

Mechanical Properties and Chemical Resistance of Holoptelea Integrifolia Fibre Reinforced Epoxy Composites

Kammara Chandra SekharaAchari¹, P. Hari Sankar², Dr. H. Raghavendra Rao³

P.G. Student, Department of Mechanical Engineering, GPR Engineering College, Kurnool, A.P, India¹

Associate Professor, Department of Mechanical Engineering, GPR Engineering College, Kurnool, A.P, India²

Associate Professor, Department of Mechanical Engineering, GPR Engineering College, Kurnool, A.P, India³

ABSTRACT: During the past few decades, Composite Materials have replaced, advantageously, many of the conventional materials in various applications. Composite materials have boundless engineering applications, where strength to weight ratio, low cost and ease of fabrication were required. In the present work, specimens of natural fibre, HOLOPTELEA INTEGRIFOLIA reinforced epoxy composites were fabricated using Hand-Lay-Up process. Epoxy composite specimens of different fibre weight proportions (5gms,10gms,15gms,&20gms) were prepared. By fabricating the composites of different proportions, Tensile and Flexural tests were carried out to evaluate the mechanical properties. Also Chemical Resistance test was done to study the effect of alkali treatment of the fibre, HOLOPTELEA INTEGRIFOLIA. From the above test, it was found that, the fabricated composites were resistant to some acids, alkalines and solvents.

KEYWORDS: Naturalfibres, HOLOPTELEA INTEGRIFOLIA, Composite materials, Mechanical properties, and Chemical resistance test.

I. INTRODUCTION

Composite materials have been using for thousands of years, e.g. they have manufactured bricks with the help of mud which is thousand-year-old technology. Now days, we all depend on composite materials at some aspects of our lives. Composite material defined as a mixture of two or more than two materials different in composition. Composite materials also called composition materials or shortened to composites. Composite materials are materials made from two or more than two materials with considerably differ in physical and chemical properties, that when combined, make a material with appearances different from the individual components. Composites comprise strong load carrying material is known as reinforcement and weaker materials is known as matrix. Reinforcement provides stiffness and strength which helps to support structural load. Composite materials do not lose their respective identities but still relate their properties to the product causing from their mixture. The benefits of composite materials have their great stiffness and strength. There are in many cases, the reinforcement is stronger, tougher, harder and stiffer than the matrix. It finds application in automotive, aerospace, electronic equipment, sport goods, furniture, medical equipment & packaging Industry. Composite materials used as an industrial material for their outstanding resistance to chemicals and most forms of corrosion. This property of composite material conventionally important is hardly the only useful property. There are many important and useful properties are, low mass, low weight unequalled manufacturing and processing possibilities. Material selection is the important process in composite materials the main objective is to select the Natural fibres which are available easily and Eco-friendly. Hence we have selected the available fibre like HOLOPTELEA INTERIFOLIA as shown in Figure. 1. The most adopted Epoxy resin and industrial application hardener are employed to fabricate the laminated sheets.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016



Figure. 1. Fibre Extraction

II. FABRICATION OF COMPOSITE MATERIALS

This chapter deals with the fabrication stages carried out to obtain the composite material. This material used in fabrication process Epoxy resin, Hardner. The HAND LAY-UP TECHINQUE was used to fabricate the materials. It is the simplest and oldest open molding method of the composite fabrication processes. It is a low volume, labor intensive method suited especially for large components. Glass or other reinforcing mat or woven fabric or roving is positioned manually in the open mold, and resin is poured, brushed, or sprayed over and into the glass plies. Entrapped air is removes manually with squeegees or rollers to complete the laminates structure. Room temperature curing polyesters and epoxies are the most commonly used resins. More layers can be added and after drying the composite part can be removed from the mould. The various stages involving in hand lay-up process are as follows:

STAGE 1: Weighing the fibres as per the required ratios (5, 10, 15, 20 grams).

STAGE 2: Place the Glass moulds along the sides.

STAGE 3: Lay up the mixture of separate parent fibres of required proportions over the polythene sheet. Figure. 2 shows process of hand lay-up method.

STAGE 4: Pour the Hardener mixed Epoxy resin uniformly and place another polythene sheet over it.

STAGE 5: Allow a curing time of about 3 to 6 hours and then separate the composite plate.

STAGE 6: Composite plate was placed in oven temperature maintains at 70⁰ for 2 hours.

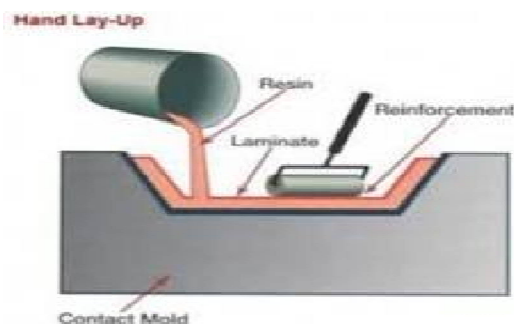


Figure. 2. Hand lay-up process

III. EXPERIMENTAL TESTS

Tensile test and Flexural test were performed in computer controlled Universal Testing Machine.

TENSILE TEST: Tensile test was performed on a computer controlled universal testing machine shown in Figure.3 according to the guidelines ASTM D638 standard with the specimen having dimensions of 150*20*3mm shown in Figure.4. Various mechanical properties such as ultimate breaking load, displacement at maximum force and ultimate stress were determined and tabulated in table.1

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016

Figures 3&4 shows the experimental set-up for the Tensile Test and the Specimen used for testing respectively.



Figure.3 Tensile test specimens



Figure.4 Experimental setup for tensile test

TABLE.1 Tensile Test values

S.No	% of Fibre (gms)	Fmax (N)	Tensile strength (MPa)	Tensile Modulus (MPa)
1	5	205.35	6.85	1759.00
2	10	284.86	9.50	2625.28
3	15	666.71	22.25	2871.87
4	20	733.17	24.44	3184.35

FLEXURAL TEST:The Flexural tests were performed in Universal testing machine as shown Figure.6 according to the ASTM D790 standard specimen size 150*15*3 mm as shown in Figure.7. The important mechanical properties such as ultimate breaking load, displacement at maximum force and ultimate stress were determined and tabulated in table.2



Figure.5 Experimental setup for Flexural Test



Figure.6 Flexural Test specimens

Figures 5 & 6 shows the experimental set-up for the Flexural Test and the Specimen used for testing respectively.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016

TABLE.2. Flexural Test values

S.No	% of Fibre (gms)	Fmax (KN)	Flexural strength (MPa)	Flexural Modulus (MPa)
1	5	0.10	32.52	3517.73
82	10	0.10	56.92	4144.58
3	15	0.06	87.83	6287.43
4	20	0.20	110.97	9344.56

Chemical Test

The chemical resistance test of the composites was studied as per ASTM D 543-87 Method.

$$W = \frac{w_2 - w_1}{w_1}$$

W = weight (%) of final sample

W₂ = weight of treated sample

W₁ = weight of untreated sample.

TABLE.3. Before weights of the fibre chemical resistance test

Name of the Fibre	Specimen 1	Specimen 2	Specimen 3	Specimen 4	Specimen 5	Specimen 6	Specimen 7	Specimen 8
	(grams)	(grams)	(grams)	(grams)	(grams)	(grams)	(grams)	(grams)
Holoptelea Integrifolia	0.24	0.26	0.28	0.30	0.30	0.32	0.26	0.38

TABLE.4. After weights of the fibre chemical resistance test

Name of the Fibre	Specimen 1	Specimen 2	Specimen 3	Specimen 4	Specimen 5	Specimen 6	Specimen 7	Specimen 8
	(grams)	(grams)	(grams)	(grams)	(grams)	(grams)	(grams)	(grams)
Holoptelea Integrifolia	0.31	0.29	0.34	0.36	0.36	0.36	0.31	0.42

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016

TABLE.5. Values of chemical resistance test

Chemicals	W1	W2	$W = \frac{W2-W1}{W1}$
40% nitric acid	0.24	0.31	+0.2917
10% Hydrochloric acid	0.26	0.29	+0.1154
8% Acetic acid	0.28	0.34	+0.2143
10% Sodium Hydroxide	0.30	0.36	+0.2000
20% Sodium Carbonate	0.30	0.36	+0.2000
Benzene	0.32	0.36	+0.3846
Carbon Tetrachloride	0.26	0.31	+0.1923
water	0.38	0.42	+0.1053

IV. RESULTS AND DISCUSSIONS

1. Experimental Results in Tensile Test:

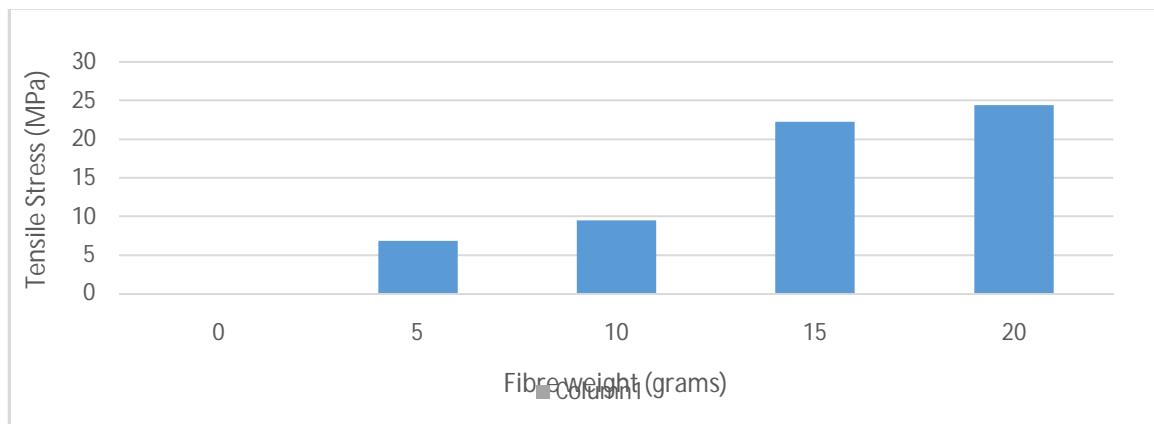


Figure.7 Tensile Stress Vs of FibreWeight

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016

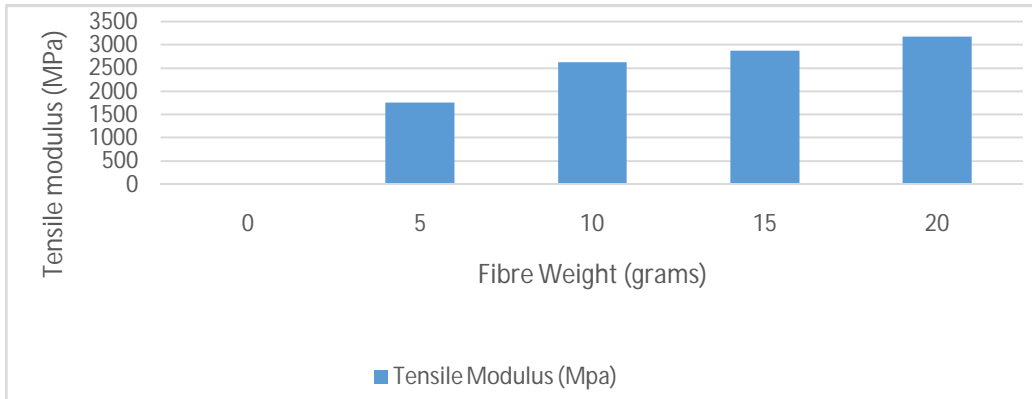


Figure.8 Tensile Test VsFibre weight

The effect of fibrecontent on Tensile Stress and Modulus is shown in Figure 7 & 8. It is seen that the tensile stress increases with increase the fibre i.e. from 6.85MPa to 24.44MPa. This is because of the stress provided by the HoloptelaIntegrifoliafibre into the matrix. The Tensile Modulus is also increases as per the increase in the fibre weight i.e. from 1759MPa to 3184.35MPa.

2. Experimental results in Flexural Test:

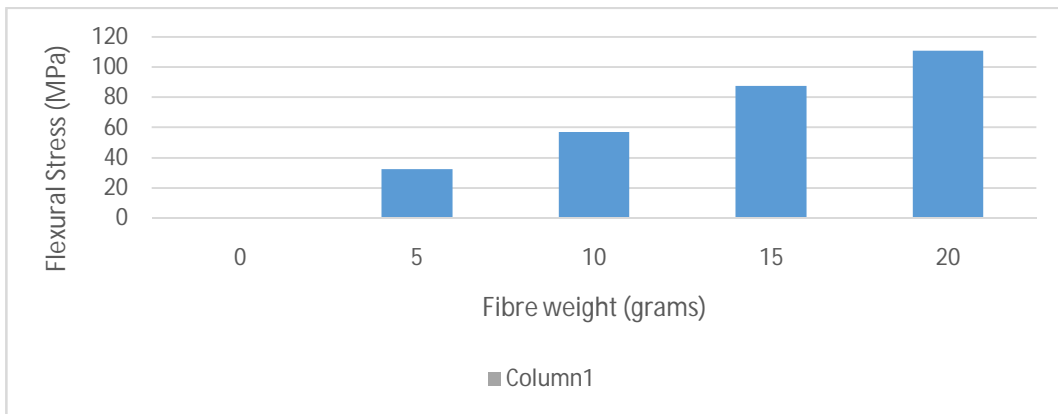


Figure.9 Flexural Stress VsFibreWeight

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016

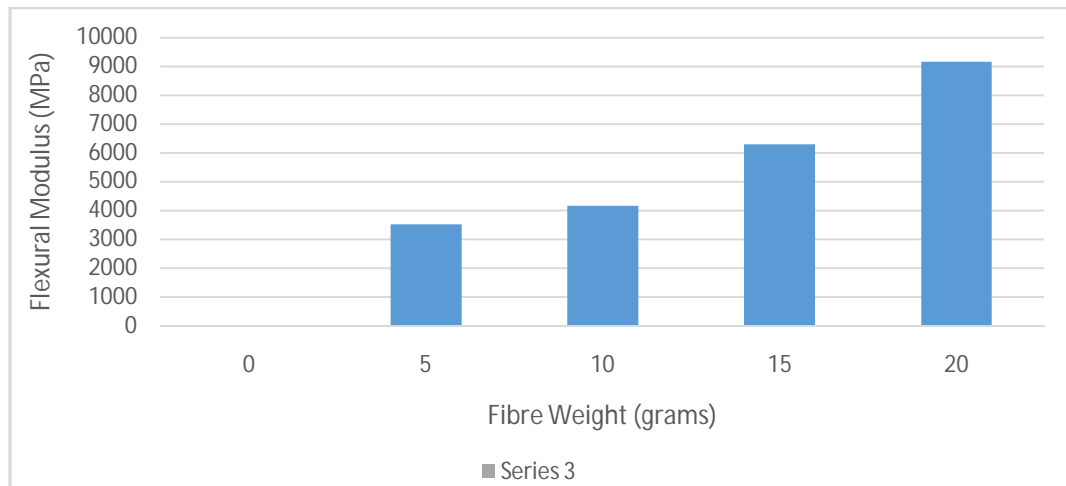


Figure.10. Flexural modulus Vs Fibre weight

The effect of fibre content on Flexural Stress and Modulus is shown in Figure. It is seen that the Flexural stress increases with increase of the fibre i.e. from 32.52MPa to 110.97MPa. This is because of the stress provided by the *Holoptelea Integrifolia* fibre into the matrix. The Flexural Modulus also increases as per the increase in the fibre weight i.e. from 3517.73MPa to 9344.56MPa.

V. CONCLUSION

The fibre reinforced pure composites are fabricated by the simple hand lay-up technique under the same laboratory condition. The proposed composites are subjected to the mechanical characterization, such as tensile strength, flexural strength, and chemical resistance test etc. the following conclusions have been driven out from the experimental results.

1. Based on the experimental investigations, micro mechanics assessment and static analysis the strength determining factors such as ultimate breaking load, ultimate stress, displacement at maximum force, Tensile strength, and Flexural strength.
2. The *Holoptelea Integrifolia* reinforced composites have more Tensile properties obtained at 20 gms of fibre, and Maximum Flexural Strength is obtained at 20 gms weight of the fibre.
3. Results indicate that the fibre improves the properties and can be considered as great potential to increase with varying the fibre weight ratio.
4. The effect of Chemical Resistance test were studied. After conducting test the fibre weights may increase this indicates the density also increases. Which indicates better strength for the fibres.
5. In future, there is tremendous investments on natural fibres, to bring a great impact on manufacturing sectors.

REFERENCES

1. Chandramohan D., Marimuthu K., Tensile and Hardness tests on natural fibre reinforced polymer composite material. IJAEST, 6, 2011, 97-104.
2. Wambua P., Ivens J., Verpost I. Natural fibres: can they replace glass in fibre reinforced plastics? Composites Science and Technology, 63, 2003, 1259-1264.
3. Sanjay Mazumdar "Growth opportunities: materials innovation will drive composites usage to new heights". High Performance Composites, May 2012.
4. D. NabiSaheb and J.P. Jog "Natural fibre polymer composites: A review" Advances in Polymer Technology, Vol. 18. No.4, PP.351-363 1999.
5. Jindal, U.C (1986) development and testing of bamboo fibres reinforced plastic composites journal of composites 20: 19 (1986)
6. Venkata Reddy, G., Venkata Naidu, S. and Shobha Rani, T. (2009). A Study on Hardness and flexural properties of Kopok/Sisal Composites, Journal of Reinforced Plastic and Composites, 28: 2035-2044.



ISSN(Online) : 2319-8753
ISSN (Print) : 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016

7. VaradaRajulu. A, Narasimha Chary .K, Rama Chandra Reddy. G, void content, density, weight reduction and mechanical properties of short bamboo fibres/stryrentedpolyster composites. *Bamboo &Ruttan* 3, 95-102 (2003).
8. H. Raghavendra Rao, P. HariSankar, & M. Murali Mohan chemical Resistance and impact properties of Bamboo/Glass fibre reinforced polyster hybrid composites international journal of Engineering Research ISSN: 2319-6890 (online). 2347-5013 (print) volume no.3 ISSUE NO: special 1, PP: 79-81.
9. C.S. Varma, V.M.Chariar, R.Purahit tensile strength analysis of bamboo composites, Issue-2, Mar-Apr 2012 PP. 12531264.