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An Experimental Study on Properties of Bagasse Ash Concrete with Steel Fibre

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Abstract: This paper reports on a comprehensive study on the properties of concrete contain bagasse ash and steel fibers. Properties studied include unit weight and workability of fresh concrete, and compressive strength, flexural tensile strength, splitting tensile strength. Bagasse ash is lateral product of sugarcane that is obtained after heat treatment of sugarcane. Steel fibers are concrete reinforcing material which in combination with concrete provides certain advantages in comparison with traditional reinforcement. Steel fibers are made from different wire materials, designed to provide concrete with temperature and shrinkage crack controls, enhanced flexural reinforcement, improved shear strength and increase the crack resistance of concrete. In this investigation we are using the fineness ratio's percentages as 15% of bagasse ash as replacement of cement and fiber volume fraction was 0%, 1.0%, 2% and 3% in volume proportion. The laboratory results showed that steel fiber addition, either into Portland cement concrete or bagasse ash concrete, improve the tensile strength properties and reduce workability.
Keywords: Bagasse Ash, steel fiber, experimental study, partial replacement, sugarcane

I. INTRODUCTION

The use of bagasse ash in concrete is found to affect strength characteristics adversely. One of the ways to compensate for the early-age strength loss associated with the usage of bagasse ash is by incorporating fibers, which have been proved very efficient in enhancing the strength characteristics of concrete [1]. The addition of fibers to concrete considerably improves its structural characteristics such as static flexural strength, impact strength, tensile strength, ductility and flexural toughness [2]. For long term, strength and toughness and high stress resistance, steel fiber reinforced concrete (SFRC) is increasingly being used in structures such as flooring, housing, precast, tunnelling, heavy duty pavement and mining. Generally, aspect ratios of steel fibers used in concrete mix are varied between 50 and 100.The most suitable volume fraction values for concrete mixes are between 0.5% and 2.5% by volume of concrete [3]. In general, the character and performance of fiber reinforced concrete changes with varying concrete formulation as well as the fiber material type, fiber geometry, fiber distribution, fiber orientation and fiber concentration [4].

Although, there were numerous studies carried out on the influence of fiber addition in concrete mixture mechanical and durability properties of concrete limited research work has been carried out concerning the influence of fiber addition in concrete with pozzolans.

Topcu and Canbaz [5] studied the effect of steel and polypropylene fibers on the mechanical properties of concrete containing fly ash. According to the results of the study, addition of fibers provide better performance for the concrete, while fly ash in the mixture may adjust the workability and strength-loss caused by fibers, and improve strength gain.

An area that has not been extensively examined previously is the effect of steel fiber additions on the mechanical properties of bagasse ash concrete.

Researchers have studied bagasse ash concrete and fiber reinforced concrete separately; however, considering reinforcing fibers with bagasse ash in concrete is an area that needs more study. The purpose of this research is to study the effects of steel fibers on the unit weight, workability, compressive strength, split tensile strength, flexural tensile strength.

II. EXPERIMENTAL INVESTIGATION

A. General

In the present study, cube, cylinder and prism were cast using M25 grade of concrete in the ratio 1:2.22:3.41 with water cement ratio 0.4. Tests were conducted to study compressive strength, split tensile strength and flexural tensile strength on cube, cylinder and prism respectively

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B. Material Properties

1) *Cement:* The ordinary Portland cement of 53 grade is used. Properties of this cement were tested and listed here.
   a) Fineness of cement = 3%
   b) Specific gravity if cement = 3.14
   c) Standard Consistency of cement= 29%
   d) initial setting time = 28 mins
   e) Final setting time = 280 mins
2) *Coarse Aggregate:* Crushed stone aggregate of 20mm size is brought from nearby quarry. Aggregates of size more than 20mm size are separated by sieving. Tests are carried to find out the
   a) Specific gravity = 2.65
   b) Fineness modulus = 7.6
3) *Fine Aggregate:* Manufactured sand is used in this study. It is replacement material for river sand. The result of sieve analysis confirms to

   Zone-II (according to IS: 383-1970).The tests conducted, and results plotted below.
   a) Specific gravity = 2.55
   b) Fineness modulus =3.06
4) *Steel fiber:* Steel fiber was RC 65/35 BN type low carbon and its both ends were hooked.
   a) Aspect ratio – 100
   b) Density – 7850 kg/m^3
5) *Bagasse Ash:* The test results of fly ash are as follows.
   a) Specific gravity = 2.08
   b) Fineness modulus = 4%
   c) Consistency = 36%
6) *Super Plasticizer:* Adva 960 is used where a high degree of workability. It facilitate production of high quality concrete. The properties of Super plasticizers are as follows.
   a) Specific gravity = 1.20-1.21
   b) percentage used = 0.7%
7) *Water:* Generally potable water should be used. This is to ensure that the water is reasonable free from such impurities as suspended solids, organic matter and dissolved salts, which may adversely affect the properties of the concrete, especially the setting, hardening, strength, durability, pit value, etc.

III. MIX DESIGN AND PROPORTIONS

A mix proportion of 1:2.22:3.41 with a water cement ratio of 0.4 is designed to give M25 grade concrete and in the following table quantity of ingredients are given

TABLE 1 mix proportions

Grade of concrete	Cement (kg/m^3)	FA (kg/m^3)	CA (kg/m^3)	Water (lit/m^3)
M25	350	780	1192.5	140

IV. CASTING AND CURING OF SPECIMENS

The specimens are cast by required size of moulds. The concrete is placed by the three layers for proper compaction. After casting, specimens are left for 24 hours for setting and then it is demoulded. Identification marks are made on the face of the specimen and it is immersed in curing tank.

The ordinary curing for specimen is done for 7, 14 and 28 days. Minimum three specimens were cast for each mix.

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Table 2 Specimen Details

S.No.	SPECIMEN	SIZE OF SPECIMEN	STANDARD NO of SPECIMENS
1	Concrete Cube	150mmx150mmx150mm	3
2	Cylinder	150x300mm	6
3	Prism	100mmx100mmx500mm	3

V. TESTINGMETHODS

Compressive strength, split tensile strength and flexural tensile strength were conducted and details of these tests are given in the following sections.

A. Compressive Strength Test

The compressive strength was performed on cubes of sides 150 mm in accordance with IS 516-1959. The specimens were tested in compression testing machine of capacity 3000kN. The cubes were placed in the machine such that the loading is applied to opposite side of cube as cast.

FIG 1 compressive strength test

B. Split Tensile Test

It is an indirect test to determine the tensile strength of cylindrical specimens. Split tensile test was carried out in compression testing machine. The tensile strength is calculated using equation and results were tabulated.

$$\mathbf{f_t=2P/\pi LD}$$

FIG 2 Split Tensile Test

C. Flexural Tensile Test

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam to resist failure in bending. Flexural strength is about 10 to 20 percentage of compressive strength depending on the type, size and volume of coarse aggregate used. The flexural strength of its calculated using the equation and results were tabulated.

$f_{cr}=PL/BD^2$

VI. TEST RESULTS

A. Compressive Strength Of Concrete

Compressive strength of concrete mixtures was measured at the ages of 7, 14 and 28 days and shown in Table 1. There was an increase up to 10% and reduction up to 6% compressive strength of cube concrete specimens produced with steel fiber. This may be due to the physical difficulties in providing a homogeneous distribution of the steel fibers within the concrete causing rise or drop in the compressive strength as compared to the plain concrete. The addition of steel fibers to the concrete mixture did not improve its long-term compressive strength, in general, only small increase (up to 10%) in compressive strength with increase in fiber content was observed.

TABLE 3 Compressive Strength of Concrete (N/mm^2)

MIX ID	STEEL FIBRE (%)	7 DAYS	14 DAYS	28 DAYS
M1	0	22.12	28.44	31.28
M2	1	23.9	30.6	33.78
M3	2	24.6	31.8	35.47
M4	3	23.7	31.1	34.87

B. Split Tensile Strength Of Concrete

The results show that in general, there is an increase in splitting tensile strength varying from 1% to 71% with the addition of fibers to the concrete. Steel fibres in the concrete increase the splitting tensile strength. For 1.0% and 2% the increase is significant. The highest volume fraction of fibers gives the maximum increase of strength. With 15% bagasse ash this results an increase in flexural strength of 71%.

TABLE 4 Split Tensile Strength of Concrete(N/mm^2)

H;1	STEEL FIBRE (%)	7 DAYS	14 DAYS	28 DAYS
M1	0	3.18	4.26	4.83
M2	1	4.24	5.89	6.24
M3	2	4.96	6.34	6.69
M4	3	4.12	5.21	6.15

C. Flexural Strength of Concrete

The results of flexural tensile strength tests conducted on steel fiber reinforced concrete are presented in Table 5. This comparison is valid for the concrete made with steel fiber. This On the other hand, steel fibers have no significant effects on flexural tensile strength at 1% volume fractions used in this study. The increase in the fiber content in concrete results with the further increase in flexural tensile strength for both Portland cement concrete and Bagasse ash concrete. The increase in the flexural tensile strength of concrete with the addition of steel fiber was explained in the following. Under fourth point loading, concrete prism beam specimen was subjected to bending, which results tensile and compressive strength depending on the position of distance from neutral axis. At the failure load, resultant compressive stress is nearly 6–10% of the compressive strength of the material. Therefore, it does not play an important role for the failure by compression.

However, it was the flexural tensile stress or strength that play an important role for the failure of beam. Randomly distributed steel fiber controls these cracks and stitch them.

Therefore, when steel fiber controls these crack, the load to fail the beam specimen has to be increased to cause more crack for the failure. Thus, steel fiber addition increases the ultimate flexural tensile strength of material [22]. The more the steel fiber amount in concrete the higher the increase in flexural tensile strength can easily be concluded.

TABLE 5 Flexural Strength of Concrete(N/mm^2)

MIX ID	STEEL FIBRE (%)	7 DAYS	14 DAYS	28 DAYS
M1	0	2.8	3.2	3.6
M2	1	4.21	5.39	5.67
M3	2	4.96	6.34	6.72
M4	3	4.27	5.68	6.21

VII. CONCLUSIONS

From this experimental work the following conclusions were made.

A. Addition of steel fiber reduced workability with increasing fiber content. The addition of steel fibers into concrete mixture did not improve its ultimate compressive strength, in general only small increase in compressive strength with increase in fiber content was observed. .

B. In general, the addition of steel fibers did not improve the values of modulus of elasticity, but also reduced with increasing fiber content. Moreover, there is no clear indication of significant effect of Bagasse ash on the split tensile strength of concrete.

C. From the results, we can clearly identify that optimum percentage of steel fiber was 2%.

D. From the experimental investigation it is observed that addition of 2% of steel fiber and cement by bagasse ash improvement in strength up to 5%.

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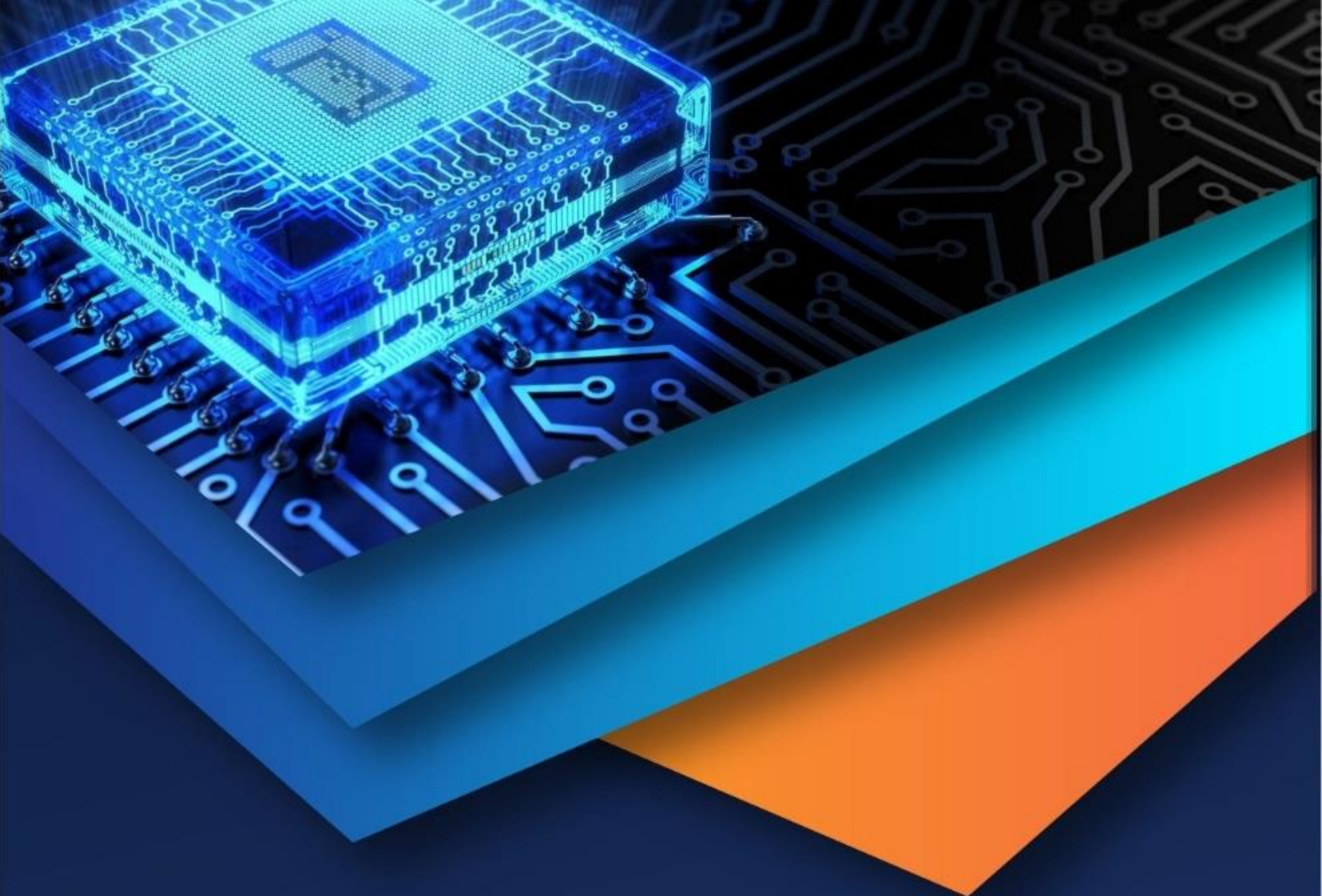

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