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Effect of Alkaline Treatment on banana fiber reinforced Epoxide Composites

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Abstract

Bio composites are materials that are made up of fibres that are natural and matrix may be of natural or polymers. It has been produces as an alternate solution and material to synthetic fibres and environment concern that has risen due to the over production and usage of artificial materials. Fibres are a class of mop-like materials that are non-stop 'filaments' or are in separate extended pieces, comparable to pieces of threads. Fiber is one of the key components of composite material. The use of composite materials is growing steadily in field engineering and various other fields rapidly. The convenience of fibres and ease of assembling have induced scientists worldwide to try by regional standards with available inexpensive fibre and to learning their achievability of fortification determinations and to what mark they realise the appreciative particulars of great strengthened polymer composite aimed at structural requisition. Banana fibre is obtained from the pseudo-stem of Musa sapientum and is one of the best fibres with good relative mechanical properties such as its high strength, smaller elongation, light weight, and it is bio- degradable and has no negative effect on environment and thus can be categorized as eco-friendly fibre. Some of the advantages of using natural banana plant-based fibre are good tensile modulus, Better torsional stiffness and impact properties. This Investigation describes the mechanical behaviour of banana fibre strengthened composite upon alkalisation with NaOH & KOH solutions with the references to the tensile loading and flexural strength testing on the fibre and comparing with the reference of untreated banana fibre properties. All the tests have been fulfilled in line with ASTM standards.

Key words: Banana fibre; alkalisation- NaOH & KOH; tensile strength; flexural strength; biodegradable; ASTM standards

1. Introduction

Composites are multifunctional physical arrangements that provide features not available from any distinct material. They are unified structures made by materially mingling two or more well-suited materials, dissimilar in arrangement, features and sometimes on form. Over the last thirty years, composite materials made up of ceramics and polymers have been the leading emergent materials. The capacity and number of claims of composite materials have grownup progressively, sharply and successfully conquering new markets persistently. Composite have become an integral part of our day-to-day life and can be found everywhere. Composites have been around for a long time with the classic example of bricks made from straw and mud. In general, the composite materials consist of matrix reinforced with fibres. Bio-based polymers such as bio composites can offer more justifiable materials with a lesser ecological and condensed carbon footprint. They can also diminish or evade microplastic discharges in the atmosphere if used properly to its full potential. A new study in the journal of

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Environmental Science and Technology says it's conceivable that humans may be consuming anywhere from 39,000 to 52,000 microplastic elements a year. With added evaluations of how much microplastic might be inhaled, that number is more than 74,000. Additionally, bio composites can bid special properties such as advanced stiffness and strength. In combination with recyclable/reusable/degradable plastics, fully bio-based and biodegradable solutions are evolved. These composites are generally thermosetting plastics. Thermosets are polymer materials which are liquid or malleable at low temperatures, but which change irreversibly to become hard at high temperatures.

Table 1 Properties of banana Fibre

Tenacity	29.97 g/denier
Fineness	17.14
Moisture Regain	12.99%
Elongation	6.539
Alco-ben Extractives	1.7001%
Total Cellulose	81.799%
Alpha Cellulose	61.490%
Residual Gum	40.99%
Lignin	14.99%

Natural fibres are sorted according to their source. They are plant, or cellulose-base, class includes such significant fibres as cotton and jute. The bodily, or protein-base, fibres include wool, mohair, and silk. Musa sapient (banana) fibre physical and chemical properties is given in the table 1. Epoxy resins are thermoset polymers possessing a great degree of chemical and solvent endurance, superior adhesion to broad range of substrates, a low order of contraction during cure, impact resistance, flexibility and good electrical properties (J.L. Massingill Jr et al.,2007). The banana fibre and epoxy resin composite Materials in the ratio of 50:50 can withstand the elevated loads when compared to the other combinations and used as a substitute material for traditional fibre reinforced polymer composites (M. Ramesh et al.,2014). The electrical and mechanical properties of Musa sapient fibre reinforced polyester composites were found to be related on the fibre content as well as the fibre surface modification (L. A. Pothan et al., 2007). The physical, mechanical, and thermal properties of banana-fibre-reinforced thermoplastic Polypropylene composites at various fibre volume ratios were investigated and the properties were good and the thermal stability was also quite high (Sanjay K et al., 2010). Chemical treatment of fiber improves the storage modulus of banana fibre reinforced polyester composites. Finally, it can be decided that composites with better modulus and low damping ideal for use as a alternative material for construction which can be developed from banana Fibre and polymer resins by the sensible control of the interphase chemistry (Laly A. Pothan et al., 2005).

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2. Fabrication

2.1 Fabrication of NaOH treated specimen:

The specimens are fabricated by firstly soaking the banana mat in 2% NaOH solution for increased bonding capacity for about two hours. After that the mat is taken out and is rinsed until traces of NaOH is removed completely using distilled water Fig 1. The rinsed mat is air dried overnight and heated in a Hot Air Oven for about 30 minutes in 50 degrees Celsius Fig 2. After the fibre is completely dry, a dead weight is placed on top of the mats to remove any creases left behind during the drying process Fig 3. Before layering up, the mould is prepared with a liberate agent to ensure that the part will not stick to the mould. A blend of epoxy resin and hardener is applied over all the fiber layer meticulously. The mixture of epoxy resin and hardener is taken in a ratio 10:1. The fibre volume is 80%matrix + 20% fibre. Now the layers are stacked one after the other. New layers are stacked one above another and there by 3 layers are made as a whole Fig 4. Then a polythene sheet is sprayed with a releasing agent and is placed over a laminate and a galvanized sheet and is placed over the polythene sheet to get even surfaces without any wrinkles. Then the entire setup is placed in a compression moulding machine at 350 psi pressure is applied and is allowed to cure for 24 hours Fig 5. The composite is taken out and inspected for imperfections and defects.

Fig 1 Banana mat soaking

Fig 2 Drying using Hot Air Oven

2.2 Fabrication of KOH treated specimen:

The specimens are fabricated by firstly soaking the banana mat in 2% NaOH solution for increased bonding capacity for about two hours. After that the mat is taken out and is rinsed until traces of KOH is removed completely using distilled water Fig 1. The rinsed mat is air dried overnight and heated in a Hot Air Oven for about 30 minutes in 50 degrees Celsius Fig 2. After the fibre is completely dry, a dead weight is placed on top of the mats to remove any creases left behind during the drying process Fig 3. Before layering up, the mould is prepared with a liberate agent to confirm that the part will not remain to the mould. A blend of epoxy resin and hardener is applied over all the layer methodically. A mixture of epoxy resin and hardener is taken in a ratio 10:1. The fibre volume is 80% matrix + 20% fibre. Now the layers are stacked one after the other. New layers are stacked one above another and there by 3 layers are made as a whole Fig 4. Then a polythene sheet is sprayed with a releasing agent and is placed over a laminate and a galvanized sheet and is placed over the polythene sheet to get even surfaces without any

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Fig 3 Dead weight placed over the dried mat Fig 4 Layering of mat and epoxy resign

Fig 5 Compressing using Hot Press Moulding

3. Experimental Procedure

The dimension of the rectangular specimen is 250mm in length,25mm in breadth,3mm in width is held by the two grippers of the INSTRON® 3382 machine and the pulling speed applied on the specimen is 5mm/min in order to measure the ultimate stress the specimen can withstand before its breaking point is known as tension test. The flexural and Tensile test for this specimen is proceeded as per the ASTM standard (D790 & D3039). For the tensile test, the sampling size was 150 × 15 mm^2 and standard length was 70 mm. Specimen dimension for three-point bending test was 100 mm × 15 mm × 70 mm. The specimen is held on Tinius Olsen's® model IT503 tensile testing machine and the specimen is tested at the speed rate of 1.2mm/min.

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Fig 6 Tensile test specimen

Fig 7 Flexural test specimen

4. Result and discussion

4.1 Tensile Test

From table 2, infer that the tensile properties of the Musa sapient (banana) fibre treated with KOH is unparalleled, showing incomparable tensile properties 39.66 MPa with NaOH treatment coming close second at 36.60 MPa. The maximum load however is different, where the NaOH treatment is higher at 1720 N. Therefore, it is concluded that the tensile properties are overall better with the KOH treatment.

S.NO	MATERIAL	TENSILE STRENGTH (MPa)	MAXIMUM LOAD (N)	STRAIN
1	Untreated Banana Laminates	23	1120	5.8
2	NaOH Treated	36.60	1720	3.1
3	KOH Treated	39.66	1460	4.28

Table 2 Tensile test results

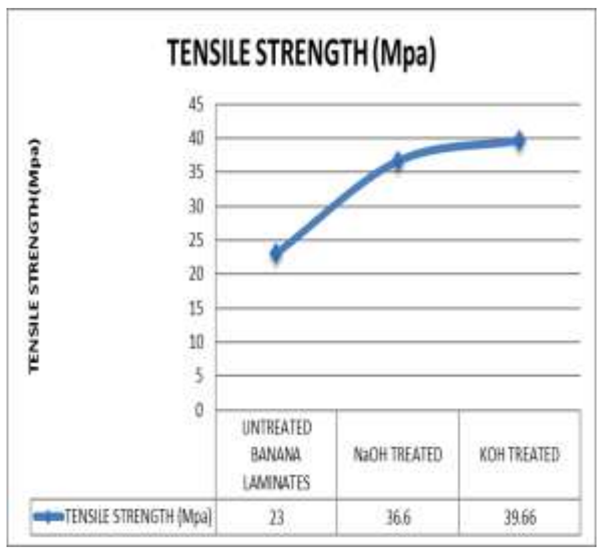

Fig 8 Tensile test graph

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4.2 Flexural Test

The table 3 refers to the Flexural properties of the banana fibres treated and untreated. From the table 3, ascertain that the properties of the banana fibre treated with KOH exhibit superior behaviour. The flexural strength that the material withstood is 61.78 MPa and the Maximum load is 43 N. The tests have been performed in line with the ASTM standards and the results reflect the same.

S.NO	MATERIAL	FLEXURAL STRENGTH (Mpa)	MAXIMUM LOAD (N)	STRAIN
1	Untreated Banana Laminates	44.14	71	12.4
2	NaOH Treated	61.28	43	12.2
3	KOH Treated	64	45	18.83

Table 3 Flexural test results

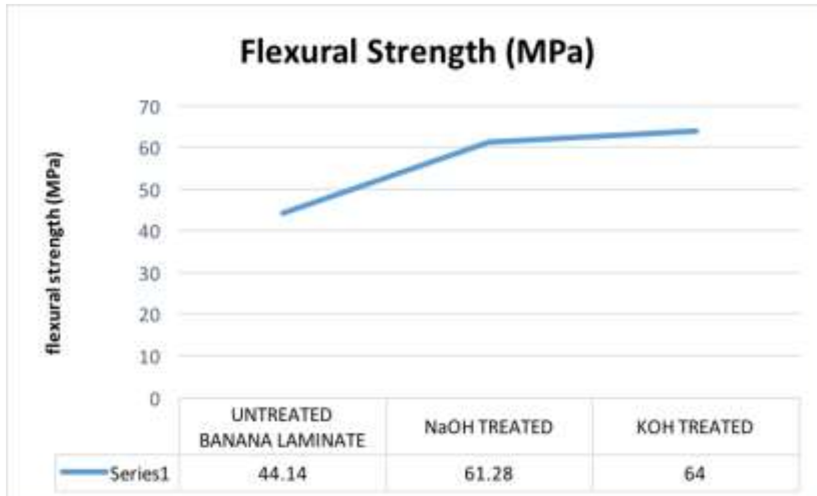

Fig 9 Flexural test graph

Conclusion:

In this study, mechanical properties were tested on the treated Musa sapient (banana) fibre composites and from the obtained results, these conclusions were drawn:

- The fabrication of banana fibre reinforced composites with ratio of epoxy and fibre volume (80%matrix+20% fibre) is conceivable by hand lay-up process.
- From the results, it has been practically concluded that alkalisation of the fibre laminates gives better result on the mechanical properties like tensile strength and flexural strength of the fabricated and treated Musa sapient (banana) fibre epoxide composite.
- On comparing the tensile strength of untreated Musa sapient (banana) fibre laminate with NaOH and KOH treated laminates, better and higher tensile strength is show by KOH treated laminates and it is clear by the bar chart.
- Similarly comparing the Flexural strength of untreated Musa sapient (banana) fibre laminate with NaOH & KOH treated laminates, better properties are exhibited by KOH treated laminates.
- From the experiment the results conclude that alkalisation of the fibre with 2%of KOH solution for two hours shows better mechanical properties.

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