Research Article **ISSN: 2395 – 5597**

International Journal of Engineering and Robot Technology

Journal home page: www.ijerobot.com

INVESTIGATION INTO THE STRUCTURALPROPERTIES OF SUGARCANE BAGASSE FIBER IN CONCRETE MATRIX

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ABSTRACT

The use of asbestos in concrete matrix such as pipes and roof tiles is being phased out due to health risks it poses. New substances such as glass, polypropylene, steel and other natural fibres are being used to reinforce concrete. The flexural and other strength properties of concrete reinforced with Sugar-cane fibre (Bagasse) were investigated by laboratory process. The specific gravity of the sugar-cane fibre was found to be 0.33. The mean water absorption value for the fibre is about 61 percent. The optimum water-cement ratio of its concrete was 0.58. The compressive strength of concrete was reduced by the inclusion of the fibre in concrete matrix. However, the flexural strength of the concrete reinforced with 25 percent of the fibre was improved to about 15 percent. The untreated (not coated with bitumen) concrete plate reinforced with sugar-cane bagasse fibre has 13.3 and the treated (bitumen-coated) plate has 3.9 mean percentage water absorptions. This is an important advantage in the plate's capacity to resist ingress of water when used as roofing sheet.

KEYWORDS

Bagasse, Flexural Strength, Roofing Sheet and Water Absorption.

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INTRODUCTION

Natural fibre has been used to reinforce concrete since ancient time; the use of straw in sun-dried mud bricks or the strengthening of mortar with horse hair are typical examples. Studies into their use in cementitious mixture seem to have gained popularity only in the last few decades (Li, 1993)[1]. According to him, although, some progress have being achieved, most notably, with roof tiles and roofing sheet using asbestos. Once the health risks associated with asbestos were discovered, there was a need to find replacement for the substance in concrete and other building materials. By the 1960s, steel, glass and synthetic fibres such as polypropylene fibres were used in concrete. The application of concrete in the field of structural engineering often involves a technique of reinforcing with materials to form a composite, so as to complement the undesirable properties of one to the other.

Concrete is good in compression but weak in tension and to overcome this deficiency, there is need for an additional material called reinforcement to help improve the tensile strength of concrete. Bagasse fibre is considered a potential light weight concrete composite material. It is the pulp or dry refuse left after the juice has been extracted from sugar cane (Stephens, 1984)[2]. Wang and Wu (2000)[3], in their Research found out that some of the outstanding functions of the fibres in fibre reinforced concrete which are restriction of creep in both tension and compression and strengthening of the material against the forces produced when water enters the pores in the cement or concrete, causing it to expand on freezing. Freeze-thaw damage is therefore reduced. Agopyan (1988)[4], found that elephant grass fibre improves the flexural and impact strength of cement sheet. Racines and Pama (2008)[5] also showed that bagasse and elephant grass fibres-concrete make good corrugated roofing sheets. They also found that sugar-cane bagasse could be used in the manufacture of fibre board. The dispersion of the fibre in the matrix, to a great extent, influences the strength of the resulting fibre-composite materials, and also that its strength could be increased by reinforcing it with stronger natural fibres, such as Bamboo strands at appropriate locations.

Bagasse fibre is a widely and cheaply available row material which could be obtained from any part of Nigeria. It is readily available in the farms or sugar mill industries. Bagasse fibre has a bulk density of about 120.1 kg/m^3 and a specific gravity of 0.5. Fibres of around 25mm mean sizes were found to be effective (Swamy, 1984)[6]. Similar results were discovered for elephant grass fibre (Obam, 2004).

Flexural strength is a measure of reinforced or unreinforced concrete beam or slab to bending stress. The property is of considerable importance in resisting cracking due to changes in moisture content or temperature. Typically, flexural strength of normal concrete is in the range of 3-7 N/mm^2 (Murdock, *et al*, 1991)[7].

$$\sigma_f = \frac{3FL}{4bd^2} \quad \text{---------------------------------[1]}$$

σ_f is flexural stress, F is maximum load, l is span of beam specimen, b is breath of beam specimen, and d is depth of specimen.

MATERIAL AND METHODS

Materials

The raw materials used in this research are Ordinary Portland cement (OPC), Rivers and, Bagasse fibre and pipe-borne water. They were all obtained in Makurdi, Nigeria.

Methods

Sieve Analysis

The bagasse fibres were sun-dried. The specific gravity of the bagasse fibre was found to be 0.33. The sand and the bagasse fibre were subjected to sieve analysis as specified in British Standard (BS) 812: section 103.1: 1985[8].

Water Absorption

Some bagasse fibre specimens were selected and weighed together (M_1). They were then soaked in water for 24 hours, then removed from the water and allowed to surface-dry. It was weighed (M_2). The process was repeated for 4 more samples. Equation (2) was used to calculate water absorption.

Percentage Water Absorption (WA) is given by

$$= \frac{M_2 - M_1}{M_1} x100 \quad \text{-----------------------------------[2]}$$

M_1 is dry mass of material

M_2 is surface-dry mass of material

CONCRETE PRODUCTION AND TESTING

Optimum Water-cement Ratio

The concrete mixing and casting were carried out manually. The 1:2:0.8 (Ratios for OPC, sand and bagasse fibre) mix ratios at0.50, 0.55, 0.58, 0.60, and 0.65 water-cement ratios were used to produce concrete cubes (150 mm size). Three cubes were produced for each mix ratio. The concrete cubes were demolded after 24 hours and immediately transferred to the curing tank. On the 28th day, the cubes were removed from the curing tank and then tested for compression as specified in BS 1881: parts 116: 1983[9].

Flexural Strength

Another concrete (ingredients: OPC, sand and bagasse fibre) was produced with 1:2 cement-sand mix ratios at 0.58 water-cement ratio and the following percentage fibre proportions: 0, 5, 10, 15, 20, 25, 30, and 35. Two concrete beams (500 x 100 x100 mm) were produced for each mix ratios. They were cured for 28 days then tested for flexural strength as specified in BS 1881: Part 118: 1983[9]. The mean flexural strength for each mix ratios noted.

The Fibre-Sandcrete Plate

The fibre-sandcrete plate (500 x500 x 25 mm size) was produced manually by mixing cement and sand in 1:2 ratios and 25 percent bagassie fibre with 0.58 water-cement ratios. 9 more samples of the fibre-sandcrete matrix plate were produced using the same procedure and mixes. They were cured for 28 days then allowed to dry at room temperature for 7 days. 5 of the plate specimens were each weighed (M_1) then immediately immersed in water for 24 hours. The remaining 5 plates were each rendered (coated) with hot bitumen (BS 4147)[10] and allowed to dry for 24 hours then immersed in water for 24 hours. They samples were removed from the water and allowed to surface-dry. Each plate was then weighed (M_2). The water absorption of the plate is given by equation (2). 3mm nails were driven with hammer through each of the plates.

RESULTS AND DISCUSSION

The result of the grading of the sugarcane bagassie fibre is shown in Figure No.1. The maximum size of the fibre used is 15mm. The water absorption properties of the fibre are shown in Table No.1. The mean water absorption value for the fibre is about 61 percent. This is a high value and is typical of organic fibres (Uzomaka, 1976)[11].

Table No.2 and 3 show the water absorption values for the untreated (uncoated) fibre-sandcrete plates and bitumen-rendered fibre-sandcrete plates respectively. The average water absorption values are 13.6 and 3.9 respectively. The water absorption of the uncoated fibre plate was reduced by 71 percent when it was coated with bitumen.

The relationship between the compressive strength of the fibre-concrete and water-cement ratios is shown in Figure No.2. The optimum water-cement ratio for its concrete is 0.58. It was also discovered that including the fibre in concrete matrix reduces its compressive strength. Figure No.3 shows the relationship between the flexural strength of the fibre-concrete and percentage of the fibre in concrete matrix. It was found that the optimum percentage of the fibre in the concrete is 25. These values are similar to the ones found for elephant-grass fibre (Obam, 2004).

Table No.1: Water Absorption Values of the Fibre

S.No	Weight of Can (A) (g)	Weight of Can + weight of saturated sample(B) (g)	Weight of Can + weight of Oven-dry sample (D) (g)	Weight of Water in the Sample (B-A) (g)	Weight of dry Sample (D-A) (g)	Water absorption (%)
1	28.4	32.6	30.0	4.2	1.6	61.9
2	28.3	33.5	30.2	5.2	1.9	63.5
3	28.6	34.0	30.6	5.4	2.0	63.0
4	28.3	33.9	30.4	5.6	2.1	62.5
5	28.5	37.1	32.4	8.6	3.9	54.7
6	28.5	36.3	31.5	7.8	3.0	61.5
7	28.4	38.5	33.2	10.1	3.8	62.4
8	28.3	36.3	31.6	8.0	3.3	58.8
9	28.7	40.2	33.2	11.5	4.5	60.9
10	28.4	39.6	32.6	11.2	4.2	62.5
Mean						61.2

Table No.2: Water Absorption Values of the Fibre-Sandcrete Plate (uncoated with bitumen)

S.No	Dry Weight of Absorption Sample (M_1) (Kg)	Wet Weight of Sample (M_2) (Kg)	Water (%)
1	12.56	14.20	13.1
2	12.43	14.15	13.8
3	11.91	13.46	13.0
4	12.32	14.02	13.8
5	12.48	14.24	14.1
Mean			13.6

Table No.3: Water Absorption Values for the bitumen-coated Fibre-Sandcrete Plate

S.No	Dry Weight of Sample (M_1) (Kg)	Wet Weight of Absorption Sample (M_2) (Kg)	Water (%)
1	13.66	14.20	4.0
2	13.71	14.24	3.9
3	13.54	14.14	4.4
4	13.36	13.86	3.7
5	13.62	14.09	3.5
Mean			3.9

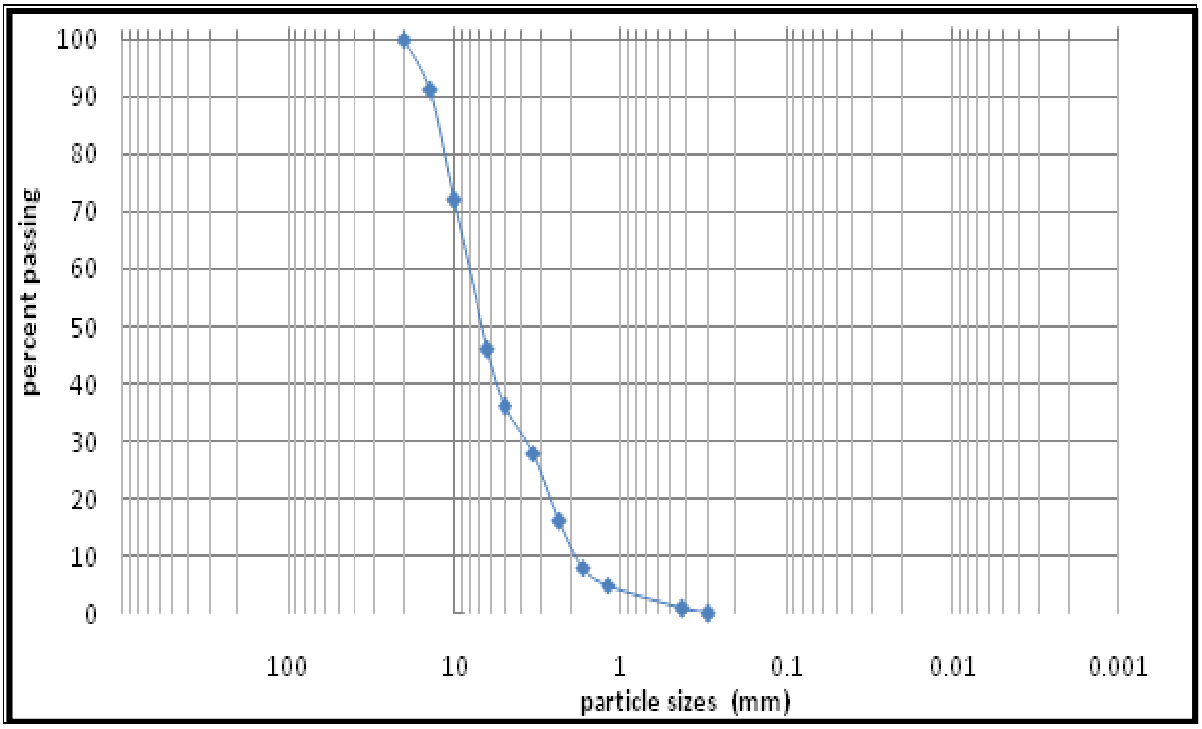

Figure No.1: Grading Curve of the Bagasse Fibre

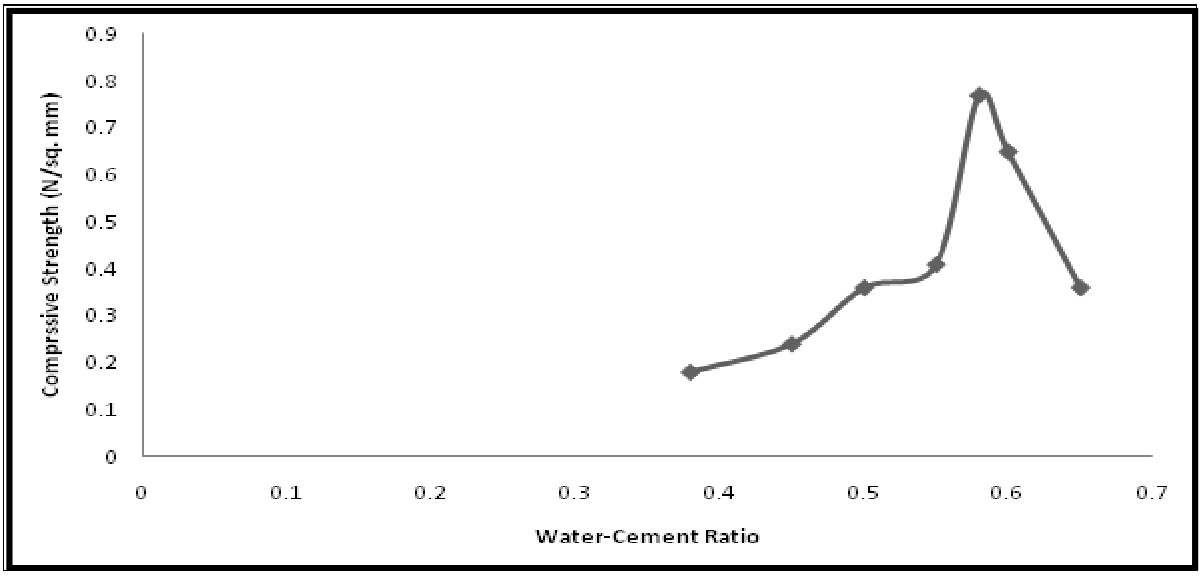

Figure No.2: Water-cement Ratio Vs Compressive Strength of the Baggassie-Fibre Concrete

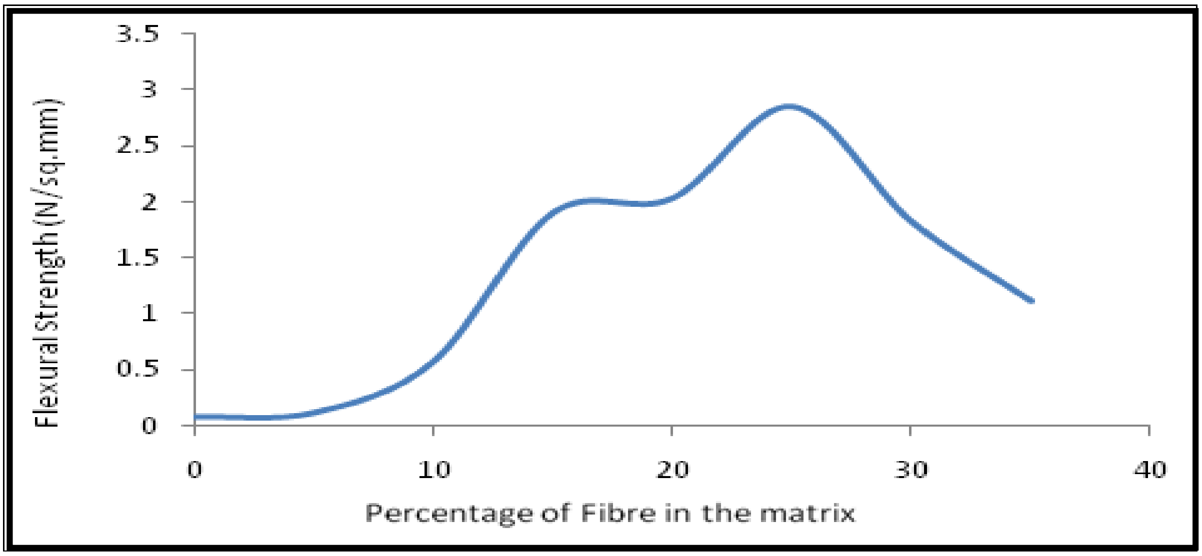

Figure No.3: Percentage of Fibre in the Matrix Vs Flexural Strength

CONCLUSION

Organic fibres are environmentally friendly. The production of acceptable building materials using vegetable fibre such as sugar-cane bagasse fibre will provide not only cheap material for the builder but could reduce the demand for the traditional materials, such as asbestos and polypropylene; forcing down their prices and minimizing their environmental hazards. The research investigates the tensile strength, water absorption and specific gravity of sugar-cane baggasse fibre and its concrete properties. Laboratory experimental procedures were adopted. The specific gravity of the sugar-cane fibre was found to be 0.33 and its mean water absorption value is about 61 percent. The optimum water-cement ratio of its concrete was 0.58. The compressive strength of concrete was reduced by the inclusion of the fibre in concrete matrix. However, the flexural strength of the concrete reinforced with 25 percent of the fibre was improved to about 15 percent. The fibre-sandcret plate showed potential for being used as roofing material.

ACKNOWLEDGEMENT

The authors wish to express their sincere gratitude to Department of Civil Engineering, University of Agriculture Makurdi, Nigeria for providing necessary facilities to carry out this research work.

CONFLICT OF INTEREST

We declare that we have no conflict of interest.

BIBLIOGRAPHY

1. Li V C. From Mechanics to Structural Engineering-The design of cementitious composites for Civil Engineering Applications, *Structural Engineering/ Earth-quake Engineering Journal*, 10(2), 1993, 37-48.
2. Stephens D J. Natural Cement Composites for Economic Housing, *Journal of Light-Weight Concrete*, 12(7), 1984, 98-104.
3. Wang Y, Wu H C. Concrete Reinforcement with Recycled Fibers, *Journal of Materials in Civil Engineering*, 12(4), 2000, 314-319.
4. Agopyan V. Vegetable fibre reinforced building material, *Blackie and sons LTD, London*, 1988, 208-242.
5. Racines P G and pama R P. A study of Bagasse Fibre Cement Composite a Low-Cost Construction Material, *Unity Press, Bangkok*, 43(4), 2008, 191-206.
6. Swamy L. Reinforced Concrete, *Surrey University press*, *London*, 1995, 200.
7. Murdock L S. Concrete Materials and Practice, *Roland Ph. Ltd*, 46(1), 1995, 36-39.
8. British Standard Sieve analysis, 812, 1985, 103.1.
9. British Standard Method for determination of flexural strength, 1881, 1983, 116.
10. British Standard Specification for Bitumen Based Hot Applied Coating Material for Iron and Steel Including Suitable Primers Where Required, 1980, 4147.
11. Uzomaka O J. Characteristics of ‘Akwara’ as reinforcing Fibre, *Magazine of Concrete Research*, 28(96), 1976, 162-167.

Please cite this article in press as: Obam Ogah and Kassar Terungwa. Investigation into the structural properties of sugarcane bagasse fiber in concrete matrix, *International Journal of Engineering and Robot Technology*, 3(1), 2016, 1-6.