Utilization of Sugarcane Bagasse Ash in Concrete: A Review

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Abstract— Research all over the world today are focusing on ways of utilizing either industrial or agricultural waste, as a source of raw materials for industry. The utilization of industrial and agricultural waste produced by industrial process has been the focus of waste reduction research for economical and environmental reasons. Sugarcane Bagasse Ash(SCBA) is left over industrial by product from sugar factory's captive power plant which is used for partial replacement of cement. Foremost crops grown in all over countries and its entire production is over 1500 million tons. After the extraction of all efficient sugar from sugarcane, large fibrous excess is obtained called Bagasse. Each ton of sugarcane produces around 25.65% of bagasse (at a moisture content of 50%) and 0.61% of residue ash. Bagasse ash mainly contains aluminium ion and silica. This amorphous silica content makes bagasse ash as a useful cement replacement material in concrete. India is the second largest country in the production of sugar after Brazil. Therefore, the usage of bagasse ash not only reduces the environmental problem but also improves quality of concrete. The result shows that the strength of concrete increased as percentage of bagasse ash replacement increased up to certain percentage.

Keywords: Ordinary Portland Cement, Sugarcane Bagasse Ash, Cement Replacement, Concrete, Compressive Strength

I. INTRODUCTION

Cement is an very important construction material for all infrastructure development projects. Demand of cement is increasing day by day. Cement production is responsible for emitting of CO_2 on large scale. For manufacturing process of Portland cement requires significant amount of energy to have the temperature up to 1500^0C [1] but also the key reaction itself is the breakdown of calcium oxide and CO_2.Due to this there are various environmental problems like air pollution, global warming. The cement is the third largest industrial source of pollution, emitting more than 5 lakh tons per year [13] of sulphur-dioxide, nitrogen oxide and carbon-monoxide, these causes environmental as well as health problems. To reduce this problem to some extent; I replaced some percentage of the cement by sugarcane bagasse ash.

Sugarcane is one of the most important agricultural plants that grown in got regions. Bagasse is a by-product during the manufacture of sugar and it has high calorific value. It is utilized as a fuel in boilers in the sugar mills to generate steam and electricity. Using waste SCBA as a pozzolanic material to reduce cement can reduce the consumption of cement and reduce landfill area requirements. This is turn helps solve environmental issue caused by cement production, decreasing both energy based and CO_2 emissions. It is well known that CO_2 is a major contributor to the greenhouse effect and the global warming of the earth. Bagasse ash is agriculture waste replaced by cement when agriculture waste is buried under controlled condition that gives good properties like amorphous silica pozzolonic properties. Therefore, it is possible to use sugarcane bagasse ash as cement replacement to improve strength and reduce cost of construction.

Components	Mass%
SiO_2	78.34
Al_2	8.55
Fe_2O	3.61
CaO	2.15
Na_2O	0.12
K_2O	3.46
MnO	0.13
TiO_2	0.50
BaO	<0.16
P_2O_5	1.07
Loss on Ignition	0.42

Table 1: Chemical composition of SCBA
Source: Experimental Study on Bagasse Ash in Concrete by R. Srinivasan K. Sathiya

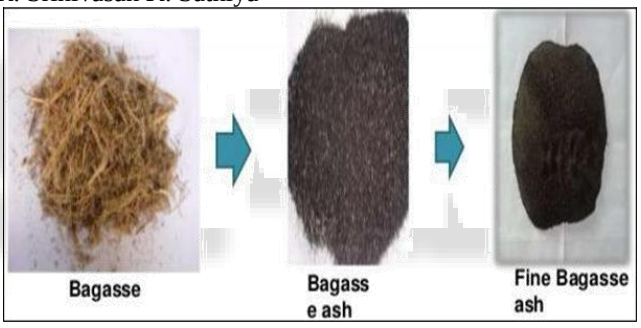

Fig. 1: Pictorial representation of Bagasse, Bagasse Ash and Fine Bagasse Ash

II. LITERATURE REVIEW

Many researchers from various countries have made experimentation in utilizing the SCBA as replacement materials in concrete.

R. Srinivasan and K. Sathiya (2010) done an experimental study on bagasse ash in concrete to analyse 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 150 mm 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/mm2 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 pozzolonic material that has the potential to be used as a partial cement replacement material up-to 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. Naresh Kumar (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.

Hailu and AbebeDinku (2012) reported that up to 10% replacement of cement by bagasse ash results in better concrete properties.

Abdolkarim Abbasi and Amin Zargar (2013) reported that Replacing cement by 10% of bagasse ash, the workability and flowability are optimized and the compressive strength at 28 days is increased by 25% compared with normal concrete.

Abdulkadir, et al (2014) concluded that 10% replacement of SCBA has the highest PAI and, based on the compressive strength results 10% and 20% replacement of SCBA with compressive strengths of 22.3N/mm2 and 20.1N/mm^2 are recommended for concrete

Sadiqul Hasan et al. (2014) investigated the properties of recycled aggregate concrete and SCBA as the partial replacement of cement observed that the strength is enhanced up to 10%.

III. Conclusion

1) From the review of literature on utilization of SCBA in concrete, the following conclusion can be drawn-
2) It is concluded that, the SCBA in blended concrete had significantly higher compressive strength, tensile strength, and flexural strength compare to that of the concrete without SCBA.
3) As for as the strength properties are concerned, the optimum level of replacement is 10%.
4) The optimum level of cement replacement is 7.5% by weight with SCBA.
5) Partial replacement of cement by SCBA increases workability of fresh concrete; therefore, use of superplasticizer is not substantial.
6) The density of concrete decreases with increases in SCBA content, low weight concrete produced in the society with waste materials (SCBA)
7) Environmental problem of disposal is getting sorted out by reusing the wastage in a better way.
8) Thus SCBA are abundantly available in Uttar Pradesh, there it can be considered as a low-cost material.

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