Study on the Using of Sugarcane Bagasse Ash as the Partial Replacement of Cement

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Abstract— Sugarcane is one of the major crops grown in over the world and its total production is increase day by day. After the extraction of all economical sugar from sugarcane, about 40-45% fibrous residues is obtained. The development exercises are expanding because of the advancement and urbanization of nations. The concrete comprise of higher quality, great toughness and different imperative variables and properties which make the concrete appropriate for construction, so requirement of cement is getting more as a construction material. Manufacturing process comprising material preparation, mixing, placing, compaction and curing is reported in the thesis. Napthalene-based superplasticiser was found to be useful to improve the workability of fresh Sugarcane Bagasse Ash, as well as the addition of extra water. The main parameters affecting the compressive strength of hardened Sugarcane Bagasse Ash are the curing temperature and curing time, the molar H2O-to-Na2O ratio, and mixing time. Manufacturing process comprising material preparation, mixing, placing, compaction and curing is reported in the thesis. Napthalene-based superplasticiser was found to be useful to improve the workability of fresh Sugarcane Bagasse Ash, as well as the addition of extra water. The main parameters affecting the compressive strength of hardened Sugarcane Bagasse Ash are the curing temperature and curing time, the molar H2O-to-Na2O ratio, and mixing time.

Keywords: Concrete, Sugarcane Bagasse Ash, Fly ash, Portland cement, Variability, Poisson's ratio, bituminous, anthracite coals

I. INTRODUCTION

The challenge for the civil engineering community in the near future will be to realize projects in harmony with the concept of sustainable development, and this involves the use of high performance materials and products manufactured at reasonable cost with the lowest possible environmental impact. Concrete is the most widely used construction material worldwide. However, the production of Portland cement, an essential constituent of concrete, releases large amounts ofCO_2 which is a major contributor to the greenhouse effect and the global warming of the planet. Moreover the developed countries are considering very severe regulations and limitations on CO_2emissions. In this scenario, the use of supplementary cementing materials (SCMs), such fly ash, slag, silica fume, and rice husk ash and sugar cane bagasse ash as a replacement for Portland cement in concrete presents one viable solution with multiple benefits for the sustainable development of the concrete industry.

Ordinary Portland cement is recognized as a major construction material throughout the world. Cement which is key ingredient of concrete which plays a great role, but it is the most expensive and environmentally unfriendly material. Researchers all over the world today are focusing on the ways of utilizing either industrial or agricultural waste, as a source of raw material for cement industry. This waste, utilization would not only be economical, but may also result in environmental pollution control measures. Industrial wastes such as sugarcane bagasse ash (SCBA) are being used as supplementary cement replacement materials. Recently Sugarcane Bagasse Ash (SCBA) has been tested in some parts of the world and also in India for its pozzolanic property and has been found to improve quality and reduce the cost of construction materials such as mortar, concrete paver blocks, concrete roof tiles and soil cement interlocking block.

II. WASTE MATERIALS

Definition of waste: "Wastes materials are substance or objects, which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law"

Solid waste is the unwanted or useless solid materials generated from combined residential, industrial and commercial activities in a given area. It may be categorized according to its origin (domestic, industrial, commercial, construction or institutional); according to its contents (organic material, glass, metal, plastic paper etc. or according to hazard potential (toxic, non-toxin, flammable, radioactive, infectious etc.

Waste is any substance which is discarded after primary use, or it is worthless, defective and of no use. If the large amount of waste materials generated were used instead of natural materials in the construction industry there would be three benefits:

- Conserving natural resources
- Disposing of waste materials (which are often unsightly)
- Freeing up valuable land for other uses

The various types of waste are used as in admixture with the certain preparation:

- Solid type waste
- Fly Ash
- Steel Aggregates and Rubber Pad
- Waste Marble
- Plastic Waste
- E- Waste
- Paper
- Glass Waste
- Sugarcane Bagasse Ash

III. PROPERTY OF BAGASSE ASH

The bagasse consists of approximately 50% of cellulose, 25% of hemicellulose and 25% of lignin. Each ton of generates approximately 26% of bagasse (at a moisture content of 50%) and 0.62% of residual ash. The residue after combustion presents a chemical composition dominates by silicon dioxide (SiO2). In spite of being a material of hard degradation and that presents few nutrients, the ash is used on the farms as a fertilizer in the harvests. In this bagasse ash was collected during the cleaning operation. 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.

IV. APPLICATION OF BAGASSE ASH

1) Making of floor and wall tiles
2) Making the bricks
3) As a mineral admixtures
4) In the light weight concrete
5) For silica sources

V. CHARACTERIZATION OF MATERIALS USED

A. Cement

1) Physical Properties of Ordinary Portland cement

Sr. No	Property	Results
1	Fineness	3 %
2	Soundness	1 mm
3	Setting Time	Initial= 85mm, Final= 165 mm
4	Specific Gravity	3.15
5	Compressive Strength	After 3 days = 27.00 MPa
		After 7 days = 34.20 MPa
		After 28 days = 44.22 MPa

B. Coarse Aggregate

1) Properties of Coarse Aggregates

Characteristics	Value
Shape	Angular
Maximum size	10 mm
Specific gravity	2.76
Impact value	5.9 %
Crushing value	19.43

C. Fine Aggregate

1) Properties of Fine Aggregates

Characteristics	Value
Grading zone of fine aggregates	Zone III
Specific gravity	2.7
Silt content	2.79 %

D. Sugarcane Bagasse Ash

VI. TESTS ON SPECIMEN AND STANDARD CONCRETE BLOCK

A. Workability Test

Workability is the property of freshly mixed concrete that determines the ease with which it can be properly mixed, placed, consolidated and finished without segregation.

Workability test conducted in lab

B. Water Absorption Test

The increase in weight as a percentage of the original weight is expressed as the absorption (in percent).

Formula used is Water absorption = [(A – B)/B] x 100%.

Where; A= weight of saturated surface dried sample in gms
B=weight of oven dried sample in gms.

C. Compressive Strength Test

For compressive strength test, cube specimens of dimensions 150 mm x 150 mm x150 mm were cast for M30 grade of concrete. The compressive strength test was carried out conforming to IS 516-1959 to obtain compressive strength for M30 grade of concretes.

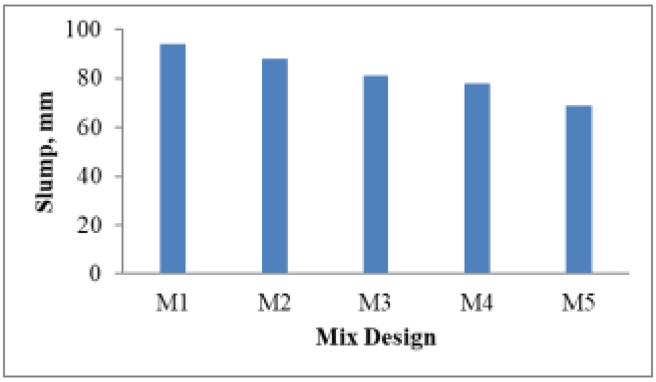
Compressive strength test

VII. RESULTS

A. Workability Test

1) Slump Test Result

S.No	Mix	Slump, mm
1	M1	94
2	M2	88
3	M3	81
4	M4	78
5	M5	73

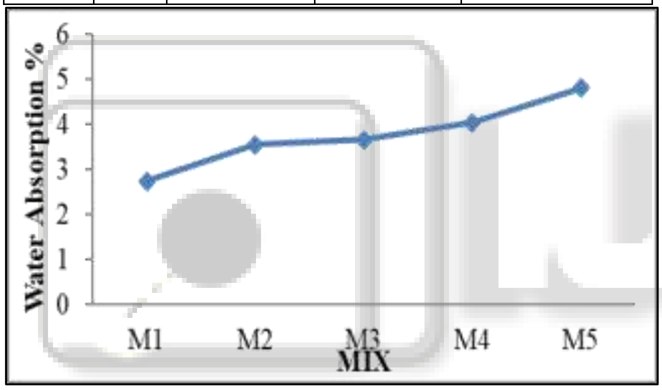


Slump value for different mix

B. Water Absorption

1) Water Absorption Test

S.No.	Mix	Wet Weight (W_2) in kg	Dry Weight (W_1) in kg	% Water Absorption (W %)
1	M1	7.45	7.25	2.75
2	M2	7.58	7.32	3.55
3	M3	7.64	7.37	3.66
4	M4	7.72	7.42	4.04
5	M5	7.84	7.48	4.81

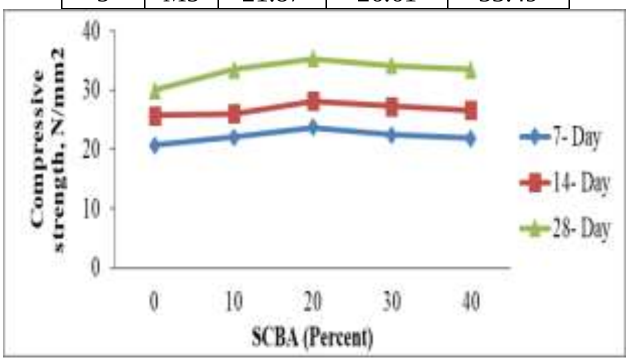


Water absorption for different samples

C. Compressive Strength

1) Compressive strength of concrete paver blocks

S.No	Mix	Compressive strength, N/mm^2		
		7 Days	21 Days	28 Days
1	M1	20.65	25.74	30.00
2	M2	22.05	26.01	33.50
3	M3	23.68	28.18	35.29
4	M4	22.41	27.30	34.18
5	M5	21.87	26.61	33.49



Compressive Strength versus SCBA Percentage

2) Cost of material per cubic meter of concrete for M25

Material	Rate	Conventional Concrete		M 30 (Optimum SCBA (10%) Concrete)	
		Quantity	Cost	Quantity	Cost
Cement	Rs400 per bag (50 Kg)	11.3 bags	Rs 4520	7 bags	Rs 2800
SCBA	Rs10/ kg	0	0	113.04 Kg	Rs1130.4
Fine Aggregate	Rs 860/m^3	0.914 m^3	Rs 786.04	0.3925 m^3	Rs 786.04
Coarse Aggregate	Rs 2400/ m^3	1.05 m^3	Rs 2520	0.785 m^3	Rs 2520
			Rs7826.04		Rs7236.44

VIII. CONCLUSIONS

Experimental results show the following outcomes:

1) As the SCBA content increases (i.e. cement content decreased) workability decreases. Because there is a decrease in fineness modulus of cementitious material, quantity of cement paste available is less for providing lubricating effect per unit surface area of aggregate. Therefore, there is a confine on the mobility.
2) It is observed that the SCBA content is increased from 0% to 40% water absorption is increasing. But according to IS 15658:2006 the water absorption for concrete is 7%. From the test results, it can be seen that the water absorption values for all the specimens of mix ratios were lower than 7% as per IS: 15658-2006 specifications.
3) The graph illustrates that compressive strength at 7, 14 and 28 days increases with the inclusion of SCBA till 20 % and later it decreases. There was an increase of 17.63 % in compressive strength at 20 % SCBA inclusion compared to normal concrete block at 28 days. At 20% of SCBA maximum compressive strength of concrete block at 7, 21 and 28 days are 23.68, 28.18 and 35.29 N/mm^2.

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