AN EXPERIMENTAL STUDY ON BAGASSE ASH AS PARTIAL REPLACEMENT FOR CEMENT IN CONCRETE

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Abstract - *With increasing demand and consumption of cement, researchers and scientist are in search of developing alternate binders that are eco-friendly and contribute towards waste management. The utilization of industrial and agricultural waste produced by industrial processes has been the focus of waste reduction research for economical, environmental and technical reasons. There are lots of environmental impacts of cement on our ecology. Cement industry creating environmental problem by emission of CO_2 during manufacturing of cement. Sugar-cane bagasse is a fibrous waste-product of the sugar refining industry, along with ethanol vapour. 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 aluminium ion and silica. This experimental and analytical study investigates the strength performance of concrete using Ordinary Portland cement and Sugarcane Bagasse Ash. Bagasse ash has been chemically and physically characterized, and partially replaced in the various percentages by weight of cement in concrete. Fresh concrete tests as well as hardened concrete tests were undertaken. The result shows that the strength of concrete increased as percentage of bagasse ash replacement increased up to certain percentage. Beyond that optimum level the strength of concrete begins to decrease drastically.*

Key Words: **Sugarcane bagasse ash, Pozzolanic property, compressive strength, Amorphous silica.**

1. INTRODUCTION

Ordinary Portland cement is recognized as major construction material throughout the world. Researchers all over the world today are focusing on ways of utilizing either industrial or agricultural waste, as a source of raw material. This waste, utilization would not only be economical, but also result in foreign exchange earnings and environmental pollution control. Currently, there has been an attempt to utilize the large amount of bagasse ash, the residue from an sugar industry and the bagasse-biomass fuel in electric generation industry. When this waste is burned under controlled conditions, it also gives ash having amorphous silica, which has pozzolanic properties. A few studies have been carried out on the ashes obtained directly from the industries to study pozzolanic activity and their stability as binders, partially replacing cement.

The main composition of bagasse ash is siliceous oxide (sio_2), which reacts with free lime from cement hydration. The pozzolanic property of sugarcane bagasse ash (SCBA) came from the silicate content of the ash. The silicate undergoes a pozzolanic reaction with the hydration products of the cement and results a reduction of the free lime in the concrete. Therefore, study attempts to make use of the sugarcane bagasse ash in India as a pozzolanic material to replace cement. Thus it is possible to use sugarcane bagasse ash as cement replacement material to improve quality and reduce the cost of construction such as mortar, concrete pavers, concrete roof tiles and soil cement interlocking block.

1.1 Sugarcane Bagasse Ash (SCBA)

The sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicellulose and 25% of lignin. Each ton of sugarcane 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 (SiO_2). 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 sugarcane harvests.

Table - 1: Chemical Composition of SCBA

Components	Mass in Percentage
Silica (sio_2)	66.89 %
Alumina (Al_2O_3)	29.18 %
Ferric Oxide(Fe_2O_3)	
Calcium oxide (Cao)	1.92 %
Magnesium oxide (Mgo)	0.83 %
Sulphur trioxide (SO_3)	0.56 %
Loss of Ignition	0.72 %

1.2 Objectives of the project

- To determine the effectiveness of sugar cane bagasse ash (SCBA) as a cement replacement material in concrete.
- To evaluate the pozzolanic activity of bagasse ash with cement.
- To achieve increase in strength and a better bonding between aggregate and cement paste.

1.3 Scope of the project

- To reduce the waste for economical, environmental and technical reasons.
- SCB can be utilized for the production of lightweight, durable and cheap concrete. Since it is available in significant quantities across the country.

1.4 Effect of mineral admixtures

Because of the spherical shape and small size, admixtures tend to fill the void space between relatively large cement grains which is otherwise occupied by water. In the water filled capillaries, the admixtures undergo pozzolanic reaction with $Ca(OH)_2$ released during cement hydration. As a result, pore refinement occurs as larger size pores are transformed into smaller size pores. There is also a marked decrease in the volume of pores and as a consequence of both the physical and pozzolanic effects of these admixtures properties of concrete in both fresh and hardened state are affected.

2. PREVIOUS STUDY

R.Srinivasan and K.Sathiya (2010) done an experimental study on bagasse ash in concrete to analyze the performance of bagasse ash as a replacement of cement in concrete works. In his experimental work, a total of 180 numbers of concrete specimens were casted. The specimens considered in this study consisted of 36 numbers of 150mm side cubes, 108 numbers of 150mm diameter and 300mm long cylinders, and 36 numbers of 750mm x 150mm x 150mm size prisms. The mix design of concrete was done according to Indian Standard (IS) guidelines M 20 grade for the granite stone aggregates and the water cement ratio are 0.48.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).

S. Abdulkadhir (2014) in his paper conducted various physical and chemical test on SCBA for the partial replacement of cement in concrete production. He concluded that calculated target mean strength of 31.56N/mm^2 was not achieved. This may due to some factors like mixing, compaction. From the density result, the SCBA concrete can be classified as normal weight concrete. The percentage reduction in density for 10%, 20% and 30% replacement of cement with SCBA are 2.7%, 6.7% and 8.47% respectively. He concluded that the SCBA is a pozzolanic material that has the potential to be used as a partial cement replacement material upto 20% and can contribute to the environmental sustainability.

Mrs.U.R.Kawade (2013) investigated the effect of use of bagasse ash on strength of concrete. In his experimental work, a total of 56 numbers of concrete specimens were casted. The standard size of cube150mm×150mm×150mm is used. The mix design of concrete was done according to Indian Standard guidelines for M 20, M 30 and M40 grade. Based upon the quantities of ingredient. The results show that the SCBA concrete had significantly higher compressive 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 15%. Although, the optimal level of SCBA content was achieved with 15.0% replacement. Partial replacement of cement by SCBA increases workability of fresh concrete, therefore use of super plasticizer is not essential.

Dr.B.G.Nareshkumar (2012) investigated experimentally the fresh and hardened properties of lightweight concrete using sugarcane bagasse ash(SCBA) as replacement for cement by weight at 0%, 5%, 10%, 15% and 20% and expanded polystyrene (EPS) beads as 100% replacement for coarse aggregate respectively. From the result it was found that there is marginal increase in workability with bagasse ash content up to 10% beyond that there is possibility of reduction in slump value. The compressive strength of lightweight concrete increases with bagasse content up to 15% and beyond this ,there is possibility of drastic reduction in strength and this 15% bagasse ash replacement strength is slightly less than OPC based lightweight concrete at 28 days but this value is comparable. He also added, If the bagasse is burnt again at controlled temp fineness of cement is increased hence it will improve the fresh and hardened properties of concrete.

Dr. D. B. Raijiwala (2015) studied the sugar cane bagasse ash which is taken from one of the sugar mill of south Gujarat (INDIA) used in M25 grade of concrete by replacing cement 5% by weight and compare with normal M25 grade of concrete to check the feasibility of sugar cane bagasse ash in concrete. For the experiment work concrete cubes of size 150x150x150mm, were prepared. The 53 grade OPC was replaced with 0% and 5% SCBA, a total of 36 concrete specimens were casted and tested. M25 Grade of concrete is adopted throughout the study with w/c ratio of 0.49. Specimen were tested for compressive strength at an interval of 7th day, 14th day, 28th day and 56th day of curing in Compressive Testing machine. The experimental result shows that the increase in the strength of concrete with use of sugar cane bagasse ash. Therefore, with the use of sugar cane bagasse ash in partially replacement of cement in concrete, we can increase the strength of concrete with reducing the consumption of cement. Also it is best use of sugar cane bagasse ash instead of land filling and make environment clean.

3. EXPERIMENTAL INVESTIGATIONS

Production of quality concrete requires meticulous care at every stage of manufacture. It is interesting to note that the ingredients of good concrete and bad concrete are the same. With the same material, if intense care is taken to exercise control at every stage, it will result in good concrete. Therefore it is necessary for us to know, what the good results are to be followed in each stage of mixing of concrete. Here the measurement of materials for making concrete is done by weight batching. The size of the mould used is 150 mm*150 mm* 150 mm. Thus the volume of 1 cube is 3,375,000 mm^3.Total number of cubes casted is 36 cubes. The mix design of concrete was done according to IS: 10262-2009 for M25 grade. Adopted water cement ratio is 0.5. 0%, 5%, 10%, 15%, 20% of SBA was replaced by the weight of cement. The ingredients of concrete were thoroughly mixed in baby 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 damping rod. 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 and 28 days. The specimens were taken out from the curing tank just prior to the test. The test for compressive strength conducted using a 2000kN compression testing machine.

Table -1: Compression test result for various SCBA Replacement

SCBA Replacement	7days (Compressive strength N/mm²)	28days (Compressive strength N/mm²)
0%	18.13	28.27
5%	26.22	29.26
10%	27.38	32.37
15%	28.50	35.63
20%	19.87	22.17
25%	14.86	18.59

3.1 Comparison analysis graph

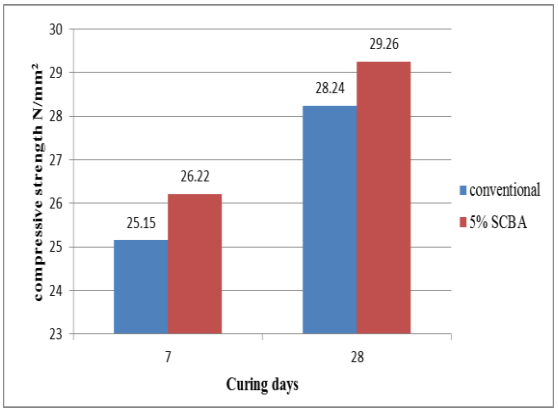

Chart - 1: Comparison of Conventional Concrete and 5% SCBA

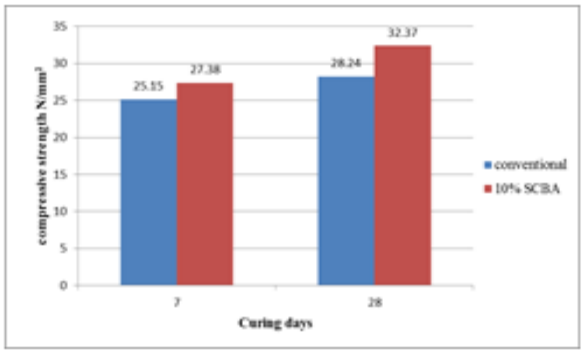

Chart - 2: Comparison of Conventional Concrete and 10% SCBA

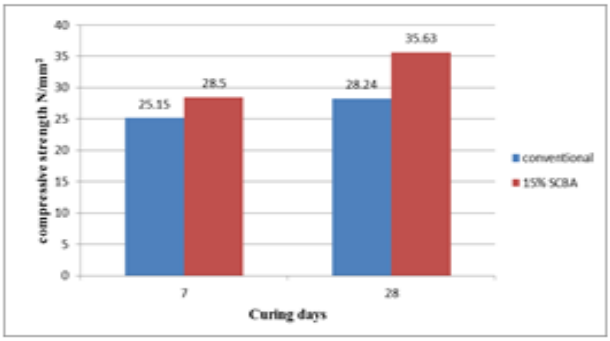

Chart - 3: Comparison of Conventional Concrete and 15% SCBA

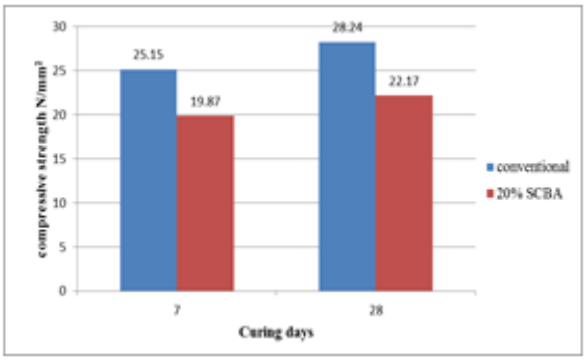

Chart - 4: Comparison of Conventional Concrete and 20% SCBA

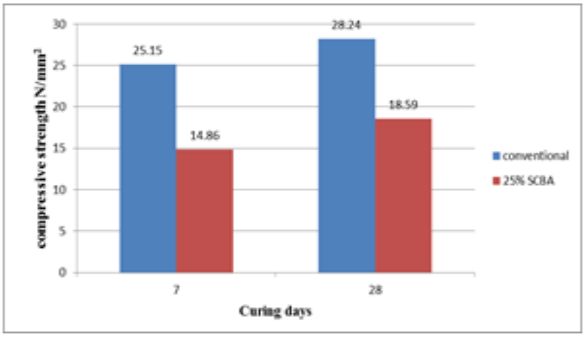

Chart - 5: Comparison of Conventional Concrete and 25% SCBA

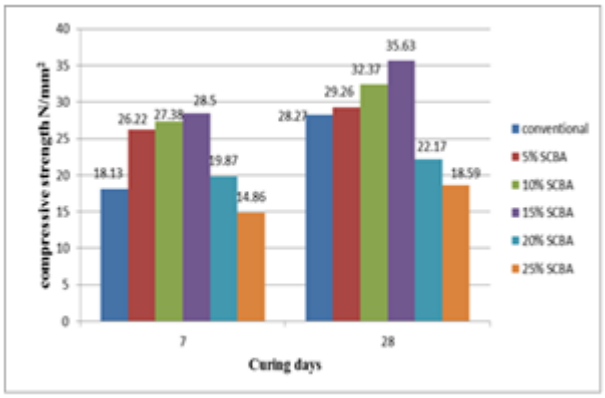

Chart - 6: Comparison of conventional concrete and other SCBA replacement

4. CONCLUSION

The SCBA in blended concrete had significantly higher compressive strength compared to that of the concrete without SCBA. It is found that the cement could be advantageously replaced with SCBA up the maximum limit of 15%. 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, thus low weight concrete can also be produced in the society with waste materials (SCBA).It was clearly shown that SCBA is a pozzolanic material that has the potential to be used as partial cement replacement material and can contribute to the environmental sustainability. The 15% of replacement of bagasse ash gives maximum compressive strength at 28 days as compared to 5%, 10% and 20% replacement of SCBA.We can increase the strength of concrete with reducing the consumption of cement.

REFERENCES

1. Ahmed Salih, E.M. (2014) 'The Usage of the Sugarcane Bagasse Ash in Sudanese Sugar Company as Pozzolanic – Cement Binder', IOSR Journal of Engineering,vol.04.

2. Balaji , K V G D. and Santhosh Kumar, T. (2014) 'Partial replacement ofCement in concrete with sugarcane bagasse ash – behaviour in HCl solution',InternationalJournal of Advanced Research in Science and Engineering.

3. Kawade, U.R. and Vaishali , D. (2013) 'Effect of use of bagasse ash on strength of concrete', International journal of innovative research in science, Engineering and Technology vol.2,Issue 7.

4. Nareshkumar ,B.G. and Yashwanth , M.K. 'An experimental study on bagasse ash as replacement for cement in lightweight concrete', International journal of latest trends in engineering and technology (IJLTET)

5. Raijiwala, B. (2015) 'Experimental study on use of sugarcane bagasse ash in concrete by partial replacement with cement', International Journal of Innovative Research in Science, Engineering and Technology vol.4.

6. Srinivasan, R. and Sathiya, K. (2010) 'Experimental study on bagasse ash in concrete', International journal for service learning in engineering,vol.5

7. Abdulkadir, T.S. and Lawal, A.A. (2014) 'Evaluation of sugarcane bagasse ash as a replacement for cement in concrete works', ACTA TEHNICA CORVINIENSIS – Bulletin of Engineering

8. BIS IS 12269-2004 Specification for 53 grade ordinary Portland cement.

9. BIS IS 516-2004 Methods of test for strength of concrete.

10. BIS IS 383-2002 Specification for coarse and fine aggregate.

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