Utilization of Sugarcane Bagasse Ash In Concrete As Replacement of Cement

Mihir kadam
Dept of Civil Engineering
KJ college of engineering & Management Research, Pune .

Abstract- *The experimental research focuses on the strength performance of concrete using Ordinary Portland Cement and Sugarcane Bagasse Ash . Ever increasing demand of cement causes shortage of cememt in construction industry which results in the inflation of cement prices . so there is an need to examine an alternate biodegradable binding material which would reduce the strain on the current cement industry . Sugarcane bagasse ash is a left-over Agro-industrial byproduct which can be used as partial replacement to cement in concrete, thus also contributing to waste management .*

In this research chemical composition of SCBA has been categorized & different concrete mixes with the Bagasse Ash replacement of 0%, 5%, 10%, 15% and 20% to the Ordinary Portland cement were prepared for M25 grade concrete with water to cement ratio of 0.5.

We can conclude that up to 10% replacement of the Ordinary Portland Cement by Bagasse ash results in higher compressive strength, split tensile strength and flexural strength at all test ages of 7, 28, 56 and 90 days.

Keywords- Bagasse Ash, concrete, Compressive strength, partial replacement, Flexural strength.

I. INTRODUCTION

Ordinary Portland cement is the most extensively used construction material in the world. Since the early 1980's, there has been an enormous demand for the mineral admixture and in future this demand is expected to increase even more. Also in this modern age every structure has its own intended purpose and hence to meet this purpose modification in traditional cement concrete has become essential. This situation has led to the extensive research on concrete resulting in mineral admixture to be partly used as cement replacement to increase workability in most structural application. If 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. For this reason sugarcane bagasse ash (SCBA) is one of the main byproduct can be used as mineral admixture due to its high content in silica (SiO2).

Cement is the most important element of the infrastructure and can be a durable construction material. However, the environmental aspect of cement has become a growing concern, as cement manufacturing is responsible for about 2.5% of total worldwide waste emissions from industrial sources. One effective way to reduce the environmental impact is to use mineral admixtures, as a partial cement replacement both in concrete and mortar, which will have the potential to reduce costs, conserve energy, and minimize waste emission. Mineral admixtures are found in various forms in nature, including blast furnace slag, fly ash, and silica fume. The use of mineral admixtures improves the compressive strength, pore structure, and permeability of the mortars and concretes because the total porosity decreases with increasing the hydration time .India is the second in the major sugar producing countries after Brazil. Bagasse is a major by-product of the sugar industry, which is utilized in the same industry as an energy source for sugar production. Residual from sugar industry and bagasse bio mass burned under controlled conditions gives ash having amorphous silica, which has pozzolanic properties. After the burning process, bagasse ash is produced, and this value tends to increase annually because sugar- cane is the major raw material used in the production of sugar and ethanol. Utilization of bagasse ash is minimal compared to its production, and good methods for its disposal are unavailable. Some applications of bagasse ash include materials for backfill, fertilizer, and removal of heavy metals from waste water. Thus, most of the bagasse ash is still disposed of as waste in landfills, causing environmental and other problems. An economical viable solution to this problem should include utilization of waste materials for new products which in turn minimize the heavy burden on the nation's landfills. Recycling of waste construction materials saves natural resources, saves energy, reduces solid waste, reduces air and water pollutants and reduces greenhouse gases. The construction industry can start being aware of and take advantage of the benefits of using waste and recycled materials.

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. The present study was carried out on

SCBA obtained by controlled combustion of sugarcane bagasse, which was procured from the Maharashtra in India. Sugarcane production in India is over 300 million tons/year leaving about 10 million tons of as unutilized and, hence, wastes material. This paper analysis the effect of SCBA in concrete by partial replacement of cement at the ratio of 0%, 10%, 15%, 20%, 25% and 30% by weight. The main ingredients consist of Portland cement, SCBA, crushed sand, coarse aggregate and water. After mixing, concrete specimens were casted and subsequently all test specimens were cured in water at 7, 28, 56 and 90 Days.

II. LITERATURE

1.) Mr U.R Kawade -Associate Professor, Department of Civil Engineering, P.D.V.V.P, College Of Engineering, Ahmednagar, Maharashtra on ”Effect of use of bagasse ash on strength of concrete ’’in 2013.

In this paper SCBA for 0, 10, 15, 20, 25 and 30% replacement by only cement and various properties of strength of concrete to 7 day,28 days.in this paper to use of material M53 grade cement, fine aggregate, Corse aggregate and the result such as And results are it is found that the cement could be advantageously replaced with SCBA up to maximum limit of 15%. Although, the optimal level of SCBA content was achieved with 15.0% replacement.

2.) Dr B.G Nareshkumar- principal and professor of Maharashtra institute of technology Mysore Karnataka, India on “An Experimental Study on Bagasse ash as Replacement for Cement in Concrete ’’

To this paper to study of investigate experimentally the fresh and hardened properties of lightweight concrete using sugarcane bagasse ash replacement by cement by weight of 0%,5%,10% and 20% and expanded polystyrene beads as 100% replacement for coarse aggregate respectively in this paper to use of materials M53 grade cement ,bagasse ash, water, EPS beads etc.

3.) R.srinivasan Senior Lecturer, Department of Civil Engineering Tamilnadu College of Engineering Karumatham Patti, Coimbatore-641659, india “Experimental Study on Bagasse Ash in Concrete ’’ in 2010.

In this paper SCBA is 0%, 5%, 15% and 25% replace by cement and check out various properties like compression test and slump test 28 days and material uses in OPC, FA, CA and SCBA in 0,5,10 and 25% . It was shown that the use of 20% SCBA decreases the compressive strength to a value which is near to the control concrete

Srinivasan and Sathiya (2010) investigated that 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.

III. MATERIALS AND METHODOLOGY

What is Bagasse ash?

Is one of the major crops grown in over 110 countries and its total production is over 1500 million tons. In India production is over 300 million tons/year that cause around 10 million tons of bagasse ash as an un-utilized and waste material. After the extraction of all economical sugar from , about 40-45 percent fibrous residue is obtained, which is reused in the same industry as fuel in boilers for heat or power generation leaving behind 8 -10 percent ash as waste, known as bagasse ash (SCBA).

Figure 1: Photograph of the Bagasse ash development

The bagasse is an important by-product of the sugar cane industry and most of it is used to produce steam and electricity in a co-generation plant at the ethanol plant. After the bagasse combustion, a new by –product is the Sugar Cane Bagasse Ash (SCBA). It consists mainly of silica (SiO2), which indicates its potential as mineral admixture for use in concrete. The results of this research program indicated that SCBA can be used as a pozzolan and substitute cement. Since durability is a very important issue for implementing new construction materials, in this Thesis, the results of tests of sulphate attack on concrete cubes made with SCBA. These tests indicated that SCBA improves the durability of a reference. Comparison of the results from the 7, and 28 days samples shows that the compressive strength, tensile strength and also flexure increases with SCBA up to 1.0% replacement and then it decreases, although the results of 2.0% replacement plain cement concrete .

DESCRIPTION OF MATERIALS

1. **Cement:**The most common OPC 53 grade Cement was used with fineness 6%and standard consistency 32%.

2. **Fine Aggregate:**Basalt stone crushed sand is used as fine aggregate. The specific gravity of sand is 2.6 and fineness modulus is 3.35. Those fractions from 4.75 mm to 50 micron are termed as fine aggregate, and the bulk density of fine aggregate is 1593.16kg/m3.

3. **Coarse Aggregates:**The crushed aggregates used were 10mm and 20mm nominal size and are tested as per Indian standards and results are within the permissible limit. The specific gravity and bulk density of 10 mm and 20mm aggregate are 2.8 and 2.85 and 1687 kg/ m3 and 1792.31kg/m3 respectively and fineness modulus is 6.260 and 6.734. 02 kg sample has been tested.

4. **Water:** Water available in the site campus conforming to the requirements of water for concreting and curing as per IS: 456-2000

5. **Sugarcane Bagasse Ash:** The bagasse ash was sieved through No. 300 sieve. The sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicellulose & 25% of lignin. Each ton of sugarcane produces approximately 26% 0f bagasse. In this, sugarcane bagasse ash was collected during the cleaning operation of a boiler operating in the **Malegaon Sugar industries, Shivnagar** located in the city of Baramati, Maharashtra.

Fineness Test on SCBA

Table No :1 Fineness Test on SCBA

Sieve Size	Passing Wt %	Retained Weight (gm)	Cumulative Weight
2.36mm	97	30	1000
1.18mm	89	60	970
600 µ	80	110	910
300 µ	50	300	800
150 µ	5	450	500
90 µ	1	40	50
Pan	0	10	10

CHEMICAL ANALYSIS OF SUGAR CANE BAGASSE ASH

Sugar cane bagasse ash collected for experimental work was tested for the chemical compound at **Chem-Tech laboratories PVT LTD, Pune**.

Table no 2: Chemical composition of SCBA

Chemical compound	Abbreviation	Percentage
Silica	Sio2	68.42
Aluminium Oxide	Al2O3	5.812
Ferric Oxide	Fe2O3	0.218
Calcium Oxide	CaO	2.56
Phosphorous Oxide	P2O5	1.28
Magnesium Oxide	MgO	0.572
Sulphide Oxide	SO3	4.33

Table No 3 : Chemical Composition of SCBA

Chemical compound	Abbreviation	Mg/Kg
Sodium Oxide	Na2O	1621
Potassium Oxide	K2O	9406
Titanium Oxide	TiO2	240

Test Report (composition)

Table No 4: Test Report for testing of Bagasse ash sample

Sr No	Test Description	Result
	ElementalAnalysisbyICP/ OES	-
1	Aluminum	2157 ppm
2	Barium	23 ppm
3	Cadmium	<1 ppm
4	Chromium	10 ppm
5	Copper	47 ppm
6	Iron	7667 ppm
7	Lead	8 ppm
8	Magnesium	6824 ppm
9	Manganese	224 ppm
10	Molybdenum	<1 ppm
11	Nickel	10 ppm
12	Phosphorous	2778 ppm
13	Potassium	15340 ppm
14	Silicon	83 ppm
15	Sodium	1335 ppm
16	Tin	1 ppm
17	Titanium	191 ppm
18	Vanadium	10 ppm
19	Zinc	55 ppm

IV. EXPERIMENTAL STUDY

1) <u>Experimental Programme:-</u>

In this experimental work, a total of 45 numbers of concrete specimens were casted. The specimens considered in this study consisted of 45 numbers of 150mm side cubes, 15 numbers of 150mm diameter and 300mm long cylinders, and 15numbers of 1000mm x 150mm x 150mm size beams. The mix design of concrete was done according to Indian Standard guidelines for M 25 grade for the 20 & 10 mm aggregates and the water cement ratio ranges between 0.44-0.63. Based upon thequantities of ingredient of the mixes, the quantities of SCBA for 0, 5, 10, 15, 20% replacement by weight were estimated. In this project work no plasticizer was used. The ingredients of concrete were thoroughly mixed in mixer machine till uniform thoroughly consistency was achieved. Before casting, machine oil was smeared on the inner surfaces of the cast iron mould. Concrete was poured into the mould and compacted thoroughly using table vibrator. The top surface was finished by means of a trowel. The specimens were removed from the mould after 24 hour and then cured under water for a period of 7,28,56,90 days. The specimens were taken out from the curing tank just prior to the test. The tests for compressive, split tensile strength were conducted using a 2000kN compression testing machine. These tests were conducted as per the relevant Indian Standard specification.

2) Testing Of Specimen & Results

2.1 Compressive Strength Test-At the time of testing, each specimen must keep in compressive testing machine. The maximum load at the breakage of concrete block will be noted. From the noted values, the compressive strength may calculated by using below formula.

Compressive Strength = Load / Area
Size of the test specimen=150mm x 150mm x 150mm

1. Representative samples of concrete shall be taken and used for casting cubes 15 cm x 15 cm x 15 cm or cylindrical specimens of 15 cm dia x 30 cm long.
2. The concrete shall be filled into the moulds in layers approximately 5 cm deep. It would be distributed evenly and compacted either by vibration or by hand tamping. After the top layer has been compacted, the surface of concrete shall be finished level with the top of the mould using a trowel; and covered with a glass plate to prevent evaporation.
3. The specimen shall be stored at site for 24+ ½ h under damp matting or sack. After that, the samples shall be stored in clean water at 27+20C; until the time of test. The ends of all cylindrical specimens that are not plane within 0.05 mm shall be capped.
4. Just prior to testing, the cylindrical specimen shall be capped with sulphur mixture comprising 3 parts sulphur to 1 part of inert filler such as fire clay.
5. Specimen shall be tested immediately on removal from water and while they are still in wet condition.
6. The bearing surface of the testing specimen shall be wiped clean and any loose material removed from the surface. In the case of cubes, the specimen shall be placed in the machine in such a manner that the load cube as cast, that is, not to the top and bottom.
7. Align the axis of the specimen with the steel platen, do not use any packing.

Table no. 5 -COMPRESSION STRENGTH RESULTS OF SCBA CONCRETE.

% SCBA	7 days (MPa)	28 days (MPa)	56 days (MPa)	90 days (MPa)
B00%	19.45	31.45	34.48	36.97
B05%	21.87	32.87	36.55	39
B10%	23.83	34.56	40.08	43.78
B15%	17.56	24.45	29.90	34.12
B20%	14.95	23.02	26.88	29.67

Fig 4-Compressive test on specimen.

2.2 Split Tensile Test :- The size of cylinders 300 mm length and 150 mm diameter are placed in the machine such that

load is applied on the opposite side of the cubes are casted. Align carefully and load is applied, till the specimen breaks. The formula used for calculation.

Split tensile strength = 2P/ µdl

Table no.6- SPLIT TENSILE STRENGTH RESULTS OF SCBA CONCRETE.

%SCBA	7 days (MPa)	28 days (MPa)	56 days (MPa)	90 days (MPa)
B00%	1.42	2.23	2.87	3.29
B05%	2.04	2.94	3.2	3.98
B10%	2.36	3.43	3.97	4.53
B15%	1.12	1.56	2.11	2.43
B20%	0.78	1.24	1.68	2.12

Fig 5 :- Split tensile strength on concrete

2.3 Flexural Strength Test- During the testing the beam specimens of size (7000x150x150)mm were used. Specimens were dried in open air after 7 days of curing and subjected to flexural strength test under flexural testing assembly. Apply the load at a rate that constantly increases the maximum stress until rupture occurs. The fracture indicates in the tension surface within the middle third of span length.

Table no 7- Flexural Strength Test results for SCBA concrete

% of SBA	7 days (MPa)	28 days (MPa)	56 days (MPa)	90 days (MPa)
B00%	7	9.23	10.12	10.12
B05%	7.76	9.89	10.43	10.44
B10%	9.08	9.94	10.67	10.79
B15%	6.34	8.69	9.46	10.12
B20%	5.67	7.68	8.38	9.25

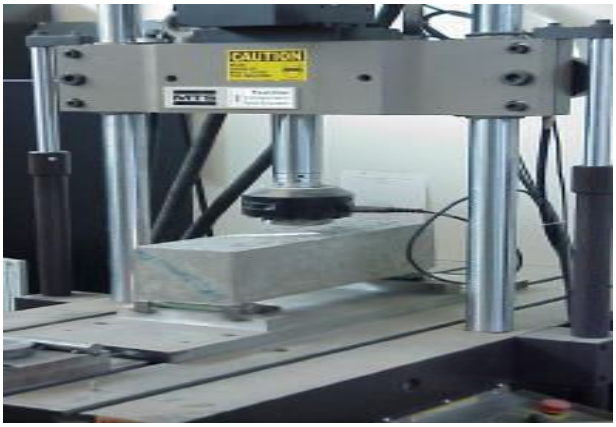

Fig6 :- Flexural strength of concrete

V. CONCLUSION

- The SCBA (SugarCane Bagasse Ash) concrete gives higher compressive strength than that of control concrete.
- The maximum compressive strength obtained in M20 grade concrete is at 10% SCBA replacement for 7, 14, 28 days curing .
- The nature of the specific heat capacity graph is not giving any relationship as it is erratic.
- Partial replacement of cement by SCBA increases workability of fresh concrete; therefore use of super plasticizer is not essential.
- The results show that the SCBA concrete had significantly higher compressive strength compare to that of the normal concrete without SCBA (till 10% partial replacement) , beyond 10% replacement the strength drastically reduces.

- The utilization of bagasse ash in concrete solves the problem of its disposal thus keeping the environment free from pollution.
- Due to non availability of natural sand at sensible cost as fine aggregate and cement in concrete for various motives, search for alternate material like SCBA which succeeds itself as a suitable standby for sand and cement at low cost .

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