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Review on Nanoclay Infused Treated Banana Fiber Reinforced Concrete

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ABSTRACT— To study the influence of nanoclay in banana fiber reinforced concrete and to compare the test results of untreated and treated banana fiber reinforced concrete. Banana fiber is treated with 3% NaOH solution and mixed with nanoclay and its mechanical properties are studied and compared with untreated banana fiber reinforced concrete. 7th day test results showed that nanoclay infused banana fiber reinforced concrete has more strength than treated and untreated banana fiber reinforced concrete and it is best for use. The main aim of mixing products such as plastics, glass etc..is to avoid cracks, gain durability and to gain flexural strength in the concrete. So this paper is focused on using treated banana fiber in micro stage which is a waste material to increase split tensile, compressive and flexural strength.

Keywords— banana fiber, nanoclay, concrete **.**

I. INTRODUCTION

The Musa Sapientum commonly known as banana fiber grows up to a height of 2-8m and length of the leaves are up to a height of 2-8m. Banana fibers are widely available worldwide as agricultural waste from banana cultivation. They are environment friendly and present important attributes such as low density ,light weight ,low cost, high tensile strength as well as being water and fire resistant. Banana fiber is a waste if not ceased for further sterilization. Concrete plays a vital role in construction and using waste for its manufacturing is a good form of replacement. It has been found that banana fiber reinforced concrete and reduced the minute cracks and increased the mechanical properties.

Table 1. Composition of banana fiber

Constituents	Percentage
Cellulose	50%
Lignin	17%
Extractives	7%
Moisture	11%
Ashes	9%

Banana fiber has high specific stiffness, strength and biodegradability. Natural fibers do not rust which is major problem in steel reinforced concrete. Banana fiber will soon become a replacement for non-renewable synthetic fiber. Enzyme treatment has been adopted to reduce moisture absorption, to clean the surface, to enhance fiber roughness and to reduce hydrophilic behavior.

Banana fiber

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These changes occurring on the fiber surface will influence the mechanical properties. Treatment parameters such as fiber immersion time, NaOH concentration were selected from reference. Fibers have better energy absorption characteristics and fatigue strength. In ordinary concrete micro cracks are developed these cracks are responsible for reduction in tensile and flexural strength, therefore banana fiber in reinforced concrete reduces these cracks which increases the durability of concrete.

II. MATERIALS REQUIRED

- Cement -OPC (tested in accordance with IS 403)*
- Coarse aggregate- 20 mm size (tested in accordance with IS 2386 -1964)*
- Fine aggregate- river sand (tested in accordance with IS 2386 part II & III-1963)*
- Banana fiber- local village, Tamil Nadu

(Whose specific gravity and density were determined using pycnometer)*

- Water- tap water

III. METHOD OF TREATMENT

The stem from banana plants were selected from a 11-month-old plantation, which was located 1050 m above sea level. Two different types of concrete blocks were prepared with the banana fibre, namely, treated and untreated banana fibre. The treated banana fibre and untreated banana fibre. The detailed treatment procedure of alkaline treatment of banana fibre and nanoclay infusion in banana fibres can be obtained from our earlier studies.

Fibres were drawn from the banana plant's pseudo stem. Pseudo stem was first air dried at an average temperature of 18°C for 72 hours. Bundles of fibre were placed in water for 12 hours at room temperature to remove impurities. The treated fibres were first washed with 2% detergent water prior to alkali treatment and dried at 70°C For 24 hours to remove external wax.

They were mercerised to remove fibre surface impurities, preparing the fibre for the effects of chemical treatment. Sequential extraction was used for the mercerisation with 1:2 mixture of ethanol and benzene, followed by washing with distilled water and then it is air dried to eliminate water soluble polymer and waxes. Then they are chemically treated to remove lignin and hemicellulose to improve fibre surface roughness and compatibility. Fibres are immersed in 3% NaOH aqueous solution for 1 hour at room temperature. Treated fibre was washed with distilled water to remove excess NaOH and then it is oven dried at 110°C.Fibers were manually separated from the bundles. Fibres having apparent defects were discoloured and those having greater uniform was selected for tensile strength testing. Fibres were cut into a length of 40 mm. About 40% volume of reinforced banana fibres were used. The diameter of the fibre were measured at different locations along their length using optical microscopy.UTM was used for assessing mechanical behaviour of fibre.50 mm gauge and 4 mm/min crosshead speed were used for all tests. A paper frame with a window was used to hold the fibre firm during the tensile strength test.SEM analysis was used for characterising the morphology of the structural change occurring at the surface of treated and untreated banana fibres and also the tested specimens fracture surface.

IV. TEST PROCEDURE

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Compression test:

The cured specimen were taken. Dimension were noted. It was then placed in the compression testing machine(CTM). Gradual load was being applied to the cube. Then the load where the specimen fails was noted.

This experiment was repeated for several samples. It was found that nanoclay infused treated banana fiber reinforced concrete has more compressive strength than the other samples.

Tensile test:

Concrete is weak in tension therefore it is not expected to resist direct tension. The cylinder sample was placed in the split tensile testing machine. Bearing strips keeps the specimen in position.

Split tensile testing machine

Then load was applied at constant rate until the specimen fails. This load was noted and results showed that nanoclay infused treated banana fiber reinforced concrete has more tensile strength than the other samples.

Flexural test:

Flexural test is used to determine the tensile strength of the concrete indirectly. The results of this test is expressed as modulus of rupture in MPa. Specimen was placed on the loading points of the flexure testing machine.

Flexure testing machine

Load was applied until the specimen fails and the point of failure and load applied at failure were noted. Results showed nanoclay infused treated banana fiber reinforced concrete has more flexural strength than the other samples.

V.Result and discussion:

The banana fibre material from the banana trunk can be seen in the figure. Various tests were conducted on all the three specimens which are concrete reinforced with untreated, treated and nano-clay treated fibres.

Nanoclay infused banana fibre

All the test results are discussed below:

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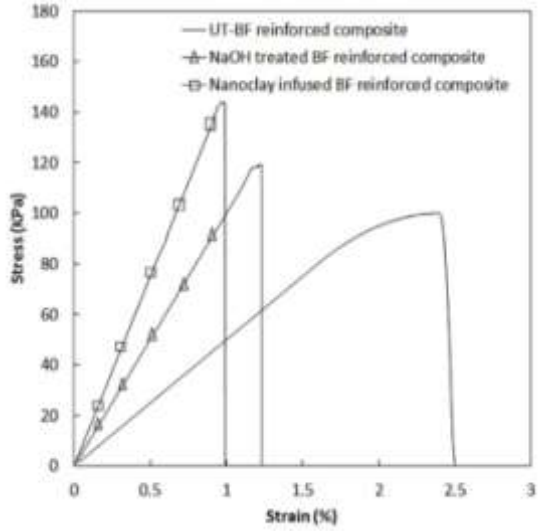
Compressive strength results:

The results from the compressive strength indicate that there was increase in compressive strength of banana fibre reinforced concrete when compared to the normal conventional concrete. There was a variation in compressive strength values when the concrete was reinforced with nano-clay infused banana fibre and treated banana fibre.



Nano-clay infused banana fibre reinforced concrete have more compressive strength than treated banana fibre reinforced concrete. This is because the fibre matrix adhesion is more in nano-clay infused banana fibre reinforced concrete than in treated banana fibre reinforced concrete. The compressive strength values are given in the table below.

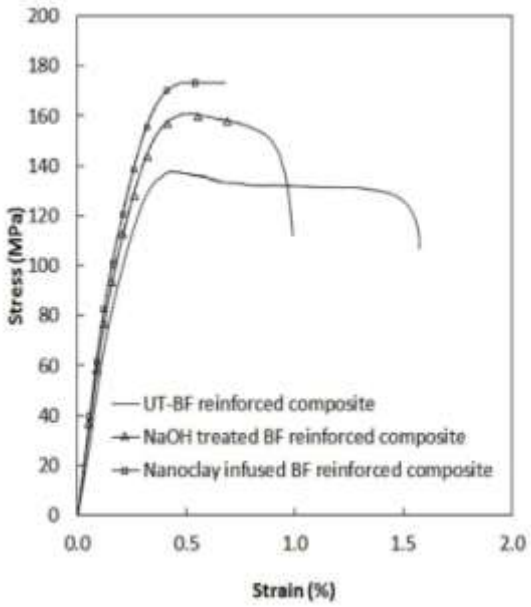
MATERIALS	COMPRESSIVE STRENGTH (KPa)
Untreated Banana Fibre Reinforced Concrete	100
Treated Banana Fibre Reinforced Concrete	120
Nanoclay Infused Treated Banana Fibre Reinforced Concrete	143

C0MPRESSIVE PROPERTIES OF BANANA FIBER REINFORCED CONCRETE AT 28TH DAY

Tensile strength results:

The value of tensile strength test results are shown below in the table.

Of the three specimens, nano-clay treated, treated and untreated fibre reinforced concrete, nano-clay treated banana fibre reinforced concrete provided the highest tensile strength value of 173 MPa and the lowest value of 137 MPa by untreated concrete.



The Young's modulus value of untreated and treated banana stem reinforced concrete was found to have same values of 8 GPa while nano-clay infused banana fibre reinforced concrete has a value of 10 GPa. So, it can be found that there is 25% increase in the value of Young's modulus from untreated to nano-clay infused banana fibre reinforced concrete.

Even the yield stress value is higher in nano-clay infused banana fibre reinforced concrete.

MATERIALS	YOUNG'S MODULUS (GPa)	ULTIMATE TENSILE STRENGTH (MPa)	YIELD STRESS (MPa)
Untreated Banana Fibre Reinforced Concrete	8	137	134
Treated Banana Fibre Reinforced Concrete	8	160	146
Nanoclay Infused Treated Banana Fibre	10	173	149

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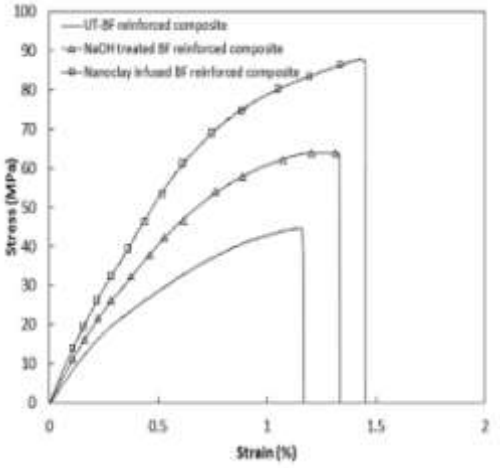
Reinforced Concrete			

TENSILE, MECHNICAL PROPERTIES OF BANANA FIBER REINFORCED CONCRETE AT 7^{TH} DAY

Flexural strength results: The flexural strength value of nanoclay infused banana fibre reinforced concrete is higher than treated fibre which in turn is higher than untreated fibre reinforced concrete.
The nanoclay infused banana fibre reinforced concrete is found to have two times the flexural strength of untreated fibre concrete.



From this we can observe that the energy absorption in nanoclay treated fibre reinforced concrete is two times greater than the untreated fibre concrete.

The flexural strength values are shown below in the table

FLEXURAL PROPERTIES	
FLEXURAL STRESS (MPa)	**FLEXURAL STRAIN (%)**
44	1.18
63	1.32
88	1.46

FLEXURAL PROPERTIES OF BANANA FIBER REINFORCED CONCRETE AT 7^{TH} DAY

Workability :
The workability of Banana fibre treated concrete is found to decrease with increase in fibre content in concrete.

V. CONCLUSION

The different behaviour of the banana fibre is studied in this paper. Banana fibres' mechanical and compressive values were recorded and observed. Banana fibres were extracted and it was treated with 3%NaOH solution. The banana fibres where divided into three parts. One part was untreated and one part was treated with NaOH solution . And the last part was infused with nanoclay. 9 samples (3cube, 3cylinder, 3beam) of banana fibre reinforced concrete were casted using these mixture. Experiments show that nanoclay has increased values in all the tests conducted. Compression results showed that nanoclay infused banana fibre reinforced concrete has more compressive strength than the untreated banana fibre and treated banana fibre reinforced concrete.

Also treated banana fibre reinforced concrete showed higher compressive strength values then the untreated banana fibre reinforced concrete. Tensile results show that nanoclay infused banana fibre reinforced concrete has more strength than the treated and untreated banana fibre reinforced concrete. Flexural results also showed that the nanoclay infused banana fibre reinforced concrete has2 times higher values than the treated and untreated fibre reinforced concrete. It was also noted that the nanoclay infused banana fibre reinforced concrete showed two times greater flexural strength than the untreated banana fibre reinforced concrete.

As far as Mechanical properties are concerned nanoclay has higher mechanical strength than the other to fibre reinforced concrete. The Young's modulus for the untreated and treated banana fibre reinforced concrete were are almost equal. The Young's modulus for the nanoclay infused banana reinforced concrete was 25% higher than the untreated fibre reinforced concrete. The yield stress and UTS test results also showed that nanoclay infused reinforced concrete has higher results than the other two fibre reinforced concrete. It has 3.1 to 3.7 times increased strain energy. Therefore it was clear from this study that the nanoclay fibre show greater results in all the tests. And this nanoclay infused fibre has 2 to 4 times increased energy absorption and Mechanical properties therefore this fibre resist crack propagation which eventually increases the duration of the concrete. Therefore nanoclay infused fibre reinforced concrete can be used as a construction material instead of normal concrete mixture.

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