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EXPERIMENTAL INVESTIGATION ON SUGARCANE BAGASSE ASH (SCBA) CONCRETE REINFORCED WITH COIR FIBERS

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Abstract

With increasing demand and consumption of cement, researchers and scientist are in search of developing alternate binders that are eco-friendly and contribute towards waste management. The utilization of industrial and agricultural waste produced by industrial processes has been the focus on waste reduction. One of the agro waste sugar cane bagasse ash (SCBA)which is a fibrous waste product obtained from sugar mills as byproduct. Juice is extracted from sugar cane then ash produced by burning bagasse in uncontrolled condition and at very high temperature. In this paper SCBA has been chemically and physically characterized and partially replaced in the ratio of 0%, 5%, 10%, 15% and 20% by weight of cement in concrete.
The properties for fresh concrete are tested like slump cone test and for hardened concrete compressive strength at the age of 28 days. The test result indicate that the strength of concrete increase up to 5-10% SCBA replacement with cement.

Keywords*-Bagasse Ash, Concrete, Compressive Strength, Split Tensile Strength, Flexural Strength, Shear Strength.*

1. INTRODUCTION

With increasing demand and consumption of cement, researchers and scientist are in search of developing alternate binders that are eco-friendly and contribute towards waste management and to increase workability in most structural application. If some of raw material having similar composition can be replaced by weight of cement in concrete then cost could be reduced without affecting its quality. For this reason sugarcane bagasse ash (SCBA) is one of the main byproduct can be used as mineral admixture due to its high content in silica (SiO_2).It is possible to use sugarcane bagasse ash (SCBA) as cement replacement material to improve quality and reduce the cost of construction materials.

Sugarcane Bagasse Ash (SBA) is one of the Agro-waste which is by-product of sugarcane industry. Bagasse is a fibrous residue after crushing and juice extraction from sugarcane. This bagasse is used as a biomass fuel in the boilers to generate power in the sugar industry or in the power station. The ash which is obtained from the boiler is a waste product known as Sugarcane Bagasse Ash (SCBA). It contains high volume of SiO_2. This waste product SCBA is already causing serious environmental pollution, which calls for urgent ways of handling the waste. Therefore it is used in construction as a partial cement replacement material.

The present study was carried out on SCBA obtained by controlled combustion of sugarcane bagasse, which was procured from the Ghataprabha, Karnataka, India. Sugarcane production in India is over 300 million tons/year leaving about 10 million tons of as unutilized and, hence, wastes material.

Coir being a biodegradable and environment friendly material is virtually irreplaceable by any of the modem polymeric substitutes. Research institutions and private enterprises is required for innovation, manufacturing and marketing of coir. Coir geo-textiles find application in a number of situations in geotechnical engineering practice. Coir geo-textiles can be used as an overlay or interlay, the former protecting the surface from runoff and the latter performing the functions of separation, reinforcement, filtration and drainage.

This paper analyses the effect of SCBA in concrete by partial replacement of cement at the ratio of 0%, 10%, 15% and 20% by weight. The main ingredients consist of Portland cement, SCBA, crushed sand, coarse aggregate and water. After mixing, concrete specimens were casted and subsequently all test specimens were cured in water at 28Days.

1.1. Tests On Fresh Concrete

Slump test most commonly used method consistency of concrete which can be employed either in laboratory or in site. Apparatus consist of slump cone made up of steel 200mm bottom diameter, 100mm top diameter and 300mm height. The slump obtained from this method was 50mm.

1.2. Tests On Hardened Concrete

1.2.1. Compressive Strength of Concrete

For evaluating the compressive, specimens of dimensions 150X150X150mm were prepared .They was tested on compressive testing machine as per IS: 516:1959. The compressive strength is calculated by using the equation,

$$F = P/A$$

1.2.2. Split Tensile Strength of Concrete

For evaluating the tensile strength, cylindrical specimens of diameter 150mm and length 300mm were prepared. Split tensile test was carried out on 2000kN capacity compression testing machine as per IS 5816:1999. The tensile strength of is calculated using the equation,

$$F = 2P/\pi DL$$

1.2.3. Flexural Strength of Concrete

For evaluating the flexural, beam specimens of dimensions 100mmX100mmX500mm were prepared. The two point loading were placed at a distance of 133mm and bottom was placed at a effective span of 400 mm. The load was applied without the shock and the increasing continuously at uniform rate. The flexural strength of the specimen shall be expressed as the modulus of rupture Fb. The modulus of rupture was calculated as follows,

$$F = PL/(bd^2)$$

1.2.4. Shear Strength of Concrete

For evaluating the shear strength, L shaped specimens were prepared. These specimens were tested on compression testing machine .A loading arrangement was made such that a direct shearing force was applied on the shorter arm of the L shaped specimen (i.e, over an area of 150mmX60mm). The maximum applied load P was noted down. The failure load F due to the applied shear force is obtained by using the relation.

$$F = (Pl_1)/(l_1+l_2)$$

1.3. Casting of Specimen and Testing Procedure

Cement, sand and aggregate were taken in a mix proportion of 1:1.67:3.04 for OPC which corresponds to M20 grade of concrete, IS guideline method of concrete mix design was adopted for mix design .Specimens of standard size as per Indian Standards have been used for determining the Compressive Strength, Flexure Strength, Tensile Strength and Shear Strength. Three specimens have been prepared for 0% and 1% by volume fraction of Coir Fibres. For preparation of the specimen, batching of constituent materials was done by weight. All the ingredients were dry mixed homogenously .To this dry, mix the required quantity of monofibres was added. Then the required quantity of water was added (w/c=0.45) and the entire mix was again homogenously mixed. The fresh concrete was compacted in the moulds by means of the table vibrator. After the compaction the specimens were given smooth finish and all the specimens were cured under polyethylene bags for about 24 hours in the laboratory environment. After 24 hours, the specimens were demoulded and transferred to the curing tank and were allowed to cure for 28 days .

After 28 days the specimen were removed from the curing tank and were kept out in the atmospheric temperature for drying. Then the specimens were tested for evaluating Compressive Strength, Flexural Strength, Split Tensile Strength, and Shear Strength.

1.4. Mixing of Concrete with Coir Fibres

Introduction of fibres to the concrete presented problem due to the way the mixer operated. To ensure complete distribution of fibers throughout the concrete mix, sometimes it became necessary to stop the mixer, remove the mixing paddles, sprinkled a layer of fibres onto the concrete surface and reactivated the machine for approximately five revolutions after each addition. In an endeavor to ensure that the fibres were well distributed and randomly orientated, and thus prevent balling or interlocking, the concrete together with the fibres were mixed by mixer/hand in this investigation.

2. EXPERIMENTAL INVESTIGATION

In this experimental work, a total of 60 numbers of concrete specimens were casted. 15 cubes, 15 beams, 15 cylinders and 15 shear specimens.
The mix design of concrete was done according to Indian Standard guidelines M 20 grade. The standard sizes of

- Cube specimens for testing Compressive Strength of dimensions 150mm×150mm×150mm.
- Cylindrical specimens for testing Split Tensile Strength of diameter 150mm and length 300mm.
- Beam specimens for testing flexural strength of dimensions 100mm×100mm×500mm
- L shaped specimen's were prepared for testing Shear.

2.1. Materials

Ordinary Portland Cement: In this experiment, we have used 43 Grade Ordinary Portland Cement of ACC brand. The cement used was fresh and without any lumps. The specific gravity of cement was found to be 3.15.

Types of Pozzolana: Industrial Pozzolonic material Sugarcane Bagasses ash.

Sr. No	Component	Mass %
1	Silica (SiO2)	66.89
2	Alumina (Al2O3) Ferric Oxide (Fe2 O3)	29.18
3	Calcium Oxide (CaO)	1.92
4	Magnesium Oxide (MgO)	0.83
5	Sulphur Tri Oxide (SO3)	0.56

Fine Aggregates: Clean river sand is used as fine aggregates. The specific gravity and fineness modulus are found to be 2.73 and 2.7% respectively ZONE III .

Coarse aggregate: The specific gravity of C.A is 2.93 and water absorption is 0.8%. The size of C.A of 20mm down was adopted.

Water: Portable tap water is used for the preparation of specimens and the curing of the specimens.

Fibres: Coir Fibres was added to concrete by 1% weight of the cement.

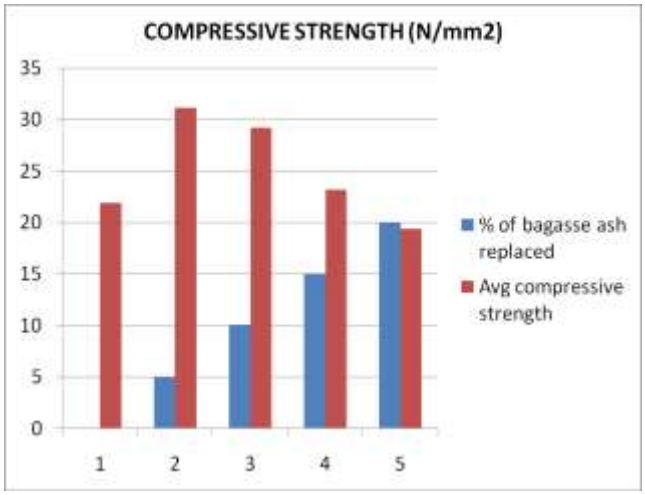
2.2. Experimental Results

The strength results obtained from the experimental investigations are showed in tables. All the values are the average of the three trails in each case in the testing program of this study. The results are discussed as follows.

2.2.1. Compressive Strength Results

Table 2.2.1Compressive strength overall Results

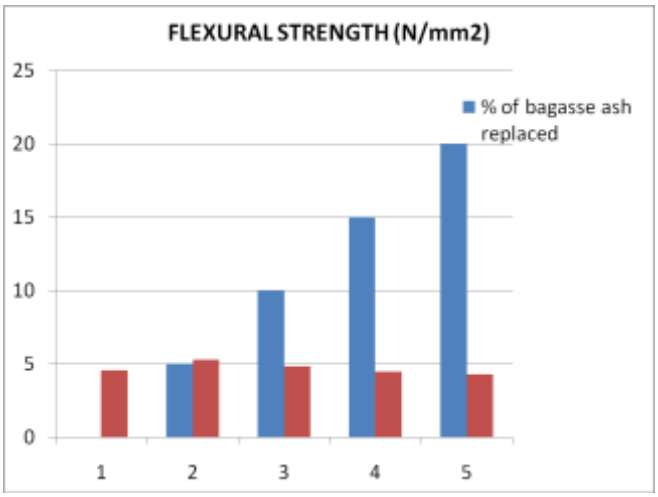
% Of SCBA	Mean Strength (N/mm^2)	% Increase Or Decrease In Strength
0	21.93	-
5	31.11	+41.86
10	27.98	+27.58
15	23.18	+05.69
20	19.45	-11.30



Graph: Compression Strength

Table 2.2.3. Flexural strength Overall Results

% Of Fibers	Mean Strength (N/mm^2)	% Increase Or Decrease In Strength
0	4.54	-
5	5.25	+15.63
10	4.84	+6.60
15	4.43	-2.42
20	4.25	-6.38

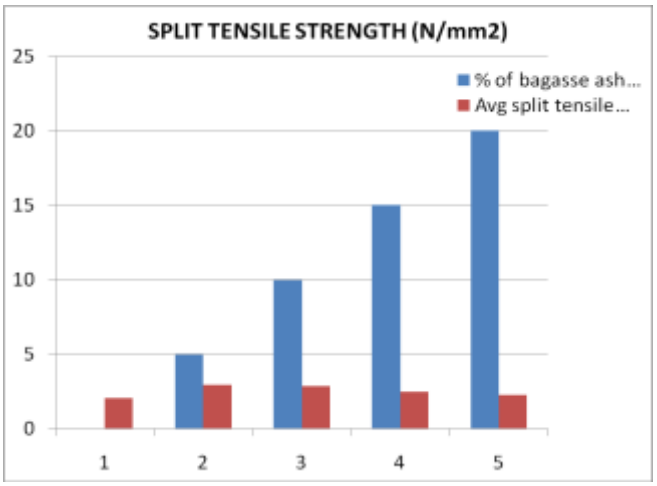


Graph: Flexural Strength

2.2.2. Split Tensile Strength Results

Table 2.2.2. Split tensile strength Overall Results

% Of SCBA	Mean Strength (N/mm^2)	% Increase Or Decrease In Strength
0	2.30	-
5	2.98	+29.56
10	2.87	+24.78
15	2.42	+5.21
20	2.27	-1.30

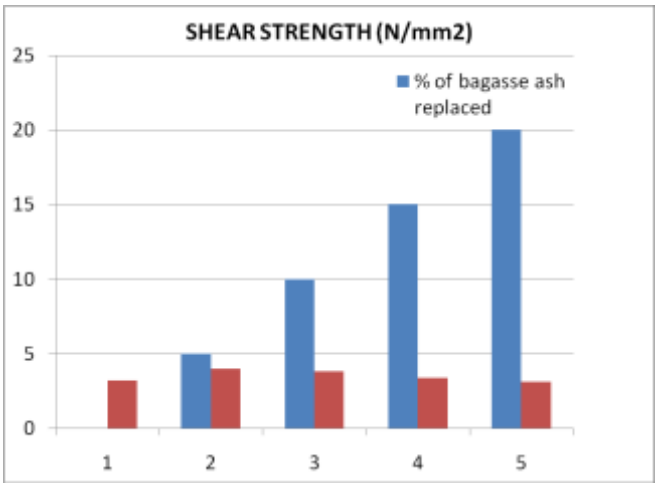


Graph: Spilt Tensile Strength

2.2.4. Shear Strength Test Results

Table 2.2.4. Shear Strength Overall Results

% Of Fibers	Mean Strength (N/mm^2)	% Increase Or Decrease In Strength
0	3.13	-
5	3.99	+27.47
10	3.81	+21.72
15	3.37	+7.66
20	3.11	-0.63



Graph: Shear Strength

2.2.3. Flexural Strength Results

3. CONCLUSIONS:

a) The cement concrete produced by replacing of up to 5-10% of Sugarcane Bagasse Ash (SCBA) with OPC and addition of 1% Coir Fibers exhibits more Compression, Split Tensile, Flexure and Shear Strength as compared to cement concrete without SCBA and Coir Fibres.

b) 5% replacement of Sugarcane Bagasse Ash (SCBA) exhibit maximum Compression, Split Tensile, Flexure and Shear Strength of the concrete.

c) From the arrived experimental values the maximum allowed replacing of SCBA effectively is up to 10%.

d) Addition of 1% Coir Fibre in concrete by replacing SCBA at various percentage with OPC imparts more Compression, Split Tensile, Flexure and Shear Strength of the concrete.

Overall result shows that there is increased Compression, Flexure, Shear and Tensile strength with addition of fibers and SCBA for OPC when compared to normal concrete.

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