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Investigational Study on Bagasse Ash in Concrete by Partially Substitute with Cement

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Abstract:- The utilization of business and agricultural waste created by industrial processes has been the main focus of waste diminution analysis for economical, environmental, and technical reasons. Sugar-cane bagasse is a fibrous waste-product of the sugar refining industry, along with ethanol vapor. This waste product (Sugar-cane Bagasse ash) is already causing serious environmental pollution, which calls for urgent ways of handling the waste. Bagasse ash mainly contains aluminum ion and silica. In this paper, Bagasse ash has been chemically and physically characterized, and partially replaced in the ratio of 0%, 5%, 15% and 25% by weight of cement in concrete. Fresh concrete tests like compaction factor test and slump cone test were undertaken was well as hardened concrete tests like compressive strength, split tensile strength, flexural strength and modulus of elasticity at the age of seven and 28 days was obtained. The result shows that the strength of concrete increased as percentage of bagasse ash replacement increased.

Keywords – Compressive Strength, Flexural Strength, Split Tensile Strength, Sugarcane Bagasse Ash

1. INTRODUCTION

Cement which is one of the ingredients of concrete plays a great role, but it is most expensive. Therefore requirements for economical and more environmental-friendly cementing materials have extended interest in other cementing material that can be used as a partial replacement of the normal Portland cement. Ground Granulated Blast Furnace Slag (GGBS), Fly Ash (FA), Silica Fume (SF) have been used successfully for this purpose. 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 [1]. for this reason sugarcane bagasse ash (SCBA) is one of the main by-product can be used as mineral admixture due to its high content in silica (SiO2). The ash, therefore, becomes an industrial waste and poses disposal problems [2]. Sugarcane bagasse is an industrial waste which is used worldwide as fuel in the same sugar-cane industry [3]. Recently Sugarcane Bagasse Ash (SBA), 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 part 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 [4]. The main composition of bagasse ash is siliceous oxide sio2 that react with free lime from cement hydration [5]. The pozzolanic property of SBA 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 sugar cane is grown [6]. Therefore, this study attempts to make use of the SBA in India as a pozzolanic material to replace cement. An experimental investigation was carried out explore its Consistency, setting time, workability, compressive strength, split tensile strength, flexural strength and durability characteristic.

2. Materials And Methods

Cement: In this present study 43 grade Ordinary Portland Cement (OPC) is used for all concrete mixes. The cement used is fresh and without any lumps. The testing of cement is done as per IS: IS 8112 - 1989 [7]. The specific gravity, normal consistency, initial and final setting time of cement was found as per Indian standard specifications. Fine aggregate: The sand used in this present study is ordinary river sand. The sand passing through 4.75 mm size sieve is used in the preparation of concrete mix. The sand confirms to grading Zone II as per IS: 383-1970 [8]. The properties of sand such as fineness modulus and specific gravity were determined as per IS: 2386-1963 [9]. The specific gravity of fine aggregate is found to be 2.65. The water absorption is 0.5%. The bulk density of fine aggregate in loose and compact state is 1579 kg/m3 and 1689 kg/m3 respectively. Coarse aggregate: The coarse aggregate used in this present study is 20 mm down size locally available crushed stone obtained from local quarries. The physical properties have been determined as per IS: 2386-1963 [9]. The specific gravity of coarse aggregate is found to be 2.68. The water absorption is 0.25%. The bulk density of coarse aggregate in loose and compact state is 1471 kg/m3 and 1565 kg/m3 respectively. Water: The water used in the mixing of concrete was potable water and its free from suspended solids and organic materials. Sugarcane Bagasse Ash: The SBA used in this present study was taken from Sugar factory which is located in Pandavapura, Mandya district of Karnataka State, India. 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 800oC. But it was suggested that at a temperature around 650oC the crystallization of minerals occurs. This reduces the pozzolanic activity of the bagasse ash. For this study, fresh SBA taken from the furnace was used. It was cooled in air by applying a small quantity of water.

2.2 Cement

Ordinary Portland cement (OPC)[5] conforming to Indian standard code IS 8112-1995 was used.

2.3 Aggregates

There are the inert filler in the concrete mixture which constitute between 70 – 75% by volume of the whole mixture. Graded river sand passing through 1.18 mm sieve with fineness modulus of 3.05 and specific gravity of 2.35 was used as fine aggregate (Fa). It was clean and free from organic material and clay.

Locally available crushed granite aggregate, passing through 12.5 mm sieve while being retained on 4.75 mm sieve with the fineness modulus of 4.03 and specific gravity of 2.88 (conforming to IS 383-1970) was used as coarse aggregate (Ca)[6] and contained only so much fine materials[15] as was permitted for various sizes in the specification.

2.4 Water

The water used for the study was free of acids, organic matter, suspended solids, alkalis and impurities when present may have adverse effect on the strength of concrete Potable water with PH value of 7.0 confirming to IS 456-2000 was used for making concrete and curing this specimen as well.

2.5 Silica Fume

The Silica fume obtained from the M/s ELKEM Pvt Ltd, Bombay confirming to ASTM C1240 was used for this study, Its physical and chemical properties .

2.6 Fly Ash

Fly ash (FA) obtained from Thermal power plant, Mettur Salem district, Tamilnadu state, India confirming to IS:3812-1981 used in mineral admixture in day powder form the physical and chemical properties .

2.7 Chemical admixtures

Superplasticisers (SP) or high range water reducing admixtures are an essential component of HPC. Conplast SP 430 was used as superplasticiser (conforming to IS: 9103:1999).

2.8 Blended cement

SF and FA blended cements were prepared by replacing OPC with combination of SF and FA blended cement were prepared by replacing OPC with different amount of SF+FA by weight of cement).

The blended cement was prepared in dry condition. The mixtures were thoroughly homogenized and kept in polythene bottles.

TABLE:1 CHEMICAL COMPOSITION OF SBA

Chemical Composition	Residual Bagasse Ash (%)
SiO_2	65.37
Al_2O_3	0.22
Fe_2O_3	5.98
CaO	1.50
LOI	21.04

3.EXPERIMENTAL WORK

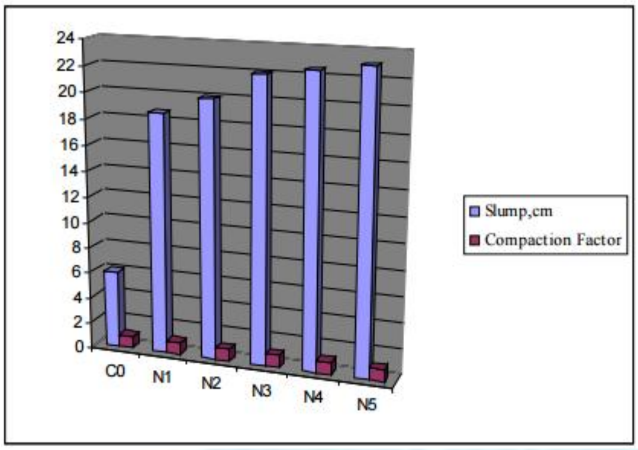
In this study, a total 180 numbers of concrete specimens were casted. In those 60 numbers of cubes, 60 numbers of cylinders and 60 numbers of beams respectively. The cubes, cylinders and beams size were 150mm x150mm, 150mm diameter & 300 mm height and 500mm x100mm x100mm respectively. The mix design of concrete was done according to IS: 10262-2009 [10] for M25 grade. Adopted water cement ratio is 0.5. 0%, 5%, 10%, 15%, 25% of SBA was replaced by the weight of cement. The ingredients of concrete were thoroughly mixed in concrete mixer machine. Before casting oil was smeared to the inner surface of the moulds. Concrete was poured in to the moulds and compacted thoroughly using vibrator. The top of the surface was finished by means of a trowel. After 24 hours the specimens were removed from the mould and then cured under water for period of 7, 28, 56 and 90 days. The specimens were taken out from the curing tank just prior to the test. The test for compressive strength, split tensile strength were conducted using a 2000kN compression testing machine, the flexural strength was conducted by using universal testing machine.

4.RESULTS AND DISCUSSIONS

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. Workability A high-quality concrete is one which has acceptable workability (around 6.5 cm slump height) in the fresh condition and develops sufficient strength. Basically, the bigger the measured height of slump, the better the workability will be, indicating that the concrete flows easily but at the same time is free from segregation. Maximum strength of concrete is related to the workability and can only be obtained if the concrete has adequate degree of workability because of self compacting ability. The workability of C0 and N series concrete are presented in Figure 2. The figure shows the influence of SCBA content on the workability of mixtures at constant water to binder ratio of 0.48. The results show that unlike the C0 series, all investigated SCBA mixtures had high slump values and acceptable workability. This may be due to the increasing in the surface area of sugarcane ash after adding SCBA that needs less water to wetting the cement particles.

FRESH CONCRETE

Sample Designation	% of SCBA	Workability	
		Slump(mm)	Compaction factor
C0	0	60	0.95
N1	5	187	0.96
N2	10	200	0.96
N3	15	220	0.97
N4	20	225	0.97
N5	25	230	0.97



The strength test results obtained for concrete cube, cylinder and prism specimens with partial replacement of SCBA shown in Table 2 and 3. From the table, it is clear that the addition of SCBA in plain concrete increases its strength under compression, tension, young's modulus, and flexure up to 10% of replacement after that strength results was decreases.

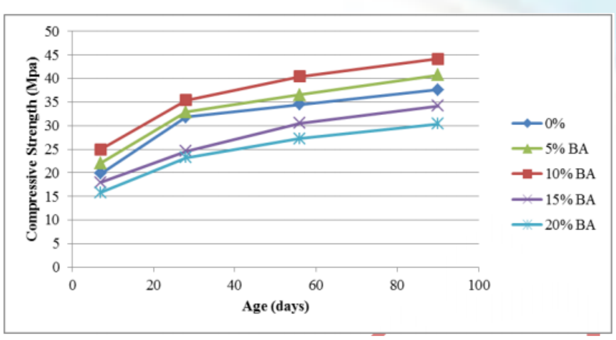


Figure 1: Compressive Strength of M25 Grade Concrete at Different Ages

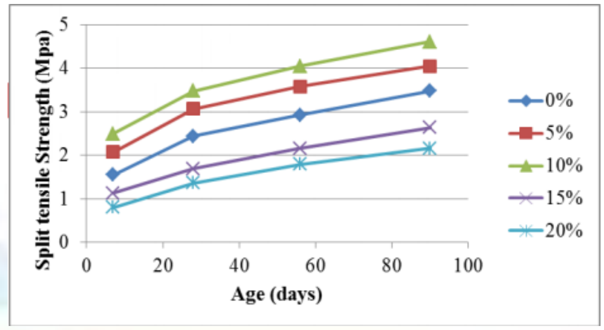


Figure 2: Split Tensile Strength of M25 Grade Concrete at Different Ages

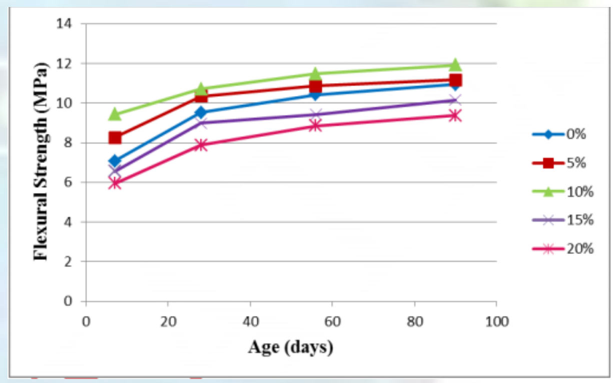


Figure 3: Flexural Strength of M25 Grade Concrete at Different Ages

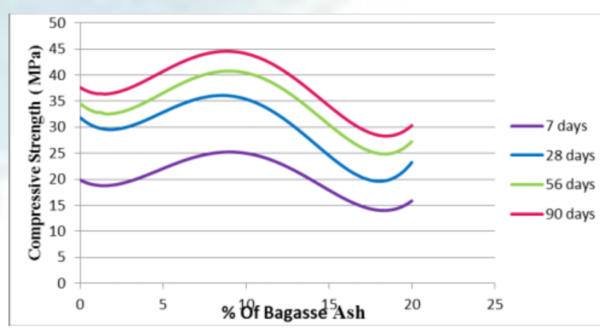


Figure 4: Compressive Strength of M25 Grade Concrete at

6.CONCLUSION

The results show that the SCBA in blended concrete had significantly higher compressive strength, tensile strength, and flexural strength compare to that of the concrete without SCBA. It is found that the cement could be advantageously replaced with SCBA up to maximum limit of 10%. Although, the optimal level of SCBA content was achieved with 1.0% replacement. Partial replacement of cement by SCBA increases workability of fresh concrete; therefore use of super plasticizer is not substantial. The density of concrete decreases with increase in SCBA content, low weight concrete produced in the society with waste materials (SCBA).

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