Industrial Engineering Letters
ISSN 2224-6096 (Paper) ISSN 2225-0581 (online)
Vol.4, No.4, 2014

Mechanical And Chemical Properties Of Bamboo/Glass Fibers Reinforced Polyester Hybrid Composites

G.Meenambika Bai, H.Raghavendra Rao,

Department of Mechanical Engineering

G.P.R.Engineering College, Kurnool-518002, India

E.mail: meenasonu2@gmail.com, Ph No:9014779683

E-mail: hanchaterrao@gmail.com, Ph No:9491784848

ABSTRACT

The chemical resistance of Bamboo/Glass reinforced polyester hybrid composites to acetic acid, Nitric acid, Hydrochloric acid, Sodium hydroxide, Sodium carbonate, Benzene, Toluene, carbon tetrachloride and water was studied. The flexural properties of these composites were also studied. The effect of alkali treatment of bamboo fibers on these properties was studied. It was observed that the flexural properties of the hybrid composites increase with glass fiber content. These properties found to be higher when alkali treated bamboo fibers were used in hybrid composites. The hybrid fiber composites showed better resistance to the chemicals mentioned above. The elimination of amorphous hemi-cellulose with alkali treatment leading to higher crystallinity of the bamboo fibers with alkali treatment may be responsible for these observations.

KEYWORDS

Bamboo fiber, composites, chemical resistance, flexural strength, glass fiber, polyester

INTRODUCTION

Several studies on the composites made from polyester matrix and natural fibers like jute, wood, banana, sisal, cotton, coir and wheat straw were reported in the literature. Jindal (1) reported the development of bamboo fiber reinforced plastic composites using araldite (CIBA CY 230) resin as matrix. Though bamboo is extensively used as a valuable material from times immemorial (because of its high strength and low weight) the studies on this fiber reinforced plastics are meager . In the present work, the bamboo/glass fiber reinforced high performance polyester hybrid composites were developed and their flexural properties with fiber content (with varying ratio of glass/bamboo fibers) were studied. The effect of alkali treatment of the bamboo fibers on these properties was also studied. The chemical resistance properties with varying fiber percentage were also studied.

MATERIALS AND METHODS

Materials :

High performance polyester resin LY 556 and the curing agent hardener HY 951 system were used as the matrix. Bamboo fibers (dendrocalamus strictus) were procured from Tripura state of India in the dried form. Some of these fibers were soaked in 1% of NaOH solution for 30 min. to remove any greasy material and hemi cellulose. Washed thoroughly in distilled water and dried under the sun for one week. The fibers with a thickness of 3 mm were selected in the mat form. The glass fibers (chopped form) have been procured from company (owens corning fiber glass mat, Bombay) were used in making the hybrid composite percentage.

Preparation of mould:

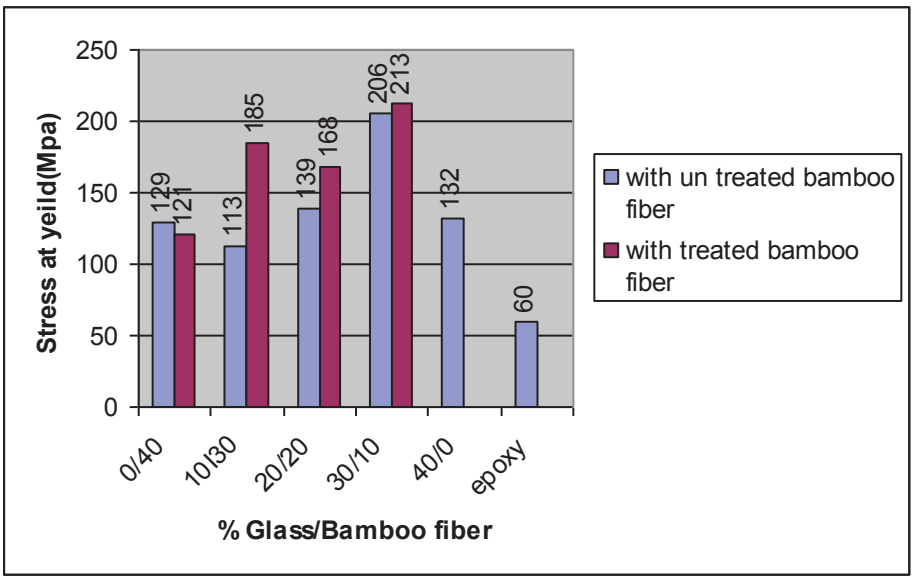
For making the composites, a moulding box was prepared with glass with 200mmx200mmx3mm mould (length x width x thickness)

Preparation of the composite and the test specimens:

The mould cavity was coated with a thin layer of aqueous solution of poly vinyl alcohol (PVA) which acts as a good releasing agent . Further a thin coating of hard wax laid over it and finally another thin layer of PVA was coated. Each coat was allowed to dry for 20 minutes at room temperature.

A 3mm thick plate was made from the polyester and hardener taken in the ratio of 100 and 10 parts by

weight respectively. Then the moulding box loaded with the matrix mixture and bamboo & glass fiber in random orientation (with varying percentage) and was placed in vacuum oven which was maintained at 100°c for 3 hours to complete the curing . After curing, the plate was removed from the moulding box with simple tapering and it was cut into samples for Flexural test 150mmx15mmx3mm and for chemical test with dimensions of 10mmx5mmx5mm. For comparison sake the specimen for matrix were also prepared in similar lines.



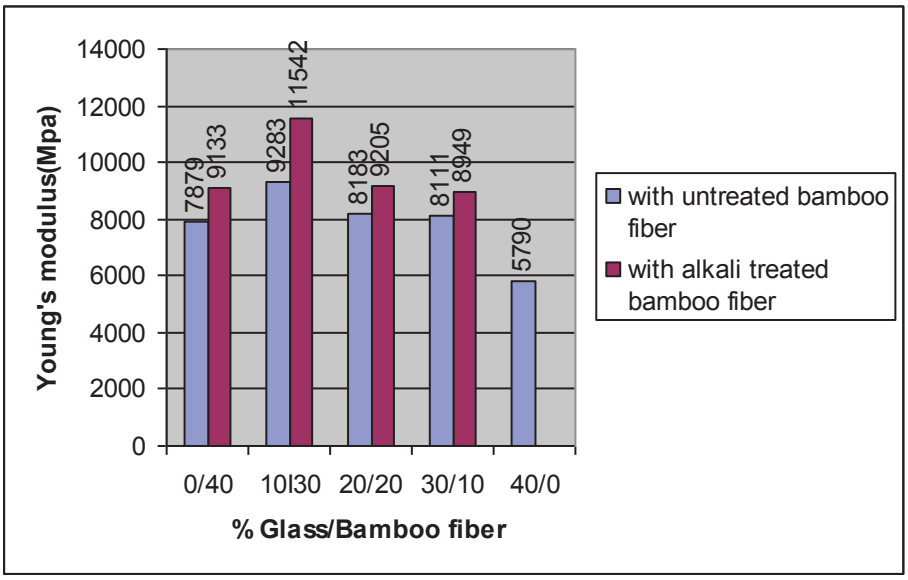
The variation of Stress at Yield with ratio of % Glass/Bamboo fiber Reinforced polyester composites

FLEXURAL LOAD MEASURMENT

The Flexural stress, and the Flexural modulii were determined using Instron 3369 model UTM. The cross head speed for flexural test was maintained at 5mm/ min. The temperature and humidity for this test were maintained at 22 ^{0}C and 50% respectively. In each case 5 samples were tested and average values were reported.

CHEMICAL RESISTANCE OF COMPOSITES

The chemical resistance of the composites was studied as per ASTM D 543-87 method. For chemical resistance test, the acids namely concentrated hydrochloric acid (10%), concentrated nitric acid (40%) and glacial acetic acid (8%), the alkalis namely aqueous solutions of sodium hydroxide (10%), ammonium hydroxide(10%) and sodium carbonate (20%) and the solvents- Benzene, carbon tetra chloride, toluene and water were selected. In each case, ten pre-weighted samples were dipped in the respective chemicals under study for 24 hours, removed and immediately washed thoroughly with distilled water and dried by pressing them on both sides by filter papers. The final weight of the samples and % weight loss/gain was determined. The resistance test was repeated for ten samples in each case and the average values reported.



The variation of Flexural modulus with ratio of % Glass/Bamboo fibers reinforced polyester composites

Chemicals	Matrix	Composite
40% nitric acid	+0.2169	+0.25491
10% Hydrochloric acid	+0.9665	+0.25491
8% Acetic acid	+0.3965	+2.4299
10% sodium hydroxide	-0.4361	-2.7191
20% sodium carbonate	+0.777	-3.9756
10% Ammonium Hydroxide	-0.3973	-2.9185
Benzene	-1.371	-1.346
Toluene	-0.691	-2.360
Carbon tetrachloride	-1.134	+4.4458
Water	-1.212	-1.626

RESULTS AND DISCUSSION

The variation of flexural stress and modulus with percentage glass/bamboo fiber ratio is presented in fig 1&2 respectively. For comparision, these values for the matrix are also presented in the same figures. From both these figures it is evident that the flexural properties are enhanced when the alkali treated bamboo fibers were used in the hybrid composites. This is understandable as the hemi cellulose and the lignin contents decrease leading to higher percentage of crystalline α-cellulose in bamboo fibers on alkali treatment. The minimum and maximum values of flexural modulus for these composites are found to be 2702 and 10067 MPa respectively. Similarly, the stress values vary in the range of 60 to 213 MPa. Similar observation was made by Varada Rajulu et al (2-9) and srinivasulu et al (10) in the case of some fiber composites and polymer coated bamboo fibers.

The effect of some acids, alkalis and solvents on the matrix and composite under study is presented in table-1. From this table it is clearly evident that for matrix and composite, the weight gained is observed after immersion. This is understandable as the matrix is cross linked and as a result formation of gel takes place instead of dissolution. Similar observation was made by Varada Rajulu et al 8 in the case of short bamboo fiber reinforced high performance polyester composites and Padma Priya et al 11 in the case of silk fabric reinforced polyester laminates. It is also observed that the effect of sodium carbonate, benzene, toluene and carbon tetra chloride is negligible on both the matrix and composites. The chemical resistance of the hybrid composites with treated bamboo fibers is found to be better for the chemicals mentioned.

CONCLUSIONS

The hybrid composites of bamboo/glass fiber reinforced polyester were made and their flexural and chemical resistance properties were studied. The effect of alkali treatment of the bamboo fibers on these properties was

studied. These hybrid composites were found to exhibit good flexural and chemical resistance properties. The hybrid composites with alkali treated bamboo fibers were found to possess higher flexural properties. The composites were found to be resistant to some acids, alkalis and solvents. The elimination of amorphous weak hemi cellulose components from the bamboo fibers on alkali treatment may be responsible for this behavior.

REFERENCES

1. Jindal, U.C (1986) development and testing of bamboo fibers reinforced plastic composites journal of composites 20: 19 (1986)

2. Varada Rajulu , A., Narasimha Chary, K., Rama Chandra Reddy, G. Void content, density, weight reduction and mechanical properties of short bamboo fibers/ stryrenated polyster composites.j. Bamboo & Ruttan.,2(2):95-102(2003).

3. Varada Rajulu, A., Narasimha Chary, K., Rama Chandra Reddy, G.,Meng, Y.Z. Void content, density, weight reduction and mechanical properties of short bamboo fibers/ stryrenated polyster composites.j. reinforced plastics and composites, 23(2):127-130.(2004).

4. Varada Rajulu, A., Babu Rao, G ., Lakshminarayana Reddy, R. Chemical resistance and tensile properties of polyester/poly carbonate blend coated bamboo fibers, journal of reinforced plastics and composites 20(4):335-340.(2001).

5. Varada Rajulu, A., Ganga Devi, L., Babu Rao, G., Lakshminarayana Reddy, R. Chemical resistance and tensile properties of polyester/unsaturated blend coated bamboo fibers, journal of reinforced plastics and composites 22(11) : 1029-1034. (2003).

6. Varada Rajulu, A., Allah Baksh, S., Narasimha Chary Reddy, G.,Chemical resistance and tensile properties of short bamboo fiber reinforced polyester composites, journal of reinforced plastics and composites 17(17): 1507-1511(1998).

7. Varada Rajulu, A., Narasimha Chary, K., Rama Chandra Reddy, G., Babu Rao, G.,Ganga Devi, L Thermo gravimetric analysis of dendro calamus strictus bamboo fibers, journal of bamboo and Ruttan I(3): 247-250.(2002).

8. Varada Rajulu, A., Narasimha Chary, K., Rama Chandra Reddy, G., Chemical resistance and tensile properties of stryrenated polyster – coated bamboo fibers, journal of fiber and textile research. 23: 49-51(1998).

9. Varada Rajulu, A., Narasimha Chary, K., Rama Chandra Reddy, G. Chemical resistance and tensile properties of POLYESTER - coated bamboo fibers, Indian journal of fiber and textile research. 21: 223-224.(1998).

10. Srinivasulu, S., Varada Rajulu, A ., Narasimha Chary, K., Rama Chandra Reddy, G. Chemical resistance and tensile properties of poly carbonate toughened polyester - bamboo fibers, bulletin of pure and applied sciences. 25(2) :137-142.(2006).

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Recent conferences: http://www.iiste.org/conference/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar