ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 3, January 2018

DEVELOPMENT AND MECHANICAL CHARACTERIZATION OF CHOPPED SIDA ACUTA FIBRE REINFORCED EPOXY COMPOSITE

CHANDRA MOHAN H. K[A], SHIVA KUMAR G. P[B], GNANENDRA REDDY G. V[C], CHOWDE GOWDA M[D]

a. Asst. Prof., Department of Mechanical Engineering, SJCIT, P.B. No. 20, B.B. Road, Chickballapur-562 101, Karnataka, India, Email ID: Chandramohan.hkc11@yahoo.com
b. Asst. Prof., Department of Mechanical Engineering, VCET, Hyderabad – 501 510 Karnataka, India, Email ID: shivakumargp99@gmail.com
c. Prof. & Head of the Department of Mechanical Engineering, SJCIT, Chickballapur, Karnataka, India, Email ID: gvgrmed@gmail.com
d. Prof. & Head (R&D), Department of Mechanical Engineering, SJCIT, Chickballapur, Karnataka, India, Email ID: chowdegowda86@gmail.com

ABSTRACT

The present study focuses on the utilization of chopped sida acuta fibres as reinforcing material in the fibre reinforced polymer (FRP) composites. In the present investigation, water retted sida acuta chopped fibres were used as reinforcement material in the polymer composites with epoxy as matrix material. The chopped sida acuta fibre composites were fabricated for different fibre loadings (10 wt.%, 15 wt.% and 20 wt.%) utilizing hand lay-up technique. The test samples of chopped sida acuta fibre composites were prepared according to ASTM standards to investigate their mechanical properties like; tensile strength, tensile modulus, compression strength, flexural strength, impact strength and hardness of chopped sida acuta fibre composites were examined according to ASTM D standards. The obtained mechanical properties of chopped sida acuta fibre composites show the strength of the composite increases with increase in fibre loading from 10 wt.% to 20 wt.%. Also the study reveals that the chopped sida acuta fibre reinforced epoxy composites are suitable for medium strength structural applications.

Key words – Chopped sida acuta fibre; Mechanical properties; Fibre loading

I. INTRODUCTION

Natural fibre composites are utilized for structural purposes do exist, but then usually with synthetic thermo set matrices which of course limit the environmental benefits. The natural fibre composites can be very cost effective material for following applications: Building and construction industry: partition boards, panels for partition and false ceiling, floor, wall, window and door frames, pre-fabricated buildings, roof tiles which can be used in times of natural calamities such as floods, cyclones, earthquakes, etc.

There are several studies available on the mechanical properties and effect of fibre loading of natural fibre reinforced polymer composites with the combination of jute fibre/epoxy resin and jute fibre/polyester resin [1 & 2], Jute - Glass Fiber Reinforced Polyester composites with different fiber composition is possible by simple hand lay-up technique. It has been noticed that the mechanical properties of the composites such as tensile strength, flexural strength, impact strength of the composites are also greatly influenced by the fibre composition. In Tensile Test, 50% GFRP - 50% Jute composition yielded the highest tensile strength of 84.59 MPa. In Flexural Test, 60% GFRP - 40% Jute composition yielded the highest flexural strength of 113.93 MPa. In Impact Test, 50% GFRP - 50% Jute composition yielded the highest impact energy of 7.12 Joules [3].

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 3, January 2018

The plant Sida acuta belongs to Malvaceae family, available abundantly in forest edges and waste lands in India. Plant sida acuta is locally also called as Bheemana kaddi gida [5] and the sida acuta fibres are generally utilized for making ropes and the sida acuta stems are utilized for making brooms and baskets.

Literature survey reveals no single researcher has characterized the mechanical behaviour like; tensile, compression, flexural, impact strength and hardness of chopped sida acuta fibre reinforced epoxy composite at different fibre loadings (10, 15 and 20 wt.%). [4] proposed a principle in which another NN yield input control law was created for an under incited quad rotor UAV which uses the regular limitations of the under incited framework to create virtual control contributions to ensure the UAV tracks a craved direction. Utilizing the versatile back venturing method, every one of the six DOF are effectively followed utilizing just four control inputs while within the sight of un demonstrated flow and limited unsettling influences. Elements and speed vectors were thought to be inaccessible, along these lines a NN eyewitness was intended to recoup the limitless states. At that point, a novel NN virtual control structure which permitted the craved translational speeds to be controlled utilizing the pitch and the move of the UAV. At long last, a NN was used in the figuring of the real control inputs for the UAV dynamic framework. Utilizing Lyapunov systems, it was demonstrated that the estimation blunders of each NN, the spectator, Virtual controller, and the position, introduction, and speed following mistakes were all SGUUB while unwinding the partition Principle.

II. EXPERIMENTAL DETAILS

A. Fabrication of chopped sida acuta fibre composite at different fibre loadings

In the present investigation the fibers extracted from the stems of sida acuta plants were trimmed into short fibres (3 cm to 6 cm length approx.), with the help of scissor and utilized as reinforcement material. The chopped fibre composite panels with different fibre loadings (10, 15 and 20 wt.%) were estimated to prepare with the dimensions 300 x 300 x 4.5 mm using hand layup technique. So that mould consisting the same dimension was fabricated with metal bars. The mould fixed on the smooth flat surface with clay. The releasing agent wax pol is applied on the smooth and flat, surface inside of the mould then mixture of Epoxy and the hardner is applied with the help of roller to make a thin layer inside the casted frame. The weighed chopped fibres distributed uniformly as much as possible inside the frame, then again the epoxy mixture is applied on the chopped fibres. The same process repeated until we place all the weighed chopped fibers into the frame. After that Teflon cloth is placed on the top of the frame. Then it is closed with the smooth surfaced flat stone. Then about 20 kg-f weight was applied on the composite. It was left for 24 hrs to allow sufficient time for curing and proper hardening. The test specimens were prepared according to ASTM D standards.

B. Mechanical characterization

In the present study, tensile test of the chopped sida acuta fibre composites has been done as per ASTM D 3039 test standards and Compression test as per ASTM D 3410. Three point bend test was carried out to obtain the flexural strength as per ASTM D 790 test standard at the same cross head speed of 1.3 mm/min.

The flexural strength (σ) of the chopped sida acuta fibre composites has been determined using the formula $\sigma = [3FL / 2bd^2]$ MPa. Where F and L are the load in N and span length in mm respectively.

Impact strength of the chopped sida acuta fibre composites was conducted using impact (charpy) tester (model-AI-IT-30, SR NO-091103 of pendulum type) as per ASTM D 256 test standards and Rockwell hardness of the chopped sida acuta fibre composites was measured using Rockwell hardness tester.

In the present investigation, **three identical samples** were taken from each fibre loading (10 wt.%, 15 wt.% and 20 wt.%) composite for individual mechanical testing. All the mechanical tests were conduct at room temperature using computerised Kalpak's Universal testing machine (UTM) having a maximum load cell of 100 kN. The test results are averaged and presented in Table 1.

III. RESULT AND DISCUSSION

A. Mechanical Properties

Figure 1 show the tensile strength and tensile modulus of chopped sida acuta fibre reinforced epoxy composite at different fibre loadings. In the present study, obtained test result show that the tensile strength and modulus of chopped sida acuta fibre composite is increased with increase in fibre loading up to 20 wt.%. Maximum values of tensile strength (10.9 MPa) and tensile modulus (1.29 GPa) of chopped sida acuta fibre

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 3, January 2018

composite is obtained at the same fibre content of 20 wt.%. In general, increase in strength of the FRP composite due to enhancing interfacial bonding between fibre and matrix material in the composite.

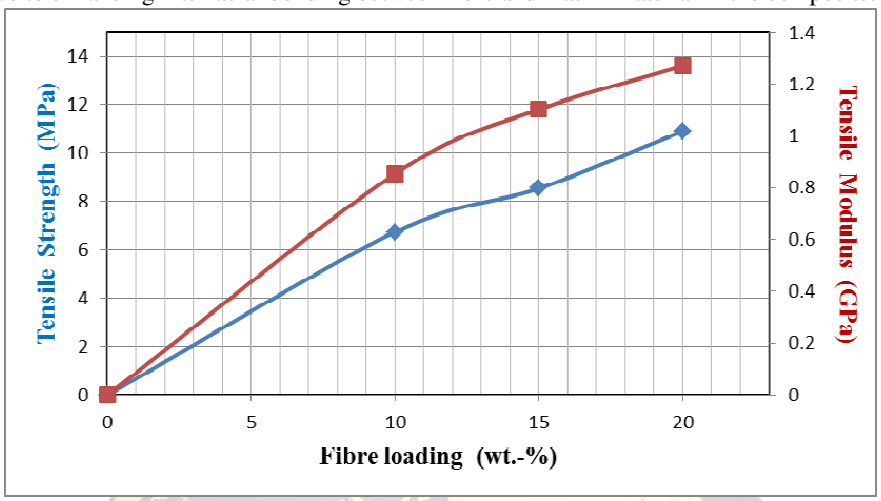

Figure 1. Tensile strength and tensile modulus of chopped sida acuta fibre composite at different fibre loadings

Figure 2 show the compression strength of chopped sida acuta fibre reinforced epoxy composite at different fibre loadings. In the present study, obtained test result show that the compression strength of chopped sida acuta fibre composite is increased with increase in fibre loading up to 20 wt.%. Maximum value of compression strength (64.34 MPa) of chopped sida acuta fibre composite is obtained at the fibre content of 20 wt.%. The compression strength and modulus in the natural fibre laminates are depends on the strength of the matrix material and its reinforcement respectively. In general, failure of composite specimens under compressive load due to a shear – compression type of failure load [6].

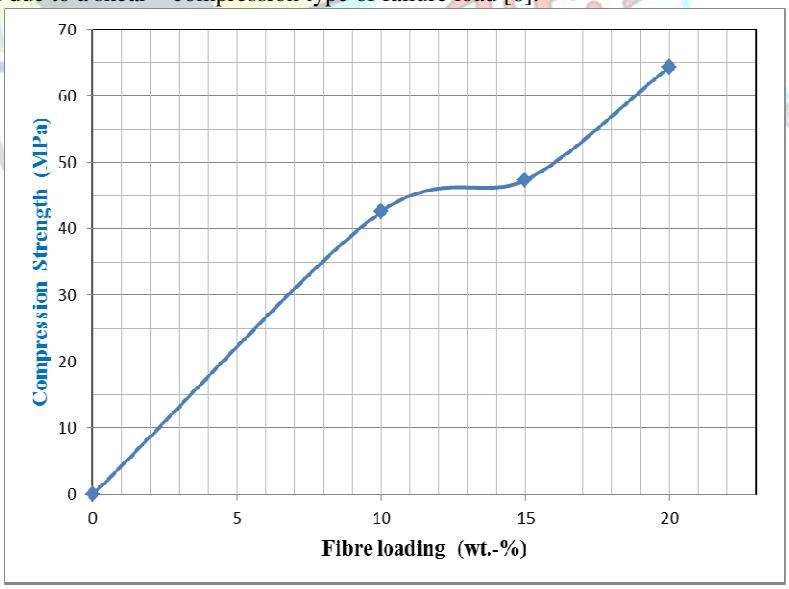

Figure 2. Compression strength of chopped sida acuta fibre composite at different fibre loadings

Figure 3 show the flexural strength of chopped sida acuta fibre reinforced epoxy composite at different fibre loadings. In the present study, the composite which having 20 wt.% of fibre loading posses higher flexural strength (28.28 MPa), as compared to 10 and 15 wt.% of fibre loaded composite. The increase in flexural

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 3, January 2018

strength of the FRP composite with increase in fibre loading mainly due to greater interfacial bonding between fibre and matrix material [7] .

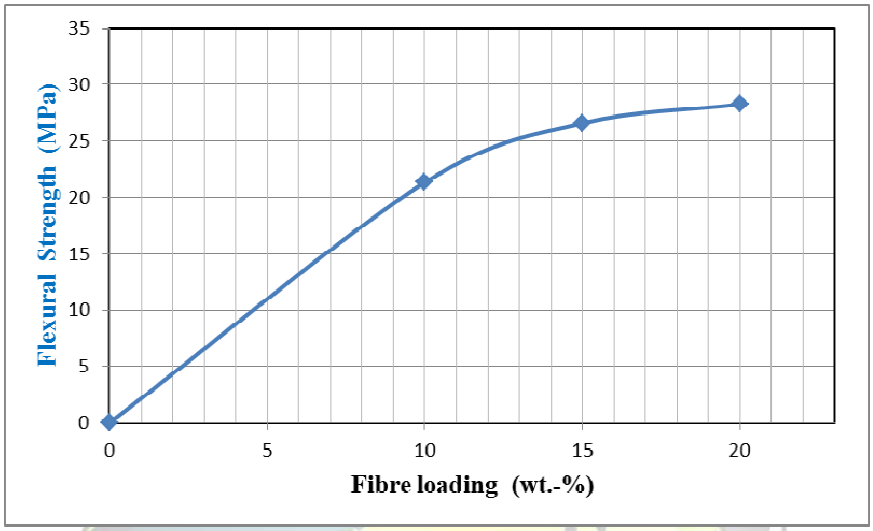

Figure 3. Flexural strength of chopped sida acuta fibre composite at different fibre loadings

Figure 4 show the energy absorbed by chopped sida acuta fibre composite at different fibre loadings due to impact load. It has been noted that the impact strength of chopped sida acuta fibre composite is increased instantly with increase in fibre loading up to 20 wt.%. In the present investigation, maximum average impact strength of chopped sida acuta fibre reinforced epoxy composite is of 2.125 J obtained at the fibre content of 20 wt.% (Table 1).

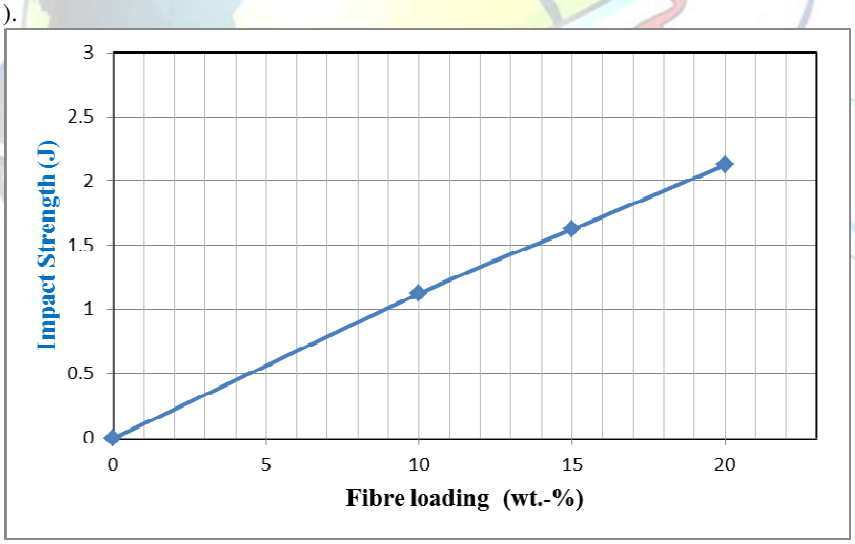

Figure 4. Impact strength of chopped sida acuta fibre composite at different fibre loadings

Figure 5 show the Rockwell hardness of chopped sida acuta fibre reinforced epoxy composite at different fibre loadings. In the present investigation, three identical composite samples were taken from each fibre composition for testing and the results are averaged (Table 1). Maximum average hardness value of chopped sida acuta fibre composite is 80.83 obtained at the fibre content of 20 wt.%. In general, hardness of the natural FRP composite mainly depends on the fibre loading and modulus of the reinforcement [8].

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 3, January 2018

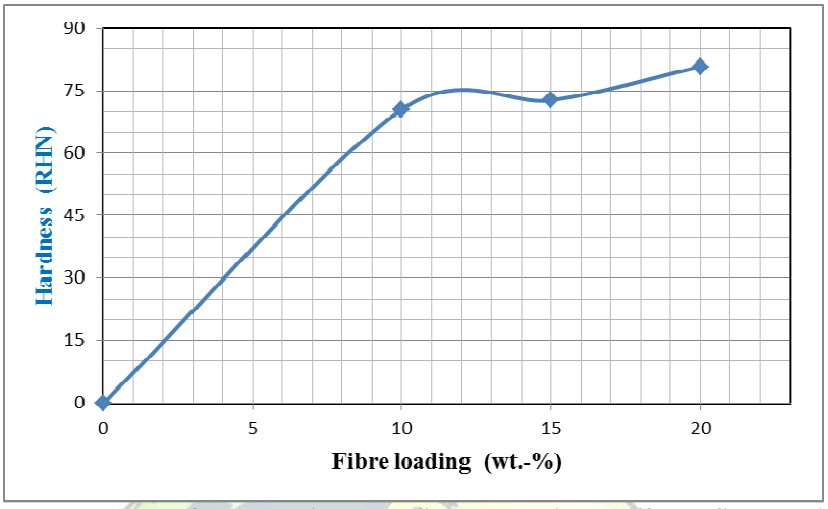

Figure 5. Hardness of chopped sida acuta fibre composite at different fibre loadings

Table 1: Mechanical properties of chopped sida acuta fibre reinforced epoxy composite at different fibre loadings

Sl. No.	Test conducted	Wt.% of Chooped sida acuta fibre	Properties	Experimental value
1	Tensile Strength	10 %	Stress (MPa)	6.730
			% of Elongation	0.784
			Young's modulus (GPa)	0.854
		15 %	Stress (MPa)	8.536
			% of Elongation	0.780
			Young's modulus (GPa)	1.102
		20 %	Stress (MPa)	10.890
			% of Elongation	0.851
			Young's modulus (GPa)	1.270
2	Compression Strength	10 %	Stress (MPa)	42.560
			% of Elongation	5.704
		15 %	Stress (MPa)	47.31
			% of Elongation	4.874
		20 %	Stress (MPa)	64.37
			% of Elongation	7.01
3	Flexural Strength	10 %	Stress (MPa)	21.341
			% of Elongation	1.852
		15 %	Stress (MPa)	26.581

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 3, January 2018

			% of Elongation	0.982
		20 %	Stress (MPa)	28.281
			% of Elongation	1.044
4	**Impact Strength**	**10 %**	Strength (J)	1.125
		15 %	Strength (J)	1.625
		20 %	Strength (J)	2.125
5	**Rockwell Hardness**	**10 %**	RHN	70.5
		15 %	RHN	72.67
		20 %	RHN	80.833

IV. CONCLUSION

The present investigation concluded that the effect of fibre loading on mechanical properties like; tensile strength, tensile modulus, compression strength, flexural strength, impact strength and hardness of chopped sida acuta fibre reinforced epoxy composite was increased with increase in fibre loading from 10 wt.% to 20 wt.%. It is found from the experimental study that 20 wt.% of chopped sida acuta fibre loading in the composite has maximum values of tensile strength, tensile modulus, compression strength, flexural strength, impact strength and hardness than that of 10 wt.% and 15 wt.% of chopped sida acuta fibre loading in the composite. However, the present study suggest that the utilization of chopped sida acuta fibre reinforced epoxy composite in light weight and medium strength structural applications.

REFERENCES

[1] Bhattacharyya DN, Chakravarti IB, Sengupta SR. J Sci. Industries Res. 1961; 20: 193.
[2] Chawla KK, Bastos AC. The mechanical properties of jute fibre and polyester / jute composite. Mechanical Behaviour of Materials 1979; 3: 191–196.
[3] Sanjay M R, Arpitha G R, B Yogesha Investigation on Mechanical Property Evaluation of Jute - Glass Fiber Reinforced Polyester. Volume 11, Issue 4 Ver. V.
[4] Christo Ananth,"A Novel NN Output Feedback Control Law For Quad Rotor UAV",International Journal of Advanced Research in Innovative Discoveries in Engineering and Applications[IJARIDEA],Volume 2,Issue 1,February 2017,pp:18-26..
[5] Dr.J.E.G.van (ATO-DLO) Dam POB 17, 6700 AA .
[6] Carlsson Leif A, Pipes R Byron. Experimental Characterisation of Advanced Composite Materials. New York: Prentice-Hall. 1987: 69-81.
[7] Dong C, Davies I.J. Flexural Properties of Wheat Straw Reinforced Polyester Composites, American J. Materials Science 2011; 1(2): 71.
[8] Srinivasa C.V. and Bharath K.N. Impact, Hardness Properties of Areca Fibre Epoxy Reinforced Composites, J. Material Science and Environment 2011; 2(4): 351.