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MECHANICAL PROPERTIES OF PINEAPPLE/SISAL HYBRID COMPOSITE FIBER WITH ADDING FILLER MATERIAL OF COPPER NANOPARTICLES

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Abstract— This paper is presence of carried out tensile strength, flexural strength and impact strength of composites made by Hybrid composite(Pineapple and sisal) being used as reinforcements with adding filler material of copper nanoparticles. The composites are prepared by hand lay-up technique. The fiber weight fraction was changes with respect the mass density and it was fixed upto 0.4 wf. Tensile test, flexural test and impact test are carried out as per ASTM codes. The tensile strength, flexural strength and Impact strength of the composites are evaluated and show the variation of their properties with variation of weight fraction ratio with the addition of copper nanoparticles.

Keywords— Pineapple and sisal fiber, copper nanoparticles, Tensile, flexural and impact test on rein forced rectangular bars

I. INTRODUCTION

Natural Reinforce Composite Fiber (FRP) materials form inexpensive and possible solution to the conventional materials. FRP materials with carbon, glass and aramid fibers have the advantages of high stiffness and strength as compare to other conventional glass fiber composite materials. Natural fiber composite are renewable and eco- friendly, exhibiting moderate strength and other mechanical properties and light in weight when compare with glass fiber composites Natural fiber reinforced composites have low density combined with good mechanical properties likely used of natural fibers are pineapple, sisal, kenaf, hemp, and banana [1-2].Hybrid means combination of more than one reinforcing phase and a single matrix or reinforcing phase .Hybrid composites have a good mechanical and thermal properties as compared to natural single composite reinforced fiber [3-6].Pineapple/sisal hybrid composite fiber reinforced showed mechanical properties of tensile, flexural and impact properties with increase in fiber content upto 40% and adding 1% copper nanoparticles as filler material for the purpose of improve the mechanical and other properties[7].If increasing the toughness, strength and density of FRP composite to adding small percentage of other mechanical materials like silicon, silicon dioxide and oil palm ash [8-13]. This paper is basically observing the mechanical properties of hybrid composite natural fibers of pineapple /sisal with adding filler material of copper nanoparticles.

II. MATERIALS AND FABRICATION

A. MATERIALS

In this present work the hybrid composite reinforced material is prepared by using the pineapple, sisal fibers with adding the copper nano particles in Wt. %.The sisal and pineapple fibers were purchased from the local market.Isenthalpic polyester resin and the catalyst Methyl Ethyl Ketone Peroxide (MEKP) are obtained from M/s. Siva resin store,Kakinada, India. The accelerator used for the investigation is Cobalt Nathanael and is added as 1% with the resin and the catalyst. The copper nano particles are prepared by copper powder.

i. Preparation of Pineapple fiber:

Pineapple fibers are extracted from the leaves of the plant Animus cosmos belonging to the Bromeliaceous family. The fiber is extracted by hand scraping after beating the leaves to break up the pulpy tissue or after a retting process (separation of fabric bundles from the cortex). That partially ferments and softens the leaves. Pineapple Leaf Fiber (PALF) serving as reinforcement fiber in most of the plastic matrix has shown its significant role as it is cheap, exhibiting superior properties when compared to other natural fiber as well as encouraging agriculture based economy. PALF is multi-cellular and lignocelluloses materials. The PALF is a multi cellular fiber like other vegetable fibers.

ii. Preparation of Sisal fiber

Sisal Fiber is one of the most widely used natural fiber and is very easily cultivated. It is obtain from sisal plant. The plant , known formally as Agave sisalana. These plants produce rosettes of sword-shaped leaves which start out toothed, and gradually lose their teeth with maturity. Each leaf contains a number of long, straight fibers which can be removed in a process known as decortications. During decortications, the leaves are beaten to remove the pulp and plant material, leaving the tough fibers behind. The fibers can be spun into thread for twine and textile production, or pulped to make paper products. Sisal fiber is fully biodegradable, green composites were fabricated with soy protein resin modified with gelatin. Sisal fiber, modified soy protein resins, and composites were characterized for their mechanical and thermal properties. It is highly renewable resource of energy. Sisal fiber is exceptionally durable and a low maintenance with minimal wear and tear.

iii. Copper nano particles preparation

Copper nano particles are prepared by using chemical method. Two solutions are prepared by mixing Cu (NO3)2 in (0.5m) ethanol and (0.4m) NaOH in ethanol. These two solutions are stirred for about 50-60 minutes under magnetic stirrer. After stirring processes, the two solutions are mixed and transferred to separate test tubes. These test tubes are placed in the centrifuge machine and centrifuged for about 20minutes. After centrifuging processes, the clear solution left is poured off leaving gel of copper nano particles.

B. CHEMICAL TREATMENT OF PINEAPPLE AND SISAL FIBERS

The natural fibers are available at local market in the form of raw. The fibers are soaked in water for 24 hours after that take the fibers from water tub and dried in sunlight for the purpose of remove the water contents. After drying, the fibers are cleaned from dust by vigorous rubbing and combing. To increase the surface roughness and to improve the adhesion properties, the fibers are treated with NaOH solution and acetic acid solution. The fibers are soaked in 5% NaOH solution for 3 hours and washed with distilled water. The obtained fibers are then soaked for 20 minutes in acetic acid solution, washed in distilled water and dried in sunlight.

C. FABRICATION OF COMPOSITE

The composites are prepared by land layup technique method. In this method the working surfaces are treated with polyvinyl alcohol(PVA) for the reason of easy removal of moulds. Four different specimens, shown in Table- 1are prepared to determine the mechanical properties of hybrid pineapple/sisal composite and copper Nano particles with fibers in polyester resin. All the specimens are fabricated by the process of hand layup method. Specimen 1 is fabricated by laying the fibers are arranged parallel in the mould as per Wt% and pouring the resin mixed with copper nano particles.

Calculation For To Find the Mass of the Fiber for Tensile test Specimen

Epoxy resin, Hardener, Pineapple, Sisal with adding of copper nanoparticles (For preparing the Hybrid polymer composite materials)

Volume of the die	=	170x 50.8 x 4 mm
	=	34544mm3
	=	34.5cm3,

Density of the Fibers/Epoxy in g/cm3 (Density= Mass/Volume (or) Volume=Mass/Density)

1. Sisal = 1.33 g/cm^3
2. Pineapple = 1.46 g/cm^3
3. Copper nanoparticles = 8.94g/cm^3
4. Epoxy Resin = 1.2 g/cm^3

$$V_c = V_{Epoxy} + V_{Sisal} + V_{Pineapple} + V_{Copper\ nanoparticles} \text{ ..... (1)}$$

$$m_c/\rho_c = m_{Epoxy}/\rho_{Epoxy} + m_{Sisal}/\rho_{Sisal} + m_{pineapple}/\rho_{pineapple} + m_{copper\ nanoparticles}/\rho_{copper\ nanoparticles}$$

$$1/\rho_c = 1/\rho_{Epoxy}\,(m_{Epoxy}/m_c) + 1/\rho_{Sisal}\,(m_{Sisal}/m_c) + 1/\rho_{pineapple}\,(m_{pineapple}/m_c) + 1/\rho_{copper\ nanoparticles}\,(m_{copper\ nanoparticles}/m_c) \text{ ..... (2)}$$

$1/\rho_c$ = (0.88/1) (1/1.2) + (1/1.33) (0.04/1) + (1/1.46) (0.04/1) + (1/8.94) (0.01/1)

$1/\rho_c$ = 0.75 + 0.03+ 0.027+0.001 = 0.81 cm^3/g

ρ_c = 1.22 g/cm^3

(For 8% Hybrid polymer Composite and 1% copper nanoparticles material)

Similarly we calculated for 24% and 36% Hybrid Natural Fiber polymer with adding of 1% copper nanoparticles

Composite material m_c = ρ_c x V_c..... (3)

m_c = 1.22 X 34.5

= 42.09gms

The above calculation is repeated for the remaining three specimens increasing the % of natural fibers.

Table- 1. Designation of Specimens.

S.No	% of Natural fibers used	Density of composite (g/cm3)	Mass of composite (gms)	Mass of fiber (Hybrid fiber) (gms)
1	9% (4+4+1) and remaining % of Epoxy resin& hardener	1.22	42.09	Pineapple& sisal 4%=42.09 X 4% =1.68
2	17% (8+8+1) and remaining % of Epoxy resin& hardener	1.24	42.78	Pineapple& sisal 8%=42.78 X 8% =3.4
3	25% (12+12+1) and remaining % of Epoxy resin& hardener	1.25	43.125	Pineapple& sisal 12%=43.125 X 12% =5.17
4	34% (16+16+1) and remaining % of Epoxy resin& hardener	1.28	44.16	Pineapple& sisal 16%=44.16 X 16% =7

Similarly, the calculation is done for Flexural and Impact Test Specimen as per ASTM standards

Calculation for To Find the Mass of the Fiber for Flexural Specimen

Epoxy resin, Hardener, Pineapple, Sisal with adding of copper nanoparticles (For preparing the Hybrid polymer composite materials)

Volume of the die = 100x 76.2 x 4 mm

= 30480mm^3

= 30.5cm^3,

Calculation for To Find the Mass of the Fiber for Impact strength Specimen

Epoxy resin, Hardener, Pineapple, Sisal with adding of copper nanoparticles (For preparing the Hybrid polymer composite materials)

Volume of the die = 68x 76.2 x 4 mm

= $20726mm^3$

= $20.7cm^3$,

Fig. i : Fibers placed in parallel alignment

III.PREPARATION OF SPECIMEN FOR TESTING

The characterization of the composites reveals that the % weight of fibers is having significant effect on the mechanical properties of composites. All the specimens are prepared as per the American Standard Testing Methods (ASTM), shown in Table-2 for performed three tests, namely Tensile Test (ASTM D638), Flexural Test (ASTM D256) and Impact Test (ASTM D790) respectively.

Table-2 Testing Standards

S.No	Test Name	ASTM Standard	Dimensions
1	Tensile test	D638-03	168X12.5X4
2	Flexural test	D256	100 X12.7X4
3	Impact test	D790	65X12.7X4

IV RESULTS AND DISCUSSIONS

Number of samples is made and sized using laser bean cutting as per ASTM D638-03, D256 and D790 standards.

A. TENSILE TEST

Table -3 The tensile properties of different composites samples

Sample no.	Description	% Weight fraction	Ultimate Tensile load	Ultimate Tensile Strength (MPa)
1	Epoxy+ pineapple+ sisal+ copper nanoparticles	4+4+1	480	9.425
2	Epoxy+ pineapple+ sisal+ copper nanoparticles	8+8+1	548	12.117
3	Epoxy+ pineapple+ sisal+ copper nanoparticles	12+12+1	568	12.374
4	Epoxy+ pineapple+ sisal+ copper nanoparticles	16+16+1	600	12.855

The displacement with respect to the four different combinations of composite specimens are shown in Fig 3.The hybrid composites of pineapple/sisal with adding filler material of copper nano particles in the ratios (12/12) and (16/16) values are higher as compared to the other weight fraction %composites. It has been determined the tensile strength is low as compared to increasing the fiber ratio to the hybrid composite.

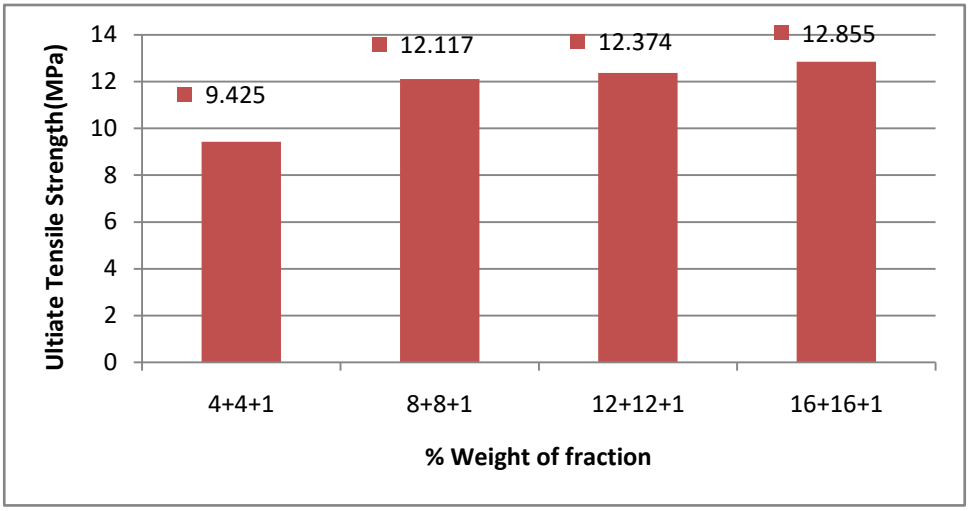

Chart : 1 Tensile Strength Vs % Weight fraction

Fig-ii: (a) Tensile specimen before testing (b) Tensile Specimens after testing

B. FLEXURAL TEST

Table – 4 The Flexural properties of different composites samples

Sample no.	Description	%Weight fraction	Flexural strength (Mpa)	Break Load (N)
1	Epoxy+ pineapple+ sisal+ copper nanoparticles	4+4+1	54.77	120
2	Epoxy+ pineapple+ sisal+ copper nanoparticles	8+8+1	68.37	180
3	Epoxy+ pineapple+ sisal+ copper nanoparticles	12+12+1	74.21	180
4	Epoxy+ pineapple+ sisal+ copper nanoparticles	16+16+1	91.12	120

The flexural test conducted on four different specimens as per the weight fraction ratio, shown in Table-4. In this test observed the flexural strength with applied break load. The hybrid composite reinforced fiber pineapple/sisal and cooper nano particles (12/12) and (16/16) are the flexural strength is more than the other weight fraction composites.

Fig-iii: (a) Specimens before testing (b) specimens after testing

C. IMPACT TEST

Table – 4.3 The Impact properties of different composites samples

Sample no.	Description	%Weight fraction	Impact energy(J)
1	Epoxy+ pineapple+ sisal+ copper nanoparticles	4+4+1	2
2	Epoxy+ pineapple+ sisal+ copper nanoparticles	8+8+1	2
3	Epoxy+ pineapple+ sisal+ copper nanoparticles	12+12+1	4
4	Epoxy+ pineapple+ sisal+ copper nanoparticles	16+16+1	4

The four different hybrid composite specimens are prepared for the test of impact, as per the % weight fraction shown in Table-5. During the test process, the specimen must be loaded in the sting machine and allows the pendulum until it fracture or breaks. It can be seen that impact strength of pineapple/sisal and copper nano particles 4/4/1,8/8/1,12/12/1 and 16/16/1 hybrid composite values are found to be 2,2,4 and 4respectively.

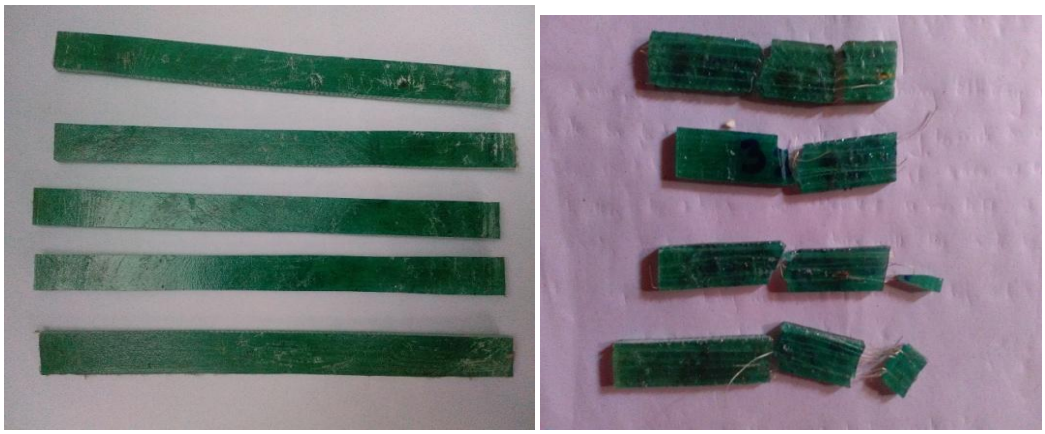

Fig –iv: (a)Specimens before testing (b) Specimens after testing

V. CONCLUSION

After observing the material properties of natural fiber reinforced epoxy hybrid composite with adding copper nano particles with four different weight fractions of the materials. The following conclusions are drawn from the present work:

- It can be observed that pineapple/sisal (16/16) and copper nano particles (1) weight fraction hybrid composite samples possess good tensile strength and can with stand the strength up to 12.85 Mpa.
- The Flexural strength of pineapple/Sisal with adding copper nano particles in weight fraction (16/16/1)the maximum strength 91.12Mpa.
- The pineapple/sisal with copper nano particles (12/12/1) composite fiber having maximum Impact energy 4J.
- From the above experimental analysis shows that the hybrid fiber reinforced epoxy composite will have better mechanical properties by increasing the percentage of copper nano particles.

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