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A REVIEW PAPER ON REPLACEMENT OF CEMENT WITH BAGASSE ASH

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ABSTRACT
Demand and consumption of cement is increasing day by day which has led researchers and scientists to search for locally available alternate binders that can replace cement partially and are ecofriendly and contribute towards waste management. In this direction the industrial & agricultural waste play vital role. The agricultural waste product like Sugar Cane Bagasse Ash (SBCA) is used as alternate binding material in the present study. This will result in saving in cement production equivalent to the alternative binding material used in concrete. The bagasse ash used for the research work is obtained from Vighnahar Sugar Factory (Pune) which is grinded and sieved through sieve of size 150 micron and passing out fraction is used in concrete as a partial replacement of cement in the ratio of 2% 4%, 6%, 8% & 10%by weight of the cement. Ordinary Portland Cement 53 grade cement is used in the study. The effect of replacement of cement by bagasse ash on properties like workability for fresh concrete are tested and for hardened concrete compressive strength at the age of 7 days and 28 days are determined.

Keywords- *Bagasse Ash, Cement, Workability, Flexural & Compressive Strength.*

I. INTRODUCTION
Throughout the world Ordinary Portland Cement is recognized major construction material. Ordinary Portland Cement is the conventional building material that actually is responsible for about 5% - 8% of global CO2 emissions. This environmental problem will most likely be increased due to exponential demand of Ordinary Portland Cement (OPC). Researchers all over the world today are focusing on ways of utilizing industrial or agricultural waste, as a source of raw materials for industry. This waste, used would not only be economical, but may also help in foreign exchange earnings and environmental pollution control. Several researchers and even the Ordinary Portland Cement industry are investigating alternatives to produce green building materials. Industrial wastes, such as blast furnace slag, fly ash and silica (SiO2) fumes are being used as supplementary cement replacement materials. Currently, there has been an attempt to utilize the large amount of Sugarcane Bagasse Ash (SCBA), the residue from an in-line 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 (SiO2), which has pozzolonic properties. A few studies have been conducted out on the ashes obtained directly from the industries for study pozzolonic activity and their suitability as binders, partially replacing cement. Despite variety use of bagasse, for production of wood, papers, animal food, compost and thermal insulation, statistics show that about one million tone extra of Sugarcane Bagasse Ash remains in the country. Sugarcane consists about 30% bagasse whereas the sugar recovered is about 10%, and the bagasse leaves about 8% bagasse ash as a waste. As the sugar production is increased, the quantity of Sugarcane Bagasse Ash produced will also be large and the disposal will be a problem. Sugarcane Bagasse Ash (SCBA) has recently been tested in some parts of the world for its use as a cement replacement material. The bagasse ash was found to improve some properties of the paste, mortar and concrete including compressive strength and water tightness in certain replacement percentages and fineness. The higher silica content in the bagasse ash was suggested to be the main cause for these improvements. Concrete is used in such large amounts because it is, simply, a remarkably good building material not just for basic construction of road but also for rather more glamorous projects. Concrete production is responsible for so much CO2 because making Portland cement not only require significant amounts of energy to reach reaction temperatures of up to 1500.00°C, but also because the key reaction itself is the breakdown of calcium carbonate into calcium oxide and CO2. of those 800.00 kg of CO2 around 530.00 kg is released by the limestone decomposition reaction itself. Concrete is the world's maximum used construction material. With the ever increasing demand and consumption of cement and in the problem of waste management, scientists and researchers all over the world are always in quest for developing

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alternate binders that are friendly to environment and contribute towards sustainable management. Also from other point of view 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. Sugarcane Bagasse Ash, an industrial waste used as fuel in the same sugar cane mill that leaves 8.00 – 10.00 ash containing unburned matter, silica and alumina. But because crystallization of minerals occurs at high temperatures, these ashes are not so reactive. Sugar Bagasse Ash (SCBA) for this study was brought from Sudanese Sugar Company (3 samples were brought from Asalaia, Sinnar, and Guneid Sugar companies). After the determination of parameters such as carbon content, chemical composition, presence of crystalline matter, Pozzolonic reactivity of Sugarcane Bagasse ash (SCBA) was evaluated by conducting strength development tests on Sugarcane Baggage Ash (SCBA) – blended Ordinary Portland Cement (OPC) concrete to verify the hydration reaction of SCBA. Sugarcane is one of the major crops grown in over 110.00 countries and its total production is over 1500.00 million tons. After the extraction of all economical sugar from sugarcane, about 40.00%– 45.00% fibrous residues is obtained by further of un-burnt matter, silicon, aluminum and calcium oxides. A few studies have been carried out on the ashes obtained directly from the industries to study Pozzolonic activity and their suitability as binders, partially replacing cement. Crystallization of minerals occurred at temperatures higher than 800.00°C. It has been reported that at burning temperatures up to 700.00° C silica was in amorphous form and silica crystals grew with time of incineration. The suitable burning condition was identified as 800.00°C for 3.00 hours. At this condition brownish white color indicated complete burning, and amorphous nature of the ash was ascertained by X-ray diffraction analysis. Sugarcane Baggage Ash (SCBA) so formed was not fine enough to be blended with cement; therefore to achieve fineness comparable to Ordinary Portland Cement (OPC), the ash obtained after burning was grounded in a ball mill and subsequently screened through 63 micron (μ) sieve. The present study was carried out on Sugarcane Baggage Ash (SCBA) obtained by controlled combustion of sugarcane bagasse, which was procured from the Maharashtra in India. Sugarcane Baggage Ash production in India is over 300.00 million tons/year leaving about 10.00 million tons of as unutilized and, hence, wastes material. This paper analyses the effect of Sugarcane Baggage Ash (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 Ordinary Portland Cement, Sugarcane Baggage Ash (SCBA), River 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. SCOPE OF WORK

Laboratory tests on cement, fine aggregate, coarse aggregate, bagasse ash, water. Whatever may be the type of concrete being used, it is important to mix design of the concrete. The same is the case with the industrial waste based concrete or bagasse ash replacement. The major work involved is getting the appropriate mix proportions. In the present work, the concrete mixes with partial replacement of cement with bagasse ash were developed using OPC 53 grade cement. A simple mix design procedure is adopted to arrive at the mix proportions. After getting some trail mix, cubes of dimensions 150mm x 150mm x 150 mm was casted and cured in the curing tank. Compressive strength, Split tensile strength and Flexural strength of concrete were conducted to know the strength properties of the mixes. Initially, a sample mix design was followed and modifications were made accordingly while arriving at the trail mixes to get optimized mix which satisfies both fresh, hardened properties and the economy [4]. Finally, a simple mix design is proposed.

III. MATERIALS & METHOD

Cement

The most common cement is used is Ordinary Portland Cement. Out of the total production, Ordinary Portland Cement accounts for about 80-90%. Many tests were conducted to cement some of them are Consistency tests, Se Time tests, Soundness tests, etc.

Fine Aggregate

Fine aggregate is locally available, free from debris & soil & nearly riverbed sand is used. The sand particles should also pack to give minimum void ratio, higher voids content leads to requirement of more mixing water. In the present study the sand conforms to zone II as per the Indian standards (IS). The specific gravity of sand is 2.680. Those passing from 4.750 mm to 150 micron are known as fine aggregate, and the bulk density of fine aggregate (loose state) is 1393.17 kg/m3 and rodded state is 1606.85 kg/m3.

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Aggregate
The crushed aggregates used were 20 mm nominal maximum size and are tested as per Indian standards and results are within the permissible limit. The specific gravity of coarse aggregate is 2.830; the bulk density of coarse aggregate is 1692.32 kg/m3 and rodded state is 1940.18kg/m3.

Water
The requirements of water for concreting & curing as per IS: 456-2000, after available in college campus.

Sugarcane Bagasse Ash (SCBA)
The Sugarcane Bagasse Ash consists of approximately 50% of cellulose, 25% of hemicellulose and 25% of lignin. Each ton of sugarcane generates approximately 26% of bagasse 0.620% of residual ash. The residue after incineration 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 Sugarcane Baggage Ash harvests.

IV. MIXING AND CASTING

The fresh concrete was mixed using flow pan mixer of 150.00Kg capacity till uniform through consistency was achieved, prior to the mixing; the materials were spread in layers in the bottom of the pan, coarse aggregate first, followed by cement and finally the fine aggregate. The constituents of the mixes were mixed dry for 1.00 minute in order to homogenize the batched mix; subsequently water was added and mixed for a further 3.00 minutes. The concrete was cast into the moulds in three layers, and 36.00 blows were given to each layer, using 16. 00 mm diameter bar, to remove any entrapped air. For each mix the required numbers of cubes (total of 150.00 cubes) were casted. The moulds were covered by sacking for 24.00 hours at room temperature. The specimens were de-molded after at least 24.00 hrs. & poured into the curing tank. Before the molding of the samples specimens workability tests were done to observe the effect of Sugarcane Bagasse Ash on fresh concrete properties.

The workability tests adopted for this investigation were the Slump Cone test and Compacting Factor test. The process of selecting suitable ingredients of concrete such as cement, sand, aggregate, water and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is known as the concrete mix design. The proportioning of ingredients of concrete such as cement, sand, aggregate & water is governed by the required performance of concrete in two states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance. The compressive strength of hardened concrete which is generally considered to be an index of its other properties, depending upon many factors, for ex. Water Cement ratio quality and quantity of cement, water, aggregate, batching, placing, compaction and curing. The cost of concrete is made up of the cost of material, plant and labour. The variation in the cost of material arise from the fact that the cement is several times costly than the aggregates, thus the aim is to produce as lean a mix as possible. The actual cost of concrete is related to the cost of materials required for producing a minimum mean strength known as characteristic strength that is specified by the designer of the structure. This depends on the quality control measures, but there is no doubt that the quality control adds to the cost of concrete. On the workability of mix the cost of labour is depend.

V. EXPERIMENTAL WORK

In this experimental work, a total of 36 numbers of concrete specimens were casted. The specimens considered in this study consisted of 36.00 numbers of 150.00 mm side cubes, The mix design of concrete was done according to Indian Standard (IS) guidelines 6.00-9.00 for M20 grade for the granite stone aggregates and the water cement ratio are 0.480. Based upon the quantities of ingredient of the mixes, the quantities of Sugarcane Bagasse Ash (SCBA) for 0%, 5%, 10%, 15%, 20% & 25% replacement by weight were estimated. The ingredients of concrete such as cement, sand, aggregate & water were thoroughly mixed in tilting or non-tilting mixer machine till uniform thoroughly consistency was achieved. Before casting, machine oil was smeared on the inner surfaces of the Cast Iron (CI) mould. Concrete was poured into the mould and compacted thoroughly using table vibrator or other types of vibrators. The top surface was finished with the help of a trowel. The specimens were removed from the mould after 24.00 hrs. then cured under water for a period of 7 and 28 days. The specimens were taken out from the curing tank or water tank just prior to the test. The tests for compressive, split tensile strength were conducted using a

2000.00 kN compression testing machine, the modulus of elasticity the test conducted using a compression testing machine and compressometer. For modulus of rupture was conducted using 1000.00 kN Universal Testing Machine (UTM). These tests were conducted as per the relevant Indian Standard (IS) specifications. In this experimental work, a total of 56.00 numbers of concrete specimens were casted. The standard size of cube 150.00 mm ×150.00 mm ×150.00 mm is used. The mix design of concrete was done according to Indian Standard (IS) guidelines for M20, M30 and M40 grade. Based upon the quantities of ingredient of the mixes, the quantities of Sugarcane Bagasse Ash (SCBA) for 0%, 10%, 15%, 20%, 25% and 30% replacement by weight were estimated. The ingredients of concrete such as cement, sand, aggregate & water were thoroughly mixed in tilting or non-tilting mixer machine till uniform thoroughly consistency was achieved. Before casting, machine oil was smeared on the inner surfaces of the Cast Iron (CI) mould. Concrete was immersed into the mould and compacted thoroughly using table vibrator & any other type of vibrator. The top surface was finished with the help of a trowel. The specimens were removed from the mould after 24.00 hrs. & then cured under water for a period of 7 and 28days. The specimens were taken out from the curing tank just prior to the test. The compressive test was conducted using a 2000.00 kN capacity compression testing machine. This test was conducted as per the relevant Indian Standard (IS) specifications.

VI. COMPRESSIVE STRENGTH DEVELOPMENT

This was due to the combined effect of relative fineness and the Pozzolonic activity of Sugarcane Baggage Ash (SCBA) and also may be due to the existing of crystalline silica ($SiO2$). According to Bui strengthening capability of a mineral admixture not only depends on the Pozzolonic reactivity, but also on the relative fineness of the filler material. At 90 day stage compressive strength for S4 10% replacement was shown clear developing strength about 0.960% of OPC while the other samples (S2 & S3) were shown 85% strength development than OPC. Decrease in compressive strength values with increase in the substitution ratio indicated that filler effect was predominant only up to 10% ash substitution. The increase in compressive strength values in the S4 is due to the combined effect of physical and chemical processes. Physical action was caused by the high specific surface area of Sugarcane Baggage Ash (SCBA) and chemical action was the Pozzolonic reaction between calcium hydroxide (CH) and silica (SiO2). Also the hydration of silica (SiO2) itself in the alkaline environment may have been responsible for increase in compressive strength. But hydration reaction in S2 and S3 specimen was slow; possible because of low reactivity of silica (SiO2) and also, the reduction in CaO contents may have caused the reduction in ultimate strength development .

V. CONCLUSION

The experimental result shows that the strength of concrete is increase with the help of Sugar Cane Bagasse Ash (SCBA).Therefore, with the use of Sugarcane Baggage Ash (SCBA) 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 (SCBA) instead of land filling and make environment clean. This was due to the combined effect of relative fineness and the Pozzolonic activity of Sugarcane Bagasse Ash (SCBA) & also may be due to the existing of crystalline silica (SiO2). According to Bui strengthening capability of a mineral admixture not only depends on the Pozzolonic reactivity, but also on the relative fineness of the filler material. At 90.00 days stage compressive strength for S4 10% replacement was shown clear developing strength about 0.960% of Ordinary Portland Cement (OPC) while the other samples (S2 & S3) were shown 85% strength development than Ordinary Portland Cement (OPC). Decrease in compressive strength values with increase in the substitution ratio indicated that filler effect was predominant only up to 10% ash substitution. The increase in compressive strength values in the S4 is due to the combined effect of physical and chemical processes. Physical action was caused by the high specific surface area of Sugarcane Bagasse Ash (SCBA) & chemical action was the Pozzolonic reaction between calcium hydroxide (CH) and silica (SiO2). Also the hydration of silica (SiO2) itself in the alkaline environment may have been responsible for increase in compressive strength. But hydration reaction in S2 and S3 specimen was slow; possible because of low reactivity of silica (SiO2) and also, the reduction in CaO contents may have caused the reduction in ultimate strength development.

REFERENCES

1. *Ganesan, K., Rajagopal, K., &Thangavel K., 2007. "Evaluation of Bagasse Ash as Supplementary Cementitious Material", Journal of Cement and Concrete Composites*
2. *R. Srinivasan, K Sathiya, 2010. "Experimental study on bagasse ash in concrete", International Journal of*

Service Learning in Engineering 5(2), p. 60

3. *Payá, J., ET. al., 2002. Sugarcane bagasse ash (SCBA): "Studies on its properties for reusing in concrete production", Journal of Chemical technology and Biotechnology 77, p... 321.*
4. *N. B. Singh, V. D. Singh and SaritaRai, 2000. Hydration of Bagasse Ash-Blended Portland cement, Journal of Cement and Concrete Research 30, p. 1485.*
5. *SumrerngRukzon, PrinyaChindaprasirt, 2012. Utilization of Bagasse Ash in High Strength Concrete, Journal of Materials and Design 34, p. 45.*
6. *V. S. Aigbodion, S. B. Hassan, T. Ause and G.B. Nyior, 2010. Potential Utilization of Solid Waste (Bagasse Ash), Journal of Minerals & Materials Characterization & Engineering 9, p.67-77.*
7. *Ganesan, K., Rajagopal, K., & Thangavel, K. 2007. "Evaluation of bagasse ash as supplementary cementitious material". Cement and Concrete Composites, 29, 515-524.*
8. *Committee Board of sugar cane and sugar (2004). Summary of sugar cane and sugar industry in Thailand in 2003/2004, Division of sugar cane and sugar industry Policy, Ministry of Industry, Vol.2 Bangkok Thailand (in Thai).*
9. *Baguant,K., Properties of concrete with bagasse ash as fine aggregate, In Proc 5th CANMET/ACI Intl. conf. on fly ash, silica fume, slag and natural pozzolans in concrete, Ed by Malhotra VM, USA, ACI SP, (1995)153(18), 315-337.*
10. *Payá, J., ET. al., Sugarcane bagasse ash (SCBA): studies on its properties for reusing in concrete production, Journal of Chemical technology and Biotechnology, (2002)77, 321-325. 6. IS 383 -1970 "Specifications for Coarse and Fine Aggregates from Natural Sources for Concrete", Bureau of Indian Standards, New Delhi.*
11. *IS 10262 -1981 "IS Method of Mix Design", Bureau of Indian Standards, New Delhi*
12. *IS 516 -1959 "Methods of Tests for strength of concrete", Bureau of Indian Standards, New Delhi*
13. *IS 456 -2000 "Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standards, New Delhi.*
14. *Ali I (2004) Biomass: An ideal fuel for sugar mills for steam/power generation. Fuel Research Centre, PCSIR, Karachi, XVII (197), Dec*
15. *Wang R, Trettin V, Rudert R (2003) Umlaut recrystallization of granulated blast furnace slag and the significance for the hydraulic Reactivity.*