Experimental Study on the Effects of Sugarcane Baggase Ash in Concrete

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Abstract - An experimental investigation was carried out to study the behaviour of M20 concrete using baggase ash as a partial replacement for OPC 53 grade cement. For this study cement was partially replaced with 0%, 5%, 10%, 15% & 20% by SCBA. Polycarboxylate ether based superplasticizers is added to the concrete with 0.5% by weight of cement. Concrete cubes, cylinder and prism were cast and tested. This study is carried out to evaluate fresh properties and mechanical properties of hardened concrete. Test results are obtained and graphs are plotted. The values of concrete using bagasse ash are compared with nominal concrete.

Key words - Sugarcane Baggase Ash (SCBA), Superplasticizer (SP), Compressive strength, split tensile strength, flexural strength.

I. INTRODUCTION

Ordinary Portland cement is most extensively used construction material throughout the world and it is most expensive of all other material. In addition there is environmental concern in the production of cement. This environmental problem will most likely be increased due to exponential demand of Portland cement. Researchers focusing on ways of utilizing industrial and agricultural waste as a source of raw materials for cement. Industrial wastes, such as blast furnace slag, fly ash and silica fume are being used as supplementary cement replacement material. Currently, there has been an attempt to utilize the agricultural waste as a replacement material. One of the agro waste **Sugarcane Bagasse Ash (SCBA)** which is a fibrous waste product obtained from sugar mills as byproduct Juice is extracted from sugarcane then ash produced by burning bagasse at very high temperature.

The Sugarcane Bagasse Ash having amorphous silica which has pozzolanic properties can be used as cement replacement material. A few studies have been carried out on the ashes obtained directly from the industries to study pozzolanic activity and their suitability as binders, partially replacing cement. Therefore it might possible to use sugarcane bagasse ash as cement replacement material to improve quality and reduce the cost of construction materials. India being one of the largest producers of sugarcane in the world produces 300 million tons per year and large quantity of sugarcane bagasse is available from sugar mills. Sugarcane bagasse is partly used as fuel at the sugar mill. The sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicelluloses and 25% of lignin. When juice is extracted from the sugarcane stalk, the waste material is burned at high temperature to produces bagasse ash as a cement replacement material.

II. MATERIAL

All through the experimental study, Ordinary Portland Cement conforming to IS 12269:1987 was used. Its specific gravity, fineness, consistency and initial setting time were 3.14, 3%, 33% and 35minutes respectively. Both fine and coarse aggregate used were confirmed to IS383:1970. Locally available river sand which passes through 2.36 mm IS sieve is used as a fine aggregate. The specific gravity, fineness modulus, bulk density and water absorption of fine aggregates are 2.7, 3.4, 1633 kg/m^3 and 0.97% respectively. By conducting sieve analysis it is found that sand confirms to grading zone II as per table 4 as of IS 383-1970. In this study the natural coarse aggregates with maximum size 20mm, and specific gravity, Bulk density, are 2.72, 1757.692kg/m^3 was used. Potable water was used for mixing and curing of the concrete. Polycarboxylate Ether (Aurocast 100) this liquid is commonly used as a Superplasticizer.

Bagasse ash sample has been collected, and then it was treated. Pulverizing is adopted for grinding ash. Sugar cane bagasse ash passing in 75micron sieve was used in this Experiment work. The physical and chemical properties of SCBA found using SEM analysis and conventional methods are discussed below.

TABLE 1 PHYSICAL PROPERTIES OF SCBA

Sl. No	Description	Value
1	Fineness modulus	2.5
2	Specific gravity	2.12
3	Bulk Density	1560.8 kg/m^3

TABLE 2 CHEMICAL COMPOSITION OF SCBA

S.NO.	MATERIALS	OPC (%)	BAGASSE ASH (%)
1	SiO_2	19.25	61.05
2	Al_2O_3	5.04	8.95
3	Fe_2O_3	3.16	5.43
4	CaO	63.61	8.10
5	MgO	4.56	2.79
6	Na_2O	0.08	0.89
7	K_2O	0.51	1.32
8	Loss on ignition	3.12	4.82

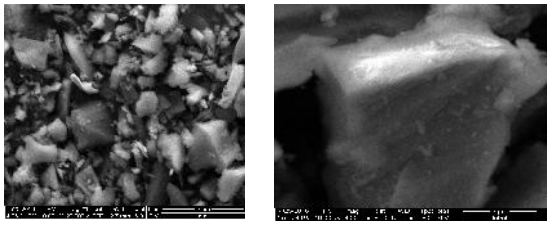

Fig.1 SEM ANALYSIS OF SCBA (5µm and 2 µm Size)

III.EXPERIMENTAL INVESTIGATION

Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the objective to achieve the stipulated strength and durability. Mix design is carried out according to IS 10262-2009.

Mix ratio = 1: 1.75:2.89 (C: FA: CA)

TABLE 3 MIX PROPORTION FOR M20 CONCRETE

MIX ID	MIXTURE CONTENT (kg/m^3)					
	C	*FA*	*CA*	*BA*	*0% Sp*	*0.5% SP*
CC	394.3	690.02	1139.6	0	197.16	167.59
BA05	374.6	690.02	1139.6	19.72	197.16	167.59
BA10	354.9	690.02	1139.6	39.43	197.16	167.59
BA15	335.2	690.02	1139.6	59.15	197.16	167.59
BA20	315.5	690.02	1139.6	78.86	197.16	167.59

BA – Bagasse ash, C – Cement, FA – Fine aggregate, CA – Coarse aggregate, SP- super Plasticizers and W/C- Water/ Cement Ratio.

TABLE 4 SPECIFICATION OF SUPERPLASTICIZER

Solid	50 ± 2 %
Appearance	Deep brown colored liquid
pH value(1:10)	5.0 ± 0.5
Specific Gravity	1.110 ± 0.02
Chloride content	Below 0.02
Solubility	Readily soluble in water

A. Measurement of Workability

The mould for slump test is in the form or frustum cone of bottom diameter 20cm, top diameter 10cm, and height 30cm.The cone is filled with fresh concrete in three layers, each approximately one quarter of height of the mould. Each layer shall be tamped with 25 strokes of the rounded end of the tamping rod. The mould is removed from the concrete by raising it slowly in vertical direction. The concrete subsides and the slump is measured immediately by determining the difference between the height of the mould and of the highest point of the specimen being tested. The test determines the consistency of the fresh concrete and given comparable results in the case of wet mixes in fig.2.

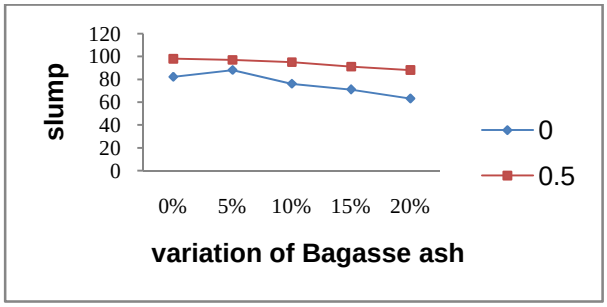

Fig.2 GRAPH OF SLUMP VS % OF SP

The workability of the concrete increased with increase in superplasticizers. Each mix must be suitable for its intense use, achieving a balance among required fluidity, strength and economy.

Fig.2 CASTING OF SPECIMEN

II. RESULTS AND DISCUSSIONS

A) Compressive Strength of Cubes

The compressive strength test is carried out for the concrete cube specimens of size 150x150x150mm for partial replacement of cement for 3, 7, 14 and 28 days of curing. The test results are tabulated as follows.

TABLE 5
AVERAGE CUBE COMPRESSIVE STRENGTH

SP variations	Days	Bagasse ash variations				
		0%	5%	10%	15%	20%
0	3	17.12	18.64	19.46	20.12	17.79
	7	19.27	21.17	22.98	23.87	20.27
	14	20.12	23.21	23.75	26.92	25.12
	28	26.87	26.52	27.83	29.43	26.81
0.5	3	18.71	19.73	19.92	21.34	18.72
	7	21.34	22.08	23.01	24.12	21.17
	14	24.78	24.06	24.66	27.11	26.42
	28	28.88	27.89	28.78	29.94	27.93

B) Split Tensile Strength of Cylinder

It is an indirect test to determine the tensile strength of cylindrical specimens. Split tensile test was carried out in compression testing machine as per IS 5816:1999.The split tensile strength test is carried out for the cylindrical specimens (150mmx300mm) for 28 days. The test results are tabulated in Fig.4.

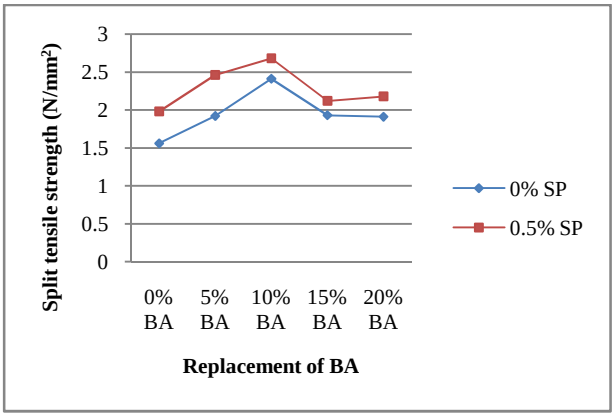

Fig.3 SPLIT TENSILE STRENGTH OF CYLINDER

C) Flexural Strength of Prism

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 percent of compressive strength depending on the type, size and volume of coarse aggregate used. Three specimens were casted for each mix and average value was taken. The flexural strength test is carried out for the prism specimens (150mmx150mmx700m) at 28 days after curing. The test results are tabulated in Fig.5.

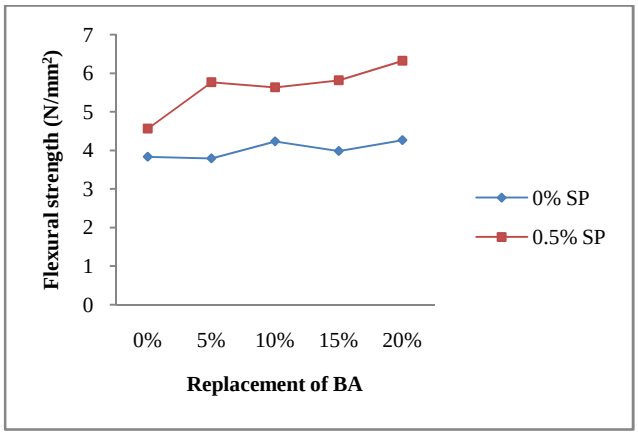

Fig.4 FLEXURAL STRENGTH OF PRISM

Fig.5 TESTING OF SPECIMEN

CONCLUSIONS

- The specimen with 15% of bagasse ash and 0.5% SP shows good results in mechanical properties such as compressive strength flexural strength, split tensile strength when compared to 0%, 5%, 10% and 20% of bagasse ash specimen.
- The compressive strength of the concrete cubes for all the mix ratios increases with

9.41%, 9.25%, 9.77% with 0.5%, 1%, 1.5% SP at curing age and decreases as the SCBA content increases.

- The flexural strength of concrete increases with 6.15% when compared with controlled concrete and the split tensile strength increases with 7.23% when compared with controlled concrete
- It was clearly shown that SCBA is a pozzolanic material that has the potential to be used as partial cement replacement material and can contribute to the environmental sustainability.
- These results indicated that the load carrying capacities of bagasse ash concrete cubes are higher than the conventional concrete.

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