Sugarcane Bagasse Ash Alternative Construction Material used in Cement Mortar in Brick Masonry

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Abstract— Due to pozzolanic reactivity, Sugarcane bagasse Ash used as a supplementary cementing material in mortar and concrete. It has economical and technical advantages to be used in mortar and concrete. I am going to replace cement by the SCBA by 5%, 10%, 15% & 20% by weight of cement in different experiments to find out the maximum strength and compare it to the normal mortar at 7,14 and 28 days. Therefore this research is an investigation of the performance of the mortar made of partially replacing the OPC and PPC with SCBA on the structural integrity and properties of SCBA mortar.

Key words: OPC and PPC, Mortar, Sugarcane Bagasse Ash, Fine Aggregate, Water

I. INTRODUCTION

With the ever increasing demand and consumption of cement and in the backdrop of waste management, scientists and researchers all over the world are always in quest for developing alternate binders that are environment friendly and contribute towards sustainable management. Sugarcane bagasse ash(SCBA) which is a voluminous by-product in the sugar mills when juice is extracted from the cane. It is, however, generally used as a fuel to fire furnaces in the same sugar mill that yields about 8-10% ashes containing high amounts of un-burnt matter, silicon, aluminum, iron and calcium oxides. But the ashes obtained directly from the mill are not reactive because of these are burnt under uncontrolled conditions and at very high temperatures. The ash, therefore, becomes an industrial waste and poses disposal problems. For obtaining amorphous and reactive sugarcane bagasse ash (SCBA), several trials were conducted to define optimum burning time and temperatures. SCBA used in this study was obtained by burning SCB at 600oC for 5 hours (James and Rao, 1986) under controlled conditions and its physical, chemical, and mineralogical characterization was done to evaluate the possibility of its use as binder partially replacing cement in the mortar applications. SCBA has two roles in mortar and concrete manufacturing as a substitute for Portland cement, Portland Pozzolana cement reducing cost of mortar and concrete in production of low cost building blocks and as an admixture in the production of high strength mortar.

II. MATERIALS

A. Sugarcane Bagasse Ash

The bagasse ash used for this research was taken from New India Sugar Mill which is located in Dhada, Kushinagar in Uttar Pradesh.

It was not possible to measure the temperature in the furnace while taking the bagasse ash, because the measuring instrument was not long enough to go through the furnace. Even though it was not possible to measure the temperature, most furnaces have a temperature above that is required for complete combustion which is around 800°C. But it was suggested that at a temperature around 650°C the crystallization of minerals occurs. This reduces the pozzolanic activity of the bagasse ash.

For this research, fresh bagasse ash taken from the furnace was used. It was cooled in air, packed in sacks and transported to Madan Mohan Malviya University o Technology, Gorakhpur.

S. NO.	Physical properties	Test Values
1.	Specific gravity	1.3
2.	Initial setting time (min)	125
3.	Final setting time (min)	300
4	Optimum moisture content (%)	16.6
5.	Maximum dry density (g/cc)	1.220

Table 1: Physical properties Bagasses Ash

Sr. No	Description of properties	Percentage (%)
1.	Silica (SiO_2)	64.34
2.	Magnesium (MgO)	0.853
3.	Calcium (CaO)	10.4
4.	Iron (Fe_2O_3)	4.54
5.	Sodium (Na_2O)	1.05
6.	Potassium (K_2O)	3.56
7.	Alumina (Al_2O_3)	11.47

Table 2: Chemical composition of Bagasse Ash

B. Cement

Cement used in the experiment work is OPC and PPC conforming to IS: Code. The properties of OPC and PPC are shown in table as given by manufacturer

Property	Test Method
Compressive Strength	ASTM 109/C 109M
Setting Time	ASTM C 191
Specific Gravity	ASTM C 188
Fineness	ASTM C 430
Soundness, Al2O3Content, MgO Content, CaOContent and Chloride Content	SLS 107
Loss on Ignition, Insoluble Residue, Total alkalis, SiO2 Content, Fe2O3 Content and SO3 Content	ASTM C 114

Table 3: Test Methods use to find out properties of Cement

Property	Results	
	OPC	PP C
Compressive Strength (MPa)		
3 Day	11.3	10.7
7 Day	13.2	14.3
28 Day	16.9	21.2

Setting time (min)		
Initial	120	164
Final	166	203
Specific Gravity	3.107	2.936
Fineness %	85.4	86.2
Soundness (mm)	0.5	1.0

Table 4: Physical properties Of PPC and OPC cement

C. Fine Aggregate:

Fine aggregate was purchased wich satisfied the required properties of fine aggregate required for experimental work and the sand conforms to Zone III as per Specification of IS-383:1970.

- Specific Gravity = 2.62
- Fineness Modulus = 2.81

D. Water

Water is an important ingredient of mortar as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked in to carefully. Mixing water should not contain undesirable organic substances or inorganic constituents in excessive proportion. In this project clean potable water is used.

E. Mix Proportion of Mortar:

The OPC and PPC was replaced by different amount of Sugarcane Bagasse Ash (0%, 5%, 10%, 15% and 20%) in dry condition. Sample prepared with OPC and PPC called the controlled samples. The mix designations are in the table. Cement mortar used in proportion of (1:3) (cement: sand) and water cement (w/c) ratio =0.55

Mix Designation	OPC or PPC	SCBA (By weight)
M_0	100	0
M_5	95	5
M_{10}	90	10
M_{15}	85	15
M_{20}	80	20
M_{25}	75	25
M_{30}	70	30

Table 5: OPC and PPC

The Mortar was mixed in laboratory at room temperature. After casting all cubes are kept for 24 hours and after that demolded and placed in a water bath at the same temperature until the time of testing.

III. Testing Procedures

Compressive strength of cement mortar were conducted on (70.7mm) cubes according to B.S. 1881-Part 4-1989, by using 100KN capacity testing machine. The compressive strength of the mortar was tested at the age of 7, 14 and 28 days.

Compressive strength is calculated by following formula:

$$\text{Compressive Strength} = \frac{P}{A}$$

(Where P is load and A is area of cube)

IV. Result and Discussion

A. Compressive Strength:

Compressive strength of mortar specimens are shown in table and fig. Comparison of data for curing time of 7 and 14 days shows that the compressive strength of OPC or PPC and mortar is higher than the others but at later age 28 days, the samples having 5%, 10%, 15% SCBA shows better result than the OPC only. The increase in strength may be due to partially to the pozzolanic reaction and the presence of reactive silica in SCBA as reported by many researchers (Ajay Goyal, A.M. Anwar, Hattori kunio,).

B. Compressive Strength Test for (OPC+SCBA)

S. No.	Percentage replacement with SCBA	Average Compressive strength N/mm^2		
		7 days	14 days	28 days
1	0%	4.8	6.2	7.0
2	5%	4.92	6.93	7.10
3	10%	5.11	7.21	7.47
4	15%	5.62	7.76	8.81
5	20%	4.88	6.28	7.00
6	25%	4.68	5.90	6.26

Table 6: Compressive Strength Test

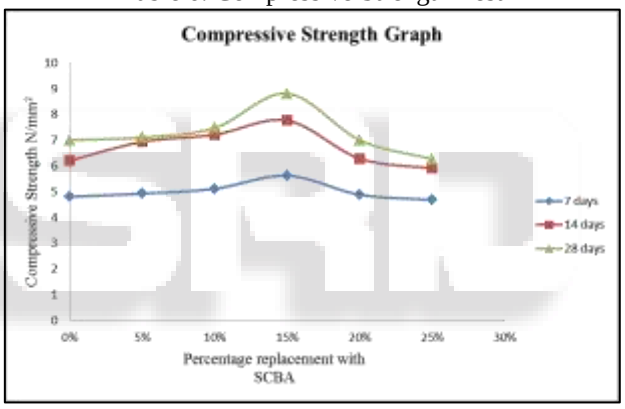

Fig. 1: Strength Test

C. Compressive Strength Test for (PPC+SCBA)

S. No.	Percentage replacement with SCBA	Average Compressive strength N/mm^2		
		7 days	14 days	28 days
1	0%	4.30	5.88	6.76
2	5%	4.20	5.71	6.49
3	10%	5.00	6.58	6.93
4	15%	5.12	7.01	8.13
5	20%	4.08	5.89	6.31
6	25%	4.21	5.11	5.81

Table 6: Compressive Strength Test

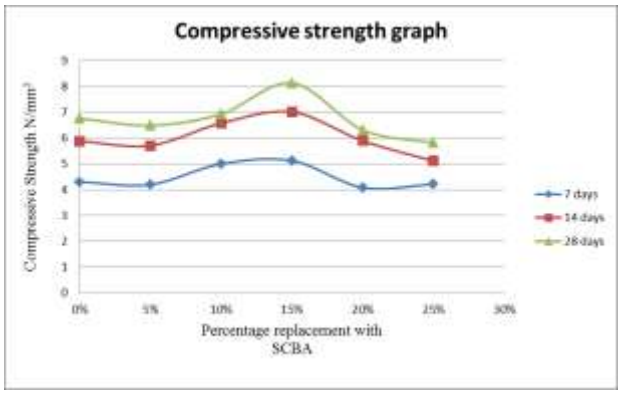

Fig. 1: Strength Test

V. CONCLUSION

1) The investigation of this thesis has revealed that replacement of ordinary Portland cement and Portland pozzolana cement by bagasse ash from 10% to 15% results in a better compressive strength than that of the control mortar with 100% ordinary Portland cement. And the compressive strength decreases as the bagasse ash replacement increases over 15%.
2) After all the strength obtain by using SCBA in OPC and PPC both with partial replacement of cement ,the strength obtain with 15% replacement of cement by SCBA in maximum in both cases.
3) However the strength obtain in case of OPC in higher than PPC
4) Because of all these reason relative strength give curiosity for OPC rather than PPC

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