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Strength Characteristics of Concrete Reinforced With Sugar Cane Bagasse Fibre

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Abstract: *This paper examined the strength characteristics of sugar cane Bagasse fibre incorporated into concrete. The Utilization of fibre in concrete production not only solves the problem of disposing this solid waste but helps conserve natural resources. A total of 40 each for cubes, cylinders and beams were cast for this study. The cubes were of dimension 100mm×100mm×100mm, the beams were 500mm×100mm×100mm in cross-section while the cylinders were 100mm in diameter and 200mm long. Five mixes of various strength grades were prepared at varying percentages of 0, 0.5, 0.75, 1.0 and 1.25%. The concrete with no fibre served as control. Conplast SP430MS was used as superplasticiser. Water-cement ratio of 0.5 was maintained for all mixes. The design mix obtained was1:1.7:2.5. Compressive strength, flexural strength, splitting tensile strength were determined at 7, 14, 21 and 28 days of curing.*

Keywords: *Sugarcane bagasse fibre, superplasticiser, compressive strength, split tensile strength, natural fibre*

I. Introduction

The concept of using fibres as reinforcement is not new. Fibres have been used as reinforcement since ancient times. Historically, horsehair was used in mortal and straw in mud bricks. In the early 1900s, asbestos fibres were used in concrete. In the 1950s, the concept of composite materials came into being and fibre-reinforced concrete was one of the topics of interest. Once the health risks associated with asbestos were discovered, there was a need to find a replacement for the substance in concrete and other building materials. By the 1960s, steel, glass (GFRC), and synthetic fibres such as polypropylene fibres were used in concrete. Concrete is one of such classical construction material, which achieved its strength, durabitlity, stability, availability and adaptability. The application of concrete in the field of structural engineering often involves a technique of reinforcing with other materials to form a composite material, so as to complement the undesirable properties of one to the other.

Bagasse fibre is a by-product of sugar cane industry whose role is sugar, rum or biofuel production. This industry is located in the tropical and sub-tropical regions of the world where sugar cane (Scientific name Saccharum officinarum) is cultivated. Sugar cane bagasse is the left over after crushing of the stalk to extract the sugar cane juice from which sugar is obtained by evaporation, crystallization and rum and ethanol which is used as bio-fuel, are obtained by fermentation. It is a generally known fact that concrete has a very high compressive strength but very limited tensile strength and to overcome these deficiencies there is need for an additional material called reinforcement to help improve the deficient tensile strength of concrete.

However, the conventional ordinary steel-reinforced concrete construction more than ever before is becoming expensive in production costs, transportation of pre-cast members, maintenance costs and the supply of much amount of steel, which takes huge capital investment to produce locally. This paper presents the results of the % volume of fiber, compressive and flexural strength of fiber reinforced concrete beams.

II. Materials And Method

The materials used for this project were locally sourced. Sugar cane bagasse rods were obtained from the rain forests of North-East Nigeria. These were cut into small relatively uniform strips using a sharp knife. The dimensions of the strips were measured with the aid of Vernier Callipers. The Sugar cane bagasse fibre were 38.44mm long and 1.8mm diameter (aspect ratio 21.36) with a mass of 26.74(kg). CONPLAST SP 430 superplasticizer admixture was used. Water -cement ratio of 0.5 was maintained for all mixes. The design mix obtained was1:1.7:2.5. The equivalent weights of the materials were: Cement (125.27kg), Sand (254.53kg), Granite (381.8kg) and Water (62.04kg) , the summary of the material used, mixed proportion for each mix and description of the mixes are shown in table 1.1, 1.2 and 1.3..

Table 1.1: Summary Of Materials Used

Quantities	Cement (kg)	Fine Agg. (kg)	Coarse Agg. (kg)	Water (kg)	Baggase (kg)	Super-plasticizer(kg)
Per m^3 of Concrete	125.27	254.53	381.8	62.64	26.74	0.125

Table 1.2: Summary Of Mix Proportions For Each Mix

Mix No	Mix ID	Water (kg)	Cement (kg)	CA (Kg)	FA (kg)	SBF (kg)	SP (g)	W/C
1	G	12.72	25.44	76.32	50.88	-	0.025	0.5
2	I	12.72	25.44	76.32	50.88	3.82	0.025	0.5
3	F	12.72	25.44	76.32	50.88	5.75	0.025	0.5
4	2	12.72	25.44	76.32	50.88	7.63	0.025	0.5
5	N	12.72	25.44	76.32	50.88	9.54	0.025	0.5

Table 1.3 Description Of Mixes

Mix No	Mix ID	Description
1	G	0% fibre(Plain concrete)
2	I	0.5% sugar cane bagasse fibre
3	F	0.75% sugar cane bagasse fibre
4	2	1.0% sugar cane bagasse fibre
5	N	1.25% sugar cane bagasse fibre

1.1Sample Preparation

The test specimen were cubes of 100 × 100 × 100mm, rectangular beams of 500 x 100 x 100mm, and cylinders of 100mm in diameter and 200mm long mixed with sugar cane bagasse fibre in varying percentages from 0% to 1.25% and with the required dosage of super plasticizer to improve workability of the mix. Crushing of the cubes was carried out at 7, 14, 21 and 28 days respectively to determine the compressive strength of the concrete, the beams were subjected to flexural tests using the centre-point loading method, and splitting tensile strength test was performed on the cast cylinder samples at curing ages of 7, 14, 21 and 28 days.

III. Results And Discussion

This results show that plain concrete (0% volume of fibre) had the highest compressive strength of 22.32 MPa at 7 days, 26.82 MPa at 14 days, 31.12 at 21 days and 36.20 at 28 days.(see Table 1.4). This implies that the compressive strengths of concrete increase as number of days increases.
Furthermore, the more the increase in the volume of fibre in concrete, the lower the compressive strength of concrete. There was much reduction in the compressive strength of concrete when sugar cane bagasse fibre volume was increased from 0% to 0.5% and also a considerable strength in concrete upon increasing the fibre volume to 0.75%-1.0%-1.25%. This suggests that increase in volume of sugar cane bagasse fibre in concrete has little effect on the compressive strength of concrete.

Table 1.4: Summary Of Compressive Strength Test Results For Cubes

Mix No	Mix ID	Average Compressive Strength (MPa)			
		`7 days	14 days	21 days	28 days
1	G	22.32	26.82	31.12	36.20
2	I	0.011	0.016	0.026	3.09
3	F	0.0055	0.001	0.002	2.55
4	2	0.0035	0.0075	0.016	2.11
5	N	0.003	0.0075	0.008	1.09

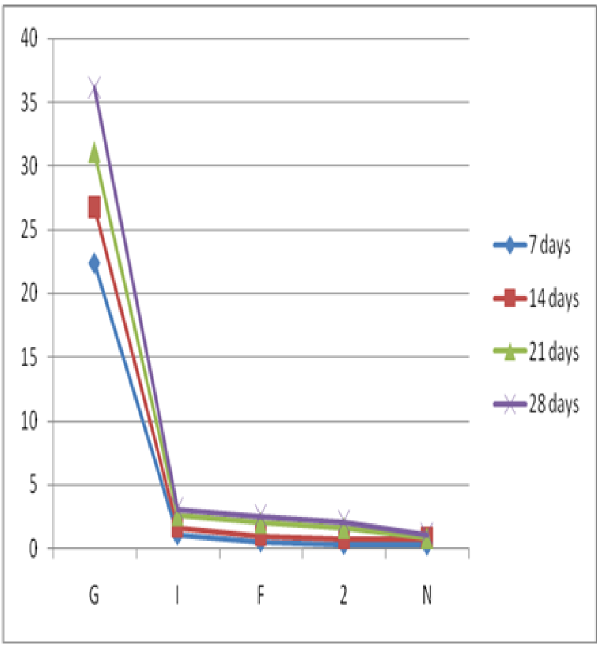

Fig. 1.1:Compressive strength for all mixes at various ages

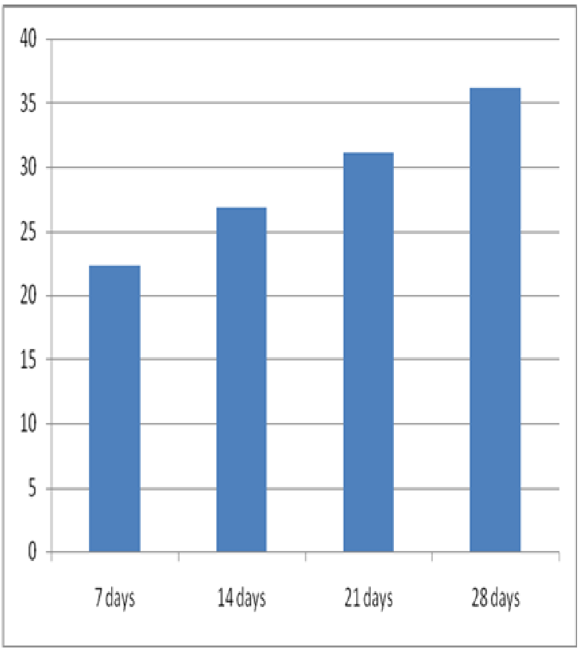

Fig. 1.2: Compressive strengths for 0% (Plain concrete) mix at various ages

The result shown graphically in Fig. 1.3and Fig. 1.4 shows that plain concrete (0% volume of fibre) has the highest flexural strengths of 2.24MPa at 7 days, 2.48 MPa at 14 days, 3.14 at 21 days and 3.15 at 28 days. This implies that the flexural strengths of concrete increase as number of days increases, the flexural strength decreases with the volume of fibres in the concrete. That is, the more the volume of fibres in the concrete, the lower the flexural strength of concrete.

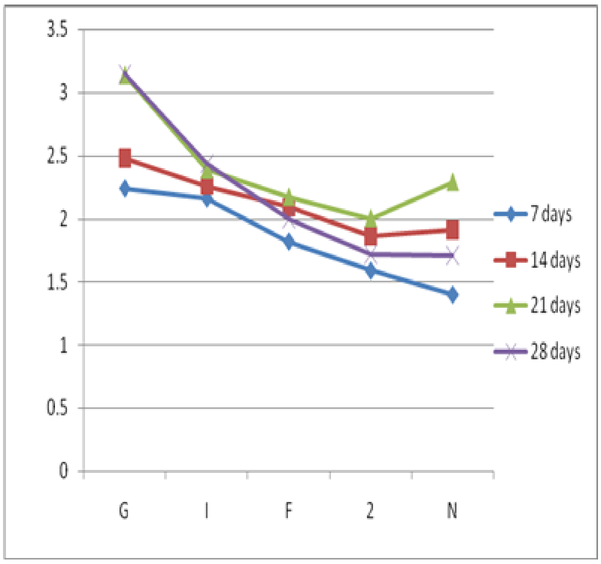

Fig. 1.3: Flexural strengths for all mixes at various ages

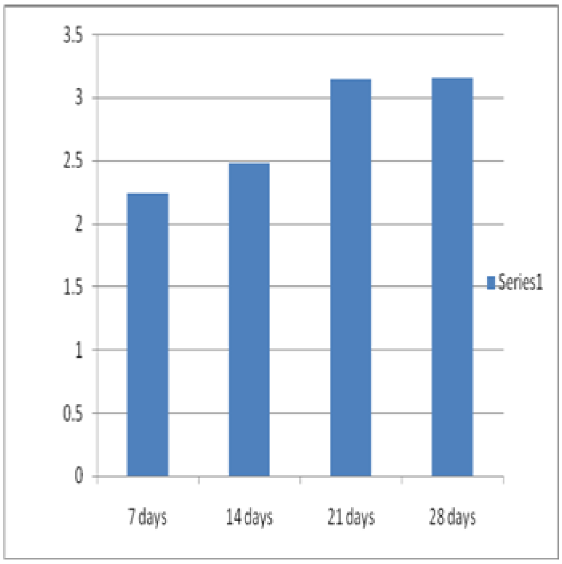

Fig. 1.4: Flexural strengths for 0% (plain concrete) mix at various ages

The result shown in Fig. 1.5 and 1.6 indicates that concrete containing 0% volume of sugar cane bagasse fibre as having the greatest splitting tensile strengths of 1.81 MPa at 7 days, 2.10 MPa at 14 days, 2.40 MPa at 21 days and 2.65 MPa at 28 days. This suggests that the splitting tensile strength of concrete increases as the days increases. In addition, sugar cane bagasse fibre seems to have no effect on the splitting tensile strength of concrete because the more the volume of fibre, the lower the splitting tensile strength of concrete which implies that the splitting tensile strength is seen to decrease with increasing fibre content.

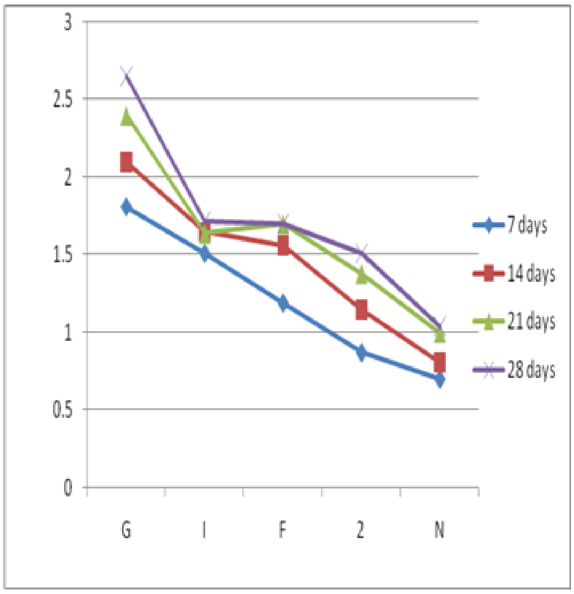

Fig. 1.5: Splitting tensile strengths for all mixes at various ages

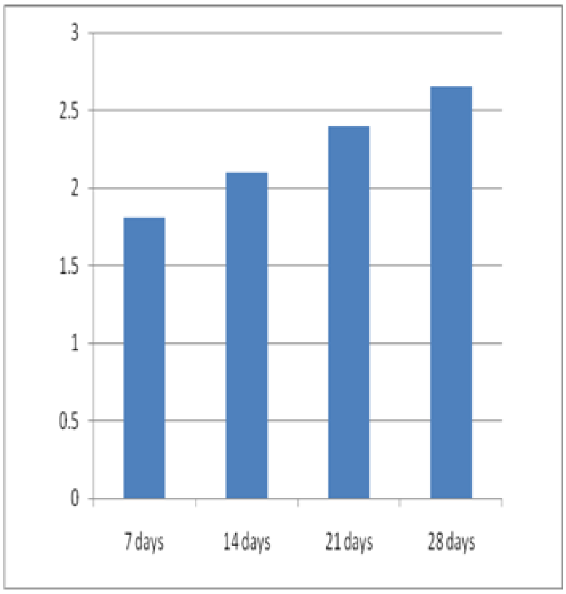

Fig. 4.6: Splitting tensile strengths for 0% (plain concrete) mix at various ages

IV. Conclusion

1. Sugar cane bagasse fibres have little impact on the compressive strength of concrete. Tthe compressive strength of plain concrete was seen to reduce so much when sugar cane bagasse fibre was added.
2. The flexural and splitting tensile strengths of concrete were significantly reduced by the addition of sugar cane bagasse fibre. Concrete containing 0% sugar cane bagasse fibre produced greatest effects on flexural strength (24% increase in strength) and splitting tensile strength(30% increase in strength).
3. Sugar cane bagasse fibre is not suitable for use in concrete since it does not improve the concrete compressive, flexural and splitting tensile strengths.

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