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Investigation on The Mechanical Properties of Banana Fiber Reinforced Polyester Composites

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ABSTRACT:
the interest in natural fiber-reinforced polymer composite materials is rapidly growing both in terms of their industrial applications and fundamental research. The natural fiber composites are more environmentally friendly, and their availability, renewability, low density, and price as well as satisfactory mechanical properties make them an attractive ecological alternative to glass, carbon and man-made fibers used for the manufacturing of composites. The main objective of this project is to investigate the effect of NaOH solution on the mechanical properties of Banana fiber in polyester composites. The composites have been made by with and without treatment of NaOH solution using polymer matrix using Banana fiber. Mechanical properties such as tensile, impact and bending strengths were Studied by Carrying out respective tests with varying weights of fiber (0.5, 1, 1.5 and 2 gm's). The tensile, impact and bending Strength of Banana fiber reinforced composites with NaOH solution was found to be increased when compared with without NaOH solution by varying fiber content. The concentrated of NaOH solution (5%) to water (for 1lit).

I. INTRODUCTION

The word "composite" means two or more distinct parts physically bounded together". Thus a material having two more distinct constituent materials or phases may be considered a composite material. Fiber-reinforced composite materials consist of fiber of high strength and modulus embedded in or bonded to a matrix with distinct interfaces (boundary) between them. In this form, both fiber and matrix retain their physical and chemical identities, yet they produce a combination of properties that cannot be achieved with either of the constituents acting alone. In general, fibers are the principal load-carrying members, while the surrounding matrix keeps them in the desired location and orientation, acts as a load transfer medium between them, and protects them from environmental damages due to elevated temperatures and humidity etc.

The properties that can be improved by forming a composite material include strength, stiffness, corrosion resistance, wear resistance, attractiveness, weight, fatigue life, temperature-dependent behavior, thermal insulation, thermal conductivity, acoustical insulation and electrical insulation.

1.1 Sodium Hydroxide (Naoh) Solution:

Sodium hydroxide (NaOH), also known as lye and caustic soda, is an inorganic compound It is a white solid and highly caustic metallic base and alkali salt of sodium which is available in pellets, flakes, granules, and as prepared solutions at a number of different concentrations.[Sodium hydroxide forms an approximately 50% (by weight) saturated solution with water. Sodium hydroxide is soluble in water, ethanol,and methanol.

This alkali is deliquescent andreadilyabsorbs moistu re and carbon dioxide in air.

Sodium hydroxide is used in many industries, mostly as a strong chemical base in the manufacture of pulp and paper, textiles,

drinking, soaps and detergents and as a drain cleaner. Worldwide production in 2004 was approximately 60 million tonnes, while demand was 51 million tonnes.

1.2. Banana Fiber:

The banana plant is a large perennial herb with leaf sheaths that form trunk-like pseudo stems. The plant has 8 - 12 leaves that are up to 9 ft long and 2 ft wide. Root development may be extensive in loose soil in some cases up to 30 ft laterally. Other plant descriptions vary; it depends on the variety the term "banana" is also used as the common name for the plants which produce the fruit. This can extend to other members of the genus Musa like the scarlet banana (Musa coccinea), pink banana (Musa velutina) and the Fe'i bananas. It can also refer to members of the genus Ensete, like the snow banana (Ensete glaucum) and the economically important false banana (Ensete ventricosum)

II. PROCEDURE

2.1. Tensile Testing:

The standard test method for tensile properties of fiber-resin composites, ASTM-D638M-89 is used to prepare specimens as per the dimensions. The test specimen has a constant cross section with tabs bonded at the ends.

The mould is prepared on smooth ceramic tile with rubber shoe sole to the required dimension. Initially the ceramic tile is cleaned with shellac (NC thinner) a spirituous product to ensure clean surface on the tile. Then mould is prepared keeping the rubber sole on the tile. The gap between the rubber and the tile is filled with mansion hygienic wax. A thin coating of PVA (polyvinyl alcohol) is applied on the contact surface of specimen, using a brush. The resulting mould is cured for 24 hours.

Hand layup method is adopted to fill the prepared mould with general purpose polyester resin of ECMALON 4413 grade, supplied by ECMAS RESINS PVT. LTD. Hyderabad, as matrix and various fibres as reinforcement. ECMALON 4413 is an unsaturated polyester resin of ortho-pathalic acid grade with clear colourless or pale yellow colour. Its viscosity is 500-600 CPS (Brookfield Viscometer) and specific gravity is 1.13 grams/c.c. at 250 C. Acid Number (mg KOH/g) is 22 and monomer content is 35%. Cobalt accelerator and MEKP catalyst are added for curing the resin at room conditions. The quantity of each of these materials, added is 2.0% of the volume of resin. The gel time is found to be about 25 min. The accelerator is mixed thoroughly with the resin and the catalyst is added later to avoid explosion. A thin coating of the resin is applied to the mould surface and known weight of the fibre is placed along the longitudinal direction of the specimen so that the fibres are oriented 00 along the axial direction of the specimen. Then the rest of the mould is filled with the resin making sure that there are no air gaps in the mould. Then, a thin Polyethylene paper of 0.2mm thick is placed on the rubber mould. A flat mild steel plate is placed on the mould and left for 24 hours to cure. Later the specimen is removed and machined to obtain the final dimensions (160mm*12.5mm*3mm). The specimen is cleaned with NC thinner and wiped off to remove dirt particles. The ends of both flat sides of the specimen are roughened enough using a sandpaper, so as to bond the end tabs.

Fig: Die for tensile testing

2.2 Bending Testing:

The standard test method for bending properties of fiber-resin composites, ASTM-D638M-89 is used to prepare specimens as per the dimensions. The test specimen has a constant cross section with tabs bonded at the ends. The mould is prepared on smooth ceramic tile with rubber shoe sole to the required dimension. Initially the ceramic tile is cleaned with shellac (NC thinner) a spirituous product to ensure clean surface on the tile. Then mould is prepared keeping the rubber sole on the tile. The gap between the rubber and the tile is filled with mansion hygienic wax. A thin coating of PVA (polyvinyl alcohol) is applied on the contact surface of specimen, using a brush. The resulting mould is cured for 24 hours. Hand layup method is adopted to fill the prepared mould with general purpose polyester resin of ECMALON 4413 grade, supplied by ECMAS RESINS PVT. LTD. Hyderabad, as matrix and various fibers as reinforcement. ECMALON 4413 is an unsaturated polyester resin of ortho-pathalic acid grade with clear colorless or pale yellow color. Its viscosity is 500-600 CPS (Brookfield Viscometer) and specific gravity is 1.13 grams/c.c. at 250 C. Acid Number (mg KOH/g) is 22 and monomer content is 35%. Cobalt accelerator and MEKP catalyst are added for curing the resin at room conditions.

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Fig: Die for impact testing

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Fig: Die for bending test

III. TESTING OF COMPOSITES

3.1. Tensile Testing:

A 2 ton capacity - Electronic tensometer, ASTM D638M-89 model, supplied by M/S Microtech, Pune, is used to find the tensile strength of composites. The specimens dimensions are (160x12.5x3) mm.Its capacity can be changed by

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load cells of 20 Kg, 200 Kg & 2000 Kg. A load cell of 2000 Kg. is used for testing composites. Self-aligned quick grip chuck is used to hold composite specimens. A digital micrometer is used to measure the thickness and width of composites.

3.2. Impact Testing:

The specimens are preparing for impact thest accordance to the ASTMD256-97tofind the impact strength of the composites. The specimen's dimensions are (63.5x12.36x10) mm and notch point is 2.36mm. Low velocity instrument disuse impact tests are performed on the composite specimens. The composite specimen notch placed at the testing peace. The impact testing machine having pendulum strikes there quired piece at the points notch with pendulum hammer, measuring the spending energy of different pieces are noted by dial indicator.

Specimens After Testing:

Fig. Without NaOH treatment of banana fiber polyester composites after tensile testing

Fig: Without NaOH treatment of banana fiber polyester composites after tensile testing

Fig: NaOH treatment of banana fiber polyester composites after bending test.

Fig: Without NaOH treatment of banana fiber polyester composites after bending test.

Fig: NaOH treatment of banana fiber polyester composites after impact test.

Fig: Without NaOH treatment of banana fiber polyester composites after impact test.

IV. RESULTS

Stess-Strain Relations Of Naoh Composites:

Ultimate Tensile strength: It is the ratio of ultimate load at failure to the cross sectional area of the specimen.

Percentage volume: It is the ratio of volume of fiber in the composite to the total volume of composites.

However, for better understanding of physical behavior of fiber reinforced composites the relevant results are represented in graphical form. For quantitative understanding, the numerical values of fiber reinforced composites typical results are tabulated as shown below. The ultimate tensile strength, at 6%, 10%, 18%, and 27%, volume percentage of banana fiber NaOH composite. However, for better understanding of physical behavior of fiber reinforced NaOH composites the relevant results are also represented in graphical form as given below in table1.

Tensile Properties Of Composites: The tensile strength calculated from the following relations

Maximum tensile strength $= \frac{P}{A}$

Where, P = Load

A = Area

Bending Properties Of Composites: The Bending Strength Calculated From The Following Relations.

Maximum bending strength (S) $= \frac{3PL}{2bt^2}$

Where,

b= width of specimen (mm)

L=span length of specimen (mm)

t =thickness of specimen (mm)

P=maximum load

Impact Properties Of Composites:

The bending strength calculated from the following relations.

Maximum impact strength $= \frac{VI}{T}$

Where,

VI = energy observed

T = thickness.

4.1 Comparison Of With And Without Naoh Treatment Composites:

Tensile Properties Of Banana Fiber Composite:

Sl.No	Weight of fiber (grams)	Volume of fiber without NaOH (%)	Volume of fiber with NaOH (%)	Mean Tensile strength without NaOH (Mpa)	Mean Tensile strength with NaOH (Mpa)
1	0.5	4	6	41.73	44.53
2	1.0	10	10	46.13	51.46
3	1.5	16	18	54.13	64.66
4	2.0	20	27	77.73	88.26

Table.1: Effect of volume of fiber on Mean tensile strength of with and without treatment of NaOH banana fiber/polyester composites.

Bending Properties Of Banana Fiber Composites:

Sl.No.	Weight of fiber (grams)	Volume of fiber without NaOH (%)	Volume of fiber with NaOH (%)	Mean Bending strength without NaOH (Mpa)	Mean Bending strength with NaOH (Mpa)
1	0.5	3	6	106.6	190.0
2	1.0	6	10	110.0	220.0
3	1.5	13	20	136.6	213.3
4	2.0	17	24	153.3	266.6

Table.2: Effect of volume of fiber on Mean bending strength of with and without treatment of NaOH banana fiber/polyester composites.

Impact Properties Of Banana Fiber Composites:

Sl.No.	Weight of fiber (grams)	Volume of fiber without NaOH (%)	Volume of fiber with NaOH (%)	Mean Impact strength without NaOH (J/mm)	Mean Impact strength with NaOH (J/mm)
1	0.5	6	7	0.045	0.11
2	1	10	11	0.075	0.18
3	1.5	18	19	0.225	0.275
4	2	23	26	0.235	0.34

Table3: Effect of volume of fiber on Mean impact strength of with and without treatment of NaOH banana fiber/polyester composites.

4.2 Tensile Properties Of Banana Fiber Composites:

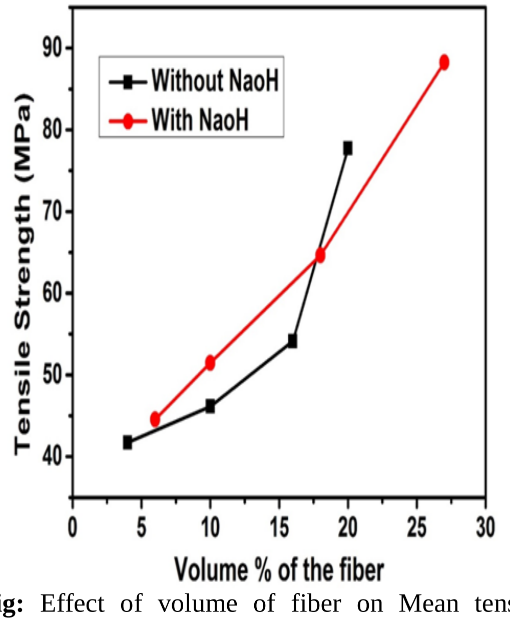

Fig: Effect of volume of fiber on Mean tensile strength of with and without treatment of NaOH banana fiber/polyester composites.

Bending Properties Of Banana Fiber Composites:

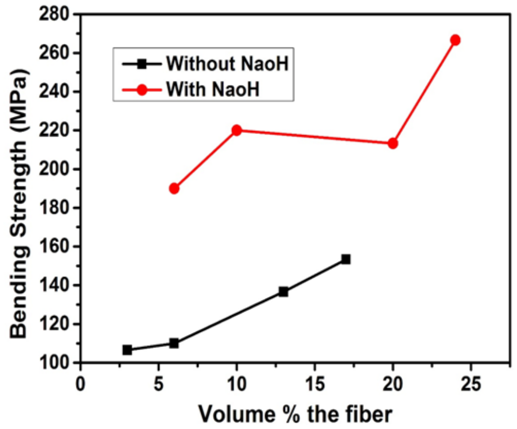

Fig: Effect of volume of fiber on Mean bending strength of with and without treatment of NaOH banana fiber/polyester composites

Impact Properties Of Banana Fiber Composites:

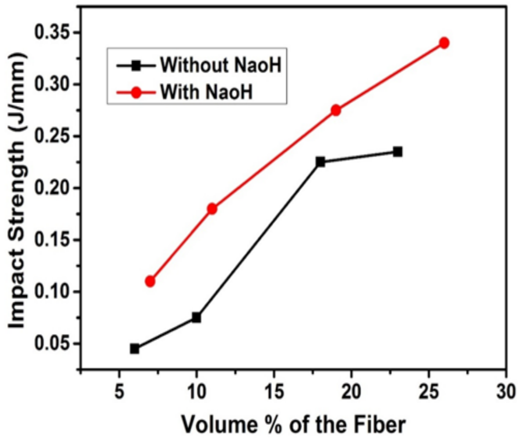

Fig: Effect of volume of fiber on Mean impact strength of with and without treatment of NaOH banana fiber/polyester composites.

V. CONCLUSIONS

From the experimental results obtained, the following conclusions are drawn

i. The mean tensile strength of NaOH treatment of banana fiber polyester composites is increased to 88.26 Mpa at volume fraction of fiber 27% than that of 77.73 Mpa without NaOH treatment at volume fraction of fiber 20%.

ii. The mean bending strength of NaOH treatment of banana fiber polyester composites is increased to 266.6 Mpa at volume fraction of fiber 24% than that of 153.3 without NaOH treatment at volume fraction of fiber 17%.

iii. The mean impact strength of NaOH treatment of banana fiber polyester composites is increased to 0.34 J/mm at volume fraction of fiber 26% than that of 0.235 J/mm without NaOH treatment at volume fraction of fiber 23%.

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