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Research Article

STUDY ON STRENGTH PARAMETER OF CONCRETE BY PARTIALLY REPLACING CEMENT WITH BAGASSE ASH AND SUGARCANE FIBER

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ABSTRACT

The aggregates which are produced naturally facing a major problems so alternative sources are used in the production of concretes with aggregates. Here, the finely powdered bagasse ashes are used as a partial replacement of cement in concrete and compared it with conventional concrete. In this work, the mechanical and durability properties of concrete with bagasse ash which is partially replaced with cement (5%, 10%, 15% to weight of cement) additional to it sugarcane fiber is also added (0.5% and 1% to weight of cement) is studied. The physical and chemical properties of the collected samples are determined. The hardened concrete specimens were subjected to compression and tensile tests after 7, 21 and 28 days of curing. The durability of the concrete specimens to sulphate attack and acid attack are tested. The concrete specimen in which the bagasse ash is partially replaced with cement showed higher values of compressive strength and tensile strength when compared to that of conventional concrete and the durability of the concrete specimens were found to be similar to that of conventional concrete.

INTRODUCTION

The main problem in construction industries is unavailability of construction materials, on the other side the main environmental problem is industrial waste. In the experimental study, an attempt has been made to use the bagasse ash in concrete. Instead of disposing, the industrial waste can be recycled and used in the construction process. The attempt has been made to utilize the industrial waste of bagasse ash used as supplementary cement replacement materials. This work examines the possibility of using bagasse ash as a partial replacement of cement and natural sugarcane bagasse for new concrete.

Bagasse ash will be partially replaced as 5%, 10%, 15% and sugarcane fiber of 0.5% and 1% is added for each bagasse ash replacement concrete and tested for its compressive strength and tensile strength up to 28 days of age and were compared with those of nominal concrete. To improve the quality and reduce cost of material we can replace cement with bagasse ash (Srinivasan and Sathiya, 2010). Requirement for economical and environment-friendly materials has extended an interest in natural fibers like natural sugarcane bagasse have been utilized. These wastes should be disposed properly without affecting the environment as well as human beings (Apurva, *et al.*, 2013).

EXPERIMENTAL PROGRAMME

Materials used

This experiment includes the casting, testing and comparison of conventional concrete with cement being replaced with bagasse ash at 5%, 10%, and 15% by weight addition to it 0.5% 1.0% of sugarcane fiber

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is added.

Bagasse ash

Bagasse ash was used as a partial replacement of cement for various volume ratios (5%, 10%, and 15%). It acts as a good pozzolanic material and can be used as an add-on for cementitiousmaterial (Inbasekar, *et al.*, 2016). The specific gravity of the bagasse ash used was 2.2. The microscopic image of bagasse ash particle used and the chemical composition of the bagasse ash is given below (Fig. 1).

Sugarcane fiber

It is a major food crop for tropics and subtropics. It is the important raw materials used for sugar production. Sugarcane bagasse is the waste produced after juice extraction from sugarcane. The Sugarcane bagasse ash is obtained as by product of control burning ofsugarcane bagasse (Abdulkadir, *et al.*, 2014; Richard, *et al.*, 2014). In this work sugarcane fiber which is used as an addition to increase the strength of the concrete (Table 1).

Mix proportions

The mix design was carried out as per the method featured in (IS: 10262, 2009). The grade of concrete chosen was M25 and it was designed to obtain a target strength of 31.6 (N/mm^2) at 28 days. The mix details are presented in Table 2.

Compression strength

Cube specimens of size 15 cm × 15 cm × 15 cm were casted for 0%, 5%, 10% and 15% particle replacement with cement and compared with conventional concrete. Universal testing machine (UTM) was used to calculate the maximum load (Fig. 2 and 3). The cube specimens were tested after 7, 21 and 28 days of curing (Tables 3 and 4).

Test for split tensile strength

Cylindrical specimens of diameter 15 cm and height 30 cm were used to determine the split tensile strength of the concrete. Universal testing machine was used to calculate the maximum load. The cylinders were tested after 7, 21, and 28 days of curing (Fig. 4 and 5). The load is applied gradually till the specimen fails (Tables 5 and 6) (Kawade, *et al.*, 2013; Ashish and Anupam, 2015).

Test for durability

Chemical attack on concrete often leads to deterioration and results in the failure of the structure. Hence it is necessary to test the durability of the concrete against chemical reactions. Six cubes were casted for each specification of concrete. The

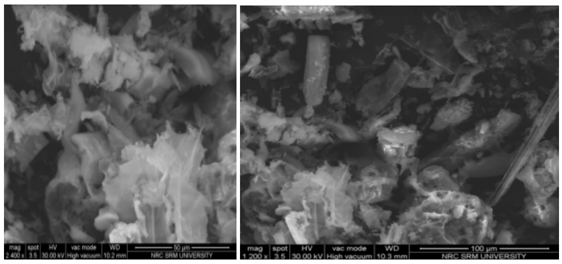


Fig. 1 FESM images of the bagasse ash particle.

Table 1. Constituents of sugarcane bagasse ash

S. No	Component	Mass %
1.	Silica (SiO_2)	66.88
2.	I. Alumina (Al_2O_3) II. Ferric Oxide (Fe_2O_3)	29.19
3.	Chloride	-
4.	Loss of Ignition	0.75
5.	Sulphur Trioxide (SO_3)	0.56
6.	Magnesium Oxide (MgO)	0.85
7.	Calcium Oxide (CaO)	1.86

Table 2. Mix ratio for M25 grade concrete

Grade of concrete	M25
Target strength	31.6 N/mm^2
Mix ratio	1:1.54:2.53
Water cement ratio	0.45

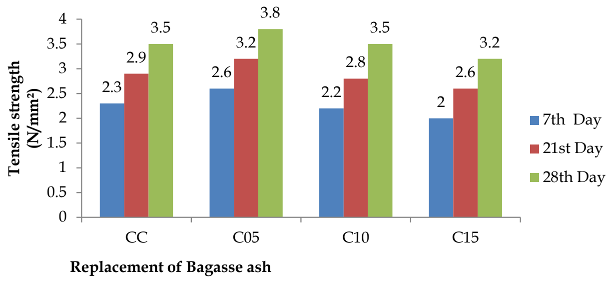


Fig. 2 Compressive strength for conventional concrete and bagasse ash concrete.

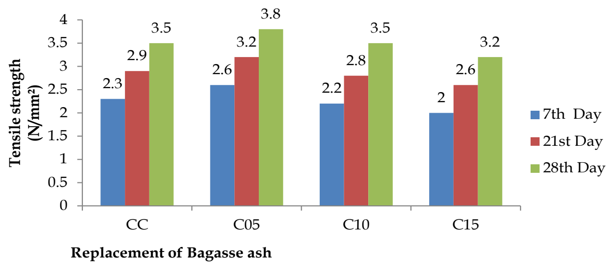


Fig. 3 Compressive strength for bagasse ash and sugarcane fiber concrete.

casted cubes were cured in clean water for seven days. After curing, the cubes were dried for 24 hours. The dry weights of the cubes were noted down. Then the cubes were cured in the respective chemical for 60 days. The concentration of the acid solution was

Table 3. Compressive strength for conventional concrete and Bagasse ash concrete

Bagasse ash	Sugarcane Fiber	Compressive Strength (N/mm²)		
		7th Day	21st Day	28th Day
5%	0.5%	22.9	29.6	35.4
	1.0%	14.5	21.6	26.6
10%	0.5%	19.3	26.1	32.6
	1.0%	11.4	18	24.1
15%	0.5%	16.1	23	27.4
	1.0%	9.02	16.5	19.3

Table 4. Compressive strength for bagasse ash and Sugarcane fiber concrete

Name of Specimen	Proportions		Compressive Strength N/mm²		
	Bagasse ash %	Cement %	7th day	21st day	28th day
CC	0	100	19.1	26.2	32
C05	5	95	22.6	29.2	35.1
C10	10	90	19.2	26.04	31.8
C15	15	85	13.9	20.8	26.2

Table 5. Tensile strength of concrete with Bagasse ash

Name Of Specimen	Proportions		Tensile Strength (N/mm²)		
	Bagasse ash %	Cement %	7th day	21st day	28th day
CC	0	100	2.3	2.9	3.5
C05	5	95	2.6	3.2	3.8
C10	10	90	2.2	2.8	3.5
C15	15	85	2	2.6	3.2

Table 6. Tensile strength for bagasse ash and sugarcane fiber concrete

Bagasse ash	Sugarcane Fiber	Tensile Strength (N/mm²)		
		7th Day	21st Day	28th Day
5%	0.5%	2.9	3.3	3.9
	1.0%	2.1	2.5	3.0
10%	0.5%	2.6	2.9	3.7
	1.0%	1.8	2.2	2.9
15%	0.5%	2.1	2.7	3.3
	1.0%	1.5	1.9	2.5

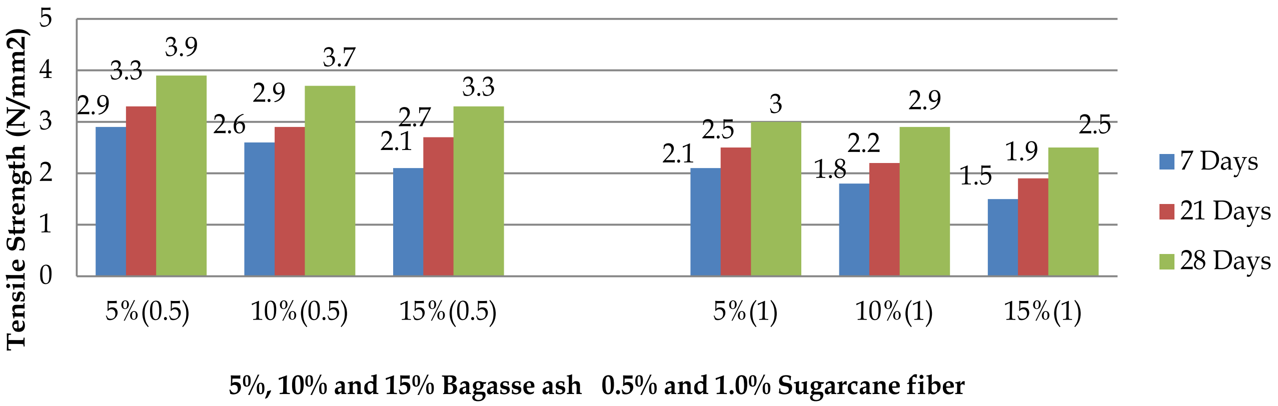
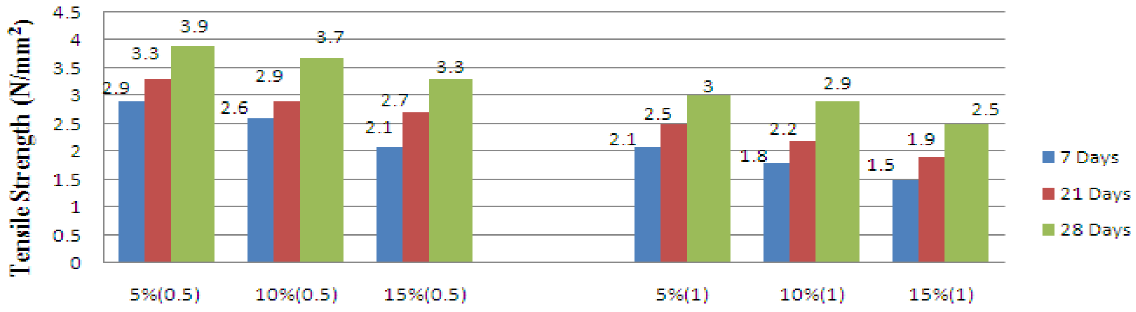


Fig. 4 Tensile strength of concrete with bagasse ash.



5%, 10% and 15% Bagasse ash 0.5% and 1.0% Sugarcane fiber

Fig. 5 Load tensile strength for bagasse ash and sugarcane fibre concrete.

Table 7. Loss in weight due to acid attack

Chemical	Specification (Bagasse ash)	Avg. weight of Specimens (Kg)	Weight of specimens after 60 days (Kg)	Loss in weight (%)
Conc.H_2SO_4	0% Conventional concrete	8.26	7.8	5.6
	5%	7.87	7.4	6
	10%	8.1	7.4	6
	15%	7.95	7.45	6.5

Table 8. Loss in weight due to sulphate attack

Chemical	Specification (Bagasse ash)	Avg. weight of Specimens (Kg)	Weight of specimens after 60 days (Kg)	Loss in weight (%)
Conc.H_2SO_4	0% Conventional concrete	8.26	7.8	5.6
	5%	7.87	7.4	6
	10%	8.1	7.4	6
	15%	7.95	7.45	6.5

maintained at 5% at its respective pH level. The weight of the cubes after 60 days of curing in chemical was noted down (Tables 7 and 8) (Khansaheb, 2015).

CONCLUSION

The From the results the following observations were made:

(i) Concrete specimens with 5% of the cement aggregate replaced with bagasse ash showed an increased compressive strength of nearly 13% on its 28th day.

(ii) The split tensile strength of the concrete replaced with bagasse ash showed similar results as that of conventional concrete.

The concrete specimens were found to be durable when subjected to acid and sulphate attacks, which makes it suitable for construction.

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