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High Strength Cementitius Matrices for Ferrocement Application

Khatik Shaikh Vaseem [1], U.S. Ansari [2]

[1]PG Students Department Of Civil Engineering SND College Of Engineering & Research Center, Yeola, India
[2]Head of Department of Civil Engineering SND College of Engineering & Research Center, Yeola, India

ABSTRACT

In this paper the experimental investigation was undertaken to develop high strength cementitious matrices for casting thin ferrocement laminates ideally suited for structure retrofit. The developed high strength matrices contain sugarcane bagasse ash (SCBA) in different percentage with cement and provide the good strength. The matrices developed had 28 days compressive strength ranges from 50 to 54 N/mm^2. The developed high strength mortar was used in producing ferrocement jackets for square column to examine the load carrying capacity. The developed high strength mortar provides appreciable increase in load carrying capacity and ductility. In terms of ferrocement efficiency, the square column wrapped with single and double layer welded wire meshes (WWM).

Keywords:- *Ferrocement, high strength mortar, square column retrofit*

I. INTRODUCTION

The Portland cement manufacturing industry produces nearly 7% of the world's carbon dioxide emissions. Apart from CO2 emission, vast amounts of natural minerals like limestone and clay are also required for cement production. Cement and large amounts of virgin materials such as sand, gravel, and crushed rock are needed for the production of concrete, which is a predominant construction material. The concrete industry consumes Portland and modified Portland cements at about 1.6 billion metric tonnes per annum. In modern technology, engineers have a responsibility to minimize the use of cement and virgin minerals for construction in line with environmentally friendly and sustainable development.

Cement which is one of the components of ferrocement mortar plays a great role, but is the most expensive and environmentally unfriendly material. Therefore requirements for economical and more environmental-friendly cementing materials have extended interest in other cementing materials that can be used as partial replacement of the normal Portland cement. Ground granulated blast furnace slag, fly ash, silica fume, metakaolin etc have been used successfully for this purpose. Recently sugarcane bagasse ash, which is a byproduct of sugar factories found after burning sugarcane bagasse which in turn is found after the extraction of all economical sugar from sugarcane, has been tested in some parts of the world for its pozzolanic property and has been found to improve some of the properties of the paste, mortar and concrete like compressive strength and water tightness in certain replacement percentages and fineness. The pozzolanic property of sugarcane bagasse ash came from the silicate content of the ash. This silicate under goes a pozzolanic reaction with the hydration products of the cement and results a reduction of the free lime in the concrete. The silicate content in the ash may vary from ash to ash depending on the burning and other properties of the raw materials like the soil on which the sugarcane is grown.

Objectives

- Study of ferrocement jacketing by using sugarcane bagasse ash as cementitious material.
- Study design criteria and working methodology of ferrocement jacketing for retrofitting.
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II. MATERIALS AND METHODOLOGY

A. Materials

Cement

Ordinary Portland cement of grade 53 make from a single lot is used for the study. All the tests are carried out in accordance with procedure laid down in IS 1489 (Part 1):1991, valid for cements.

Bagasse ash

The bagasse ash used for this research was taken from Madhukar Sahkari Sugar factory (M.S.S.K.) which is located in Yawal road, Faizpur Regional State-Maharashtra as shown in fig1. The bagasse ash in this factory is collected at each 8 hour interval from the furnace and dumped around the factory very close to factory. 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. The grinding of the ash was done in laboratory. By so doing the bagasse ash fineness was reduced to fineness similar to that of Portland cement. The grain size distribution is as shown is the Table1

Table No.1 Grain Size Distribution For Bagasse Ash And Opc Cement

Sieve size	Percentage passing (Bagasse ash)	Percentage passing (Cement)
300µm	100	100
150µm	98.9	100
90µm	89.8	93
75µm	84.7	81
pan	37.76	32

Fig. 1 Bagasse ash after grinding

The graph of the particle size distribution of the bagasse ash and ordinary Portland cement is as shown in fig.2.

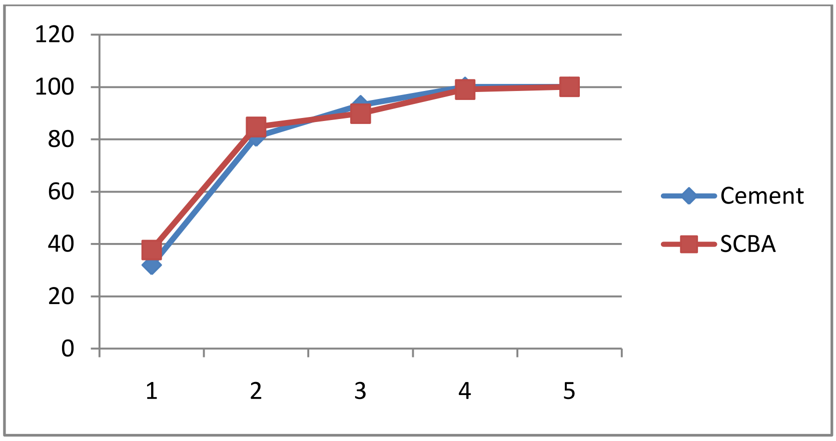


Fig.2 Gradation of bagasse ash and cement

Sugarcane bagasse ash (SCBA) obtained by controlled combustion of sugarcane bagasse, which is sugarcane industry. The bagasse ash then ground until the particles passing through 75 µ IS sieve, which is similar to that of ordinary Portland cement. The specific gravity of the SCBA is 2.17.

Fine aggregates

Those fractions from 4.75 mm to 150 micron are termed as fine aggregate. The river sand and crushed Sand is being used as fine aggregate conforming to the requirements of IS: 383-1970.

Coarse aggregate

The fractions from 20 mm to 4.75 mm are used as coarse aggregate. The Coarse Aggregates from 10 mm & 20 mm are used conforming to IS: 383 is being use.

Water

Fresh and clean water is used for casting and curing the specimens. The water is relatively free from organic matter, silt, oil, sugar, chloride and acidic material as per requirements of Indian standard.

B. Methodology

Mix proportion

Five different proportion mixes (ranging from 5% to 20% by weight of cement) including control mixes were prepare with binder (W/C+ SCBA) ratio of 0.50. The mortar composition was 0.5:1:3 (water: cementitious material: sand). These mixes designated as S0 for control and S5 to S20 for SCBA mortar. The mix proportion are given in table no.2

Table no. 2 Mix proportion

Mix code	Cement type	Cement (gm)	Bagasse ash (gm)	Water (gm)	Sand (gm)
S0	OPC	1000	0	450	3000
S5	OPC	950	50	450	3000
S10	OPC	900	100	450	3000
S15	OPC	850	150	450	3000
S20	OPC	800	200	450	3000

Where,

- S0 is OPC-BA control mortar mix with 100% OPC.
- S5 is OPC-BA mortar mix with 95% OPC and 5% SCBA by weight.
- S10 is OPC-BA mortar mix with 90% OPC and 10% SCBA by weight.
- S15 is OPC-BA mortar mix with 85% OPC and 15% SCBA by weight.
- S20 is OPC-BA mortar mix with 80% OPC and 20% SCBA by weight.

Mixing compaction of specimen

The mortars were mixed by hand mixing. The mixing time kept about 5-6 minutes.

Compressive strength of concrete:

The compressive strength test of cement mortar is the most common type test. The reasons for these are; many codes and design manuals are based on this property, many other properties of mortar depend on the compressive strength and when compared to other tests this is an easy one.

Testing Of Cube:

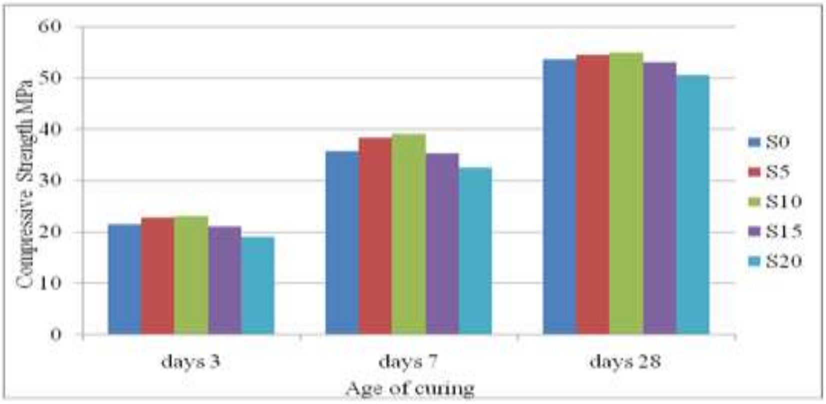
After completing the curing of the test specimens, all specimens were kept in dry place for few hours for attaining surface dry condition. Thereafter, tests were carried out in a compression testing machine of capacity of 2000KN. Load was applied at the top of the specimen until failure.

The compressive strength of each of the bock is determined by testing the cubes in a CTM machine. For each of the mixes the average value of three samples is taken as their compressive strength shown in table No.3.

As can be seen from table No.3, the compressive strength of the mortar with 5% bagasse ash has shown improvement over the control mortar by about 2% at 28 days. On the other hand S15 and S20 i.e. concretes with 15% and 20% bagasse ash, had shown a strength reduction by about 1% and 6% at 28 days. This shows that the compressive strength of the OPC-BA mortar decreases with increase in the bagasse ash content. The probable reason for this is due to the high replacement of cement by bagasse ash, thus reducing cement content of the mixture which in turn causes a reduction in the hydration reaction. In addition to this the high content of bagasse ash resulted in a higher water requirement, making the water unavailable for the hydration of the cement.

Table No. 3 Average Compressive Strength

S. N.	Mix	Average compressive strength					
		3 Days		7 Days		28 Days	
		Load (KN)	Strength (N/mm^2)	Load (KN)	Strength (N/mm^2)	Load (KN)	Strength (N/mm^2)
1	S0	107.6	21.53	178.6	35.74	268	53.61
2	S5	114	22.80	191.6	38.40	273.3	54.48
3	S10	115.6	23.13	195.6	39.14	274.3	54.88
4	S15	105	21.00	176.7	35.34	265.3	53.08
5	S20	95	19.00	163.0	32.60	252.6	50.54



II. DISCUSSION

SCBA used in cement mortar the initial and final setting time of this paste is increase. Subsequently the compressive strength of the mortar is also slightly increased in up to 10 % at 28 days. Up to 10% SCBA cement mortar used in retrofitting of short column by using ferrocement jacketing.

III. CONCLUSION

1. Sugar cane bagasse ash used as ferrocement mortar shows the slide increasing compressive strength up to 10% at 28days.
2. SCBA increases with decrease in compressive strength than the without BA.
3. Initial and final setting time of SCBA mortar increase.

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