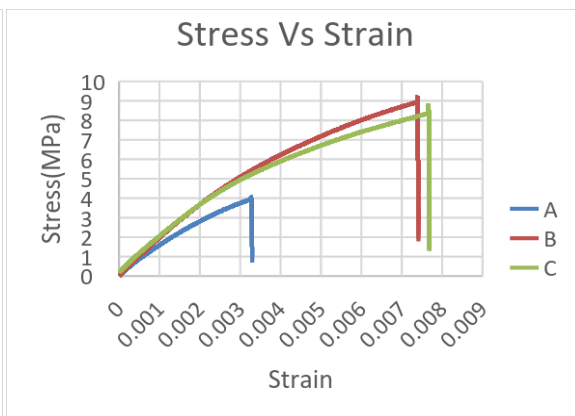


Fig. 8 Stress vs Strain diagram.

5.3 Water Absorption Test:

Specimens of required sizes are immersed in water for 24 hrs to check water absorption capacity. Difference of final weight after soaking and initial dry weight gives water gain.

Table 7. result of the tests shown in the below table

Specimen	Length × Width (mm)	Thickness (mm)	Initial dry weight In gm	Final weight after soaking In gm	Weight gain in gm	Moisture absorption capacity in %
A	39×26	11	11.240	11.280	0.040	0.356
B	39×25	8	8.070	8.130	0.060	0.744
C	39×25	9.5	10.110	10.180	0.070	0.692

6. Result and Discussion

Owing to increase in solid waste and pollution technology based world started developing effective measures to convert trash into useful resources. As per the concern of environmental protection it is always recommendable to use bio-degradable materials. Hence Natural fibre reinforced composites are best effective measures to tackle land pollution. In this paper three composite specimens are prepared referring to ASTM standard by reinforcing natural fibre Teak wood dust of (450 μ m size) in 10, 15 and 20 percentages of weight with 5% of chopped chicken feather in epoxy matrix. The developed specimen tested in UTM to measure tensile strength. Result revealed that tensile strength increased up to 15% teak wood filler composite showed highest strength 8.93 MPa but decreases with 20% dust composites. Stress strain diagram also represent that the ratio is highest for 15% teak wood filler composite. This is due to fact that tensile strength increase with adhesion of fibre and matrix as improved adhesion transfer stress effectively along the interface. Again with increase in fibre loading, fibre-fibre adhesion becomes more than fibre matrix alignment resulted in low strength. The experiment hasn't shown any significant result in terms of mechanical properties but it reduced composite density and improved strength to weight ratio which is more desirable. Moisture absorption test carried out to determine quantity of water absorbed as difference of soaked weight and initial dry weight during 24hr of test under specified condition. Difference of weight represented that due to hydrophobic nature of natural fibres weight gain is very little and negligible. Therefore composite can perform very well in moist atmosphere.

7. Conclusion

Exploitation of Earth's natural resources, Disposal of non degradable products, frequent occurrence of natural disasters call for Environment protection. So interest for Bio degradable, light weight, low priced widely availed natural reinforced composites growing rapidly. In this investigation natural fibre

chicken feather, teak wood dust reinforcement composites are successfully developed using Hand-lay-up technique. Mechanical characteristics and Moisture absorption capacity are determined experimentally. Tensile strength increased with fibre fraction up to 15% then further decreased with fibre loading. Desirable characteristics of higher strength to weight ratio is obtained with low composite density. From moisture absorption test ensure the hydrophobic nature of composite and can be used in moist atmosphere as gain in weight is negligible. Developed composite specimen is a good proposition for application as packing material, Instrument casting, light decorative fitting and other as it has shown highest tensile strength among all the materials considered. Investigation leaves wide scope for future research, research can further be extended towards development of newer composites in different matrix and mechanical characteristics like- wear characteristics flexural strength, impact strength of specimen can also be analyzed.

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