PARTIAL REPLACEMENT OF CEMENT IN CONCRETE WITH SUGAR CANE BAGASSE ASH-BEHAVIOUR IN HCl SOLUTION

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ABSTRACT

The durability aspects of concrete especially in aggressive environments have become a severe problem in modern day construction. Blended cement concrete is one of the best solutions to this durability criterion. The adoption of blended cements has shown a sharp increment in results of compressive strength in standard conditions and in aggressive conditions. Sugarcane bagasse ash (SCBA) is chosen for this study which has been confirmed as a blending material possessing pozzolanic properties which even reduces the cost of construction and environmental pollution caused due to cement manufacture and disposal of SCBA. In this paper cement is replaced by sugarcane bagasse up to 25% in regular intervals of 5%. To analyse the behaviour of SCBA concrete in HCl the casted specimens are cured in 5% HCl solution for 7, 28 and 60 days. The water binder ratio adopted is 0.4. The use of blending materials in concrete reduces the heat of hydration and increases the life of structure. When calcium hydroxide reacts with hydrochloric acid gives out ettringite (and $CaCl_2$) possessing a crystal type of structure which makes the concrete porous and allows the external chloride ions to penetrate into concrete leading in the loss of weight and strength of concrete. In this paper an attempt is made to prove that SCBA helps to restrict this attack of HCl on concrete.

Keywords: Blended Cement Concrete, Durability, Hydrochloric Acid (Hcl), Sugarcane Bagasse Ash (SCBA).

I INTRODUCTION

Agricultural and industrial by-products are commonly used in concrete production as cement replacement materials CRMs or as admixtures to enhance both fresh and hardened properties of concrete as well as to save the environment from the negative effects caused by their disposal. Approximately 1500 Million tons of sugarcane is annually produced over all the world which leave about 40-45 % bagasse after juice crushing for sugar industry giving an average annual production of 675 Million tons of bagasse as a waste material. Initiatives are emerging worldwide to strike a balance between the developments in infrastructure and prevention of the environment from contamination by reusing the industrial wastes. The feasibility of using sugarcane Bagasse Ash (SBA), a finely ground waste product from the sugarcane industry, as partial replacement for cement in conventional concrete is examined. 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 (SCBA) is one of the main by product can be used as mineral

admixture due to its high content in silica (SiO2). 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 (*Mrs.U.R.Kawade et al.,).* In this study concrete cubes are casted with different percentages of Sugarcane Bagasse ash replaced with cement by weight (i.e. 0%, 5%, 10%, 15%, 20%, and 25%), and this cubes are exposed to 5% HCL environment. Compressive strength of cubes for 7days, 28 days and 60days are observed.

1.1 Effect of Mineral Admixtures on Concrete

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

1.2 Acid Attack

Concrete is not fully resistant to acids. Most acid solutions will slowly or rapidly disintegrate Portland cement concrete depending upon the type and concentration of acid. Certain acids, such as oxalic acid and phosphoric acids are harmless. The most vulnerable part of the cement hydrate is $Ca(OH)_2$, but C-S-H gel can also be attacked. Siliceous aggregates are more resistant than calcareous aggregates. Concrete can be attacked by liquids with pH value less than 6.5. But the attack is severe only at a Ph value below 5.5. At a Ph value below 4.5 the attack is very severe.

II MATERIALS AND METHODS

In the present investigation sugar cane bagasse ash has been used as partial replacement of cement in concrete mixes. On replacing cement with different weight percentage of SCBA, the compressive strength properties are studied at 5% of HCL solution (7, 28 and 60 days). Total six series of specimen of size 100 × 100 × 100mm designed in this investigation consist of one series of specimens of normal strength concrete(i.e. 0%-15 cubes) and five series of specimens of SCBA concrete with percentage replacements of cement with SCBA by 5%,10%, 15%,20% and 25% for M35 grade concrete. A total of 180 cubes have been casted, out of which 90cubes are cured with Normal water and remaining 90 cubes are cured with 5% HCL solution. Where 3 cubes from each series are taken test for its compressive strength at room temperatures, and another 3 cubes from each series are taken and exposed to 5% HCL solution for 7days, 28 days and 60 days.

2.1 Cement

Ordinary Portland cement of 53 Grade from a single batch was used for the entire work and care has been taken to store it in airtight containers to prevent it from being affected by the atmospheric and monsoon moisture and humidity.

2.2 Sugarcane Bagasse Ash

(Srinivasanan and Sathiya, 2010) observed that Sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicelluloses 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).The ash is used on the farms as a fertilizer in the sugarcane harvests. In this project sugarcane bagasse ash was collected from the industry and its physical and chemical properties are given in Table 1 and Table 2 respectively.

Table1. Physical Properties OF Sugar Cane Bagasse Ash (SCBA)

Sl. No	Property	Test result
1.	Density	575 kg/m^3
2.	Specific gravity	2.20
3.	Particle shape	Spherical

Table2. Chemical Properties OF Sugar Cane Bagasse Ash (SCBA)

Sl. No	Component	Symbol	%
1.	Silica	SiO_2	63.00
2.	Alumina	$Al2O_3$	31.50
3.	Ferric oxide	$Fe2O_3$	1.79
4.	Manganese oxide	MnO	0.004
5.	Calcium oxide	CaO	0.48
6.	Magnesium oxide	MgO	0.39
7.	Loss of ignition	LOI	0.71

Table 1 & 2 represents the physical and chemical properties of sugar cane bagasse ash and their corresponding values obtained from laboratory testings.

2.3 Fine Aggregate

The river sand passing through 4.75 mm sieve and retained on 600 µm sieve, conforming to Zone II as per IS: 383-1970 was used as fine aggregate in the present study. The sand is free from clay, silt and organic impurities. The aggregate was tested for its physical requirements such as Gradation, Fineness modulus, and Specific Gravity and Bulk modulus in accordance with IS: 2386-1963.

2.4 Coarse Aggregate

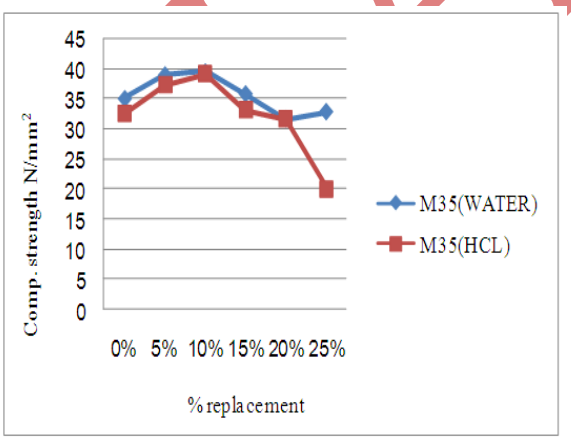
Throughout the investigations, a crushed coarse aggregate of 20 mm procured from the local crushing plant was used. The aggregate was tested for its physical requirements such as Gradation, Fineness modulus, Specific Gravity and Bulk density etc. in accordance with IS: 2386-1963 and IS: 383- 1970.

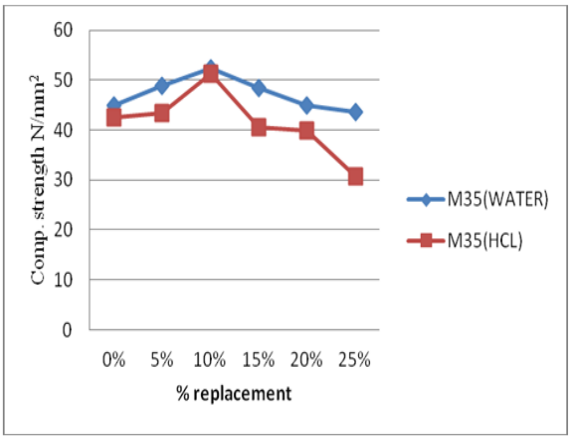
2.5 Water

Fresh portable water with pH value less than 7 free from organic matter and oil which is available in the college campus is used in mixing the concrete. Water in required quantity was measured by graduated jar and added to the concrete. The rest of the materials for preparation of the concrete mix were taken by weigh batching.

III RESULTS AND DISCUSSIONS

Concrete cubes of size 100×100×100mm were casted and tested for compressive strength in normal water and 5% HCL solution at ages of 7, 28 and 60 days for 0%, 5%, 10%, 15%, 20% and 25% replacement of sugarcane bagasse ash for M35 grades of concrete. In order to study the durability of SCBA replaced concrete in 5% HCL solution concrete cubes were casted and tested. A replacement of SCBA of 0%, 5%, 10%, 15%, 20% and 25% were chosen for this study to find out the effect of HCL solution on compressive strength of concrete.

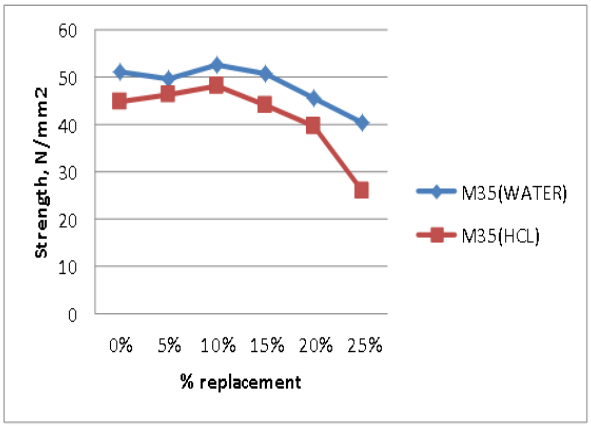




Graph1: Compressive strength of concrete (7 days) cubes cured in Normal water and HCL solution of varying percentage of SCBA

Graph 2: Compressive strength of concrete (28 days) cubes cured in Normal water and HCL solution of varying percentage of SCBA

From the results of the present study and information from the literature, the above mentioned replacement range of 5% to 25% was selected for this study of durability aspects. The solution for required concentration was prepared and p^H was maintained regularly between 4.0-4.5 throughout the study. Concrete cubes of grades M35 were casted and immersed in the prepared 5% HCL solution and tested for different ages of 7, 28 and 60 days. After 7, 28 and 60 days of immersion, the concrete cubes were taken out of acid water and then the specimens were tested for compressive strength. The resistance of concrete to acid attack was found by the % loss of compressive strength on immersing concrete cubes in acid water.



Graph 3: Compressive strength of concrete (60 days) cubes cured in Normal water and HCL solution of varying percentage of SCBA

IV CONCLUSION

From the above results obtained the following conclusions can be drawn that indicates the behaviour of Sugarcane bagasse ash replaced concrete:

1. As the percentage of sugarcane bagasse ash increases the compressive strength of concrete tends to increase up to certain percentage and then start's decreasing with the increase of ash content.
2. SCBA concrete performed better when compared to ordinary concrete up to 10% replacement of sugar cane bagasse ash.
3. Compressive strength is decreased for concrete cured in 5% HCL solution when compared to the concrete cured in normal water.
4. Compressive strength is increased for 7, 28 and 60 days when cured in normal water, but compressive strength is reduced very slight acid attack after immersion of 28 & 60 days in acid solutions.
5. Compressive strength is reduced if the curing duration is increased more than 60 days in 5% HCL solution.
6. Concrete is affected when concrete is exposed to HCL solution for longer duration.
7. Utilization of the waste material Sugar Cane Bagasse ash can be advantageously used as a replacement of cement in the preparation of concrete when it is exposed to 5% HCL solution only.

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