BEHAVIOUR OF SUGARCANE BAGASSE ASH CONCRETE EXPOSED TO ELEVATED TEMPERATURE

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ABSTRACT

In case of sudden fire, the concrete elements such as beams, columns etc will be subjected to extreme temperatures and need for assessment of their performance after fire. Hence, it is important to understand the change in the concrete strength properties due to extreme temperature exposure. In this study bagasse ash is used as partial replacement of cement because it is one of the by product which can be used as mineral admixture due to its high content in silica (SiO_2), it is also a waste product produced from Sugar manufacturing industry. In this study sugarcane Bagasse ash partially replaced in the ratio of 0%, 5%,10%,15% and 25% by weight of cement in concrete and exposed to different elevated temperature (i.e 200^0, 400^0, 600^0, 800^0) for 1 hour and immediately cooled with water. The result shows that the strength of Concrete specimens increased at 200^0C than room temperature for all percentage of replacement of cement with SCBA.

Keywords: Sugarcane Bagasse Ash, Concrete, Compressive strength, Elevated Temperature.

I INTRODUCTION

Cement, is the most important element of construction industry and a durable construction material. Cement industry is the second largest Co_2 emitting industry behind the power generation. Now a day's Agricultural and industrial by-products are used in concrete production as cement replacement materials 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. The feasibility of using sugarcane Bagasse Ash (SCBA), 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 (SiO_2), it acts as mineral admixture. 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 paper concrete cubes are casted with different percentages of Sugarcane Bagasse ash replaced with cement by weight (i.e 0%, 5%, 10%, 15%, 20%, 25%), This cubes are exposed to different elevated temperatures (200^0, 400^0, 600^0, 800^0), And immediately cooled with water. Compressive strength of cubes after cooling are observed.

II 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), 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.

III 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 various temperatures (200^0, 400^0, 600^0, 800^0). 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 M40 grade concrete. A total of 90 cubes have been casted, 5% - 15cubes, 10% - 15cubes, 15% - 15cubes, 20% - 15cubes, 25% - 15cubes. 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 200^0c temperature and this continues for 400^0 c, 600^0 c, 800^0c for 1 hour and immediately cooled by immersing them in water.

3.1 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.

3.2 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

Table- I

PHYSICAL PROPERTIES OF SCBA		
Sl. no	Property	Test result
1.	Density	575 kg/m^3
2.	Specific gravity	2.20
3.	Particle shape	Spherical

Table – II

CHEMICAL PROPERTIES OF SCBA			
Sl. no	Component	Symbol	%
1.	Silica	SiO2	63.00
2.	Alumina	Al2O3	31.50
3.	Ferric oxide	Fe2O3	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

3.3 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*.

3.4 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*.

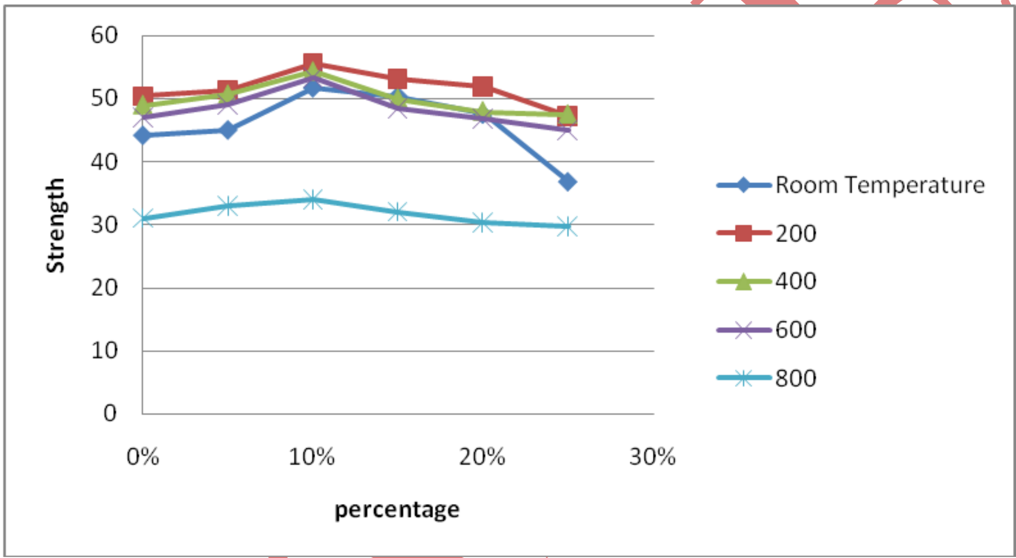
3.5 Water

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.

IV RESULTS AND DISCUSSIONS

The compressive strength of concrete at 0%, 5%, 10%, 15%, 20% and 25% SCBA replacement and exposed to various temperatures has been pictorially represented in Graph 1.

The SCBA significantly increased the compressive strength of concrete for 0% to 5% and 5% to 10% replacement of cement, but there is decrease in compressive strength for concrete after 10% even though percentage of SCBA increases. Concrete exposed to 200^{0}C had better compressive strength than room temperature. The improvement of compressive strength is mostly due to the micro filling ability and pozzolanic activity of SCBA. With a smaller particle size SCBA can fill the micro-voids within the cement particles. There is a sudden decrease in strength of concrete as they are exposed to 800^0c than at 600^0c. This sudden decrease of strength is mainly due to damage that occurs to the CSH gel which is formed due to hydration. The SCBA due to its pozzolanic activity it's readily reacts with water and calcium hydroxide, a by-product of cement hydration and produces additional calcium silicate hydrate or CSH gel. The additional CSH increases the compressive strength of concrete since it is a major strength-contributing compound. Also, the additional CSH reduces the porosity of concrete by filling the capillary pores, and thus improves the microstructure of concrete leading to increased compressive strength. As, there is Increase in percentage of SCBA in concrete, increase of workability is observed.



Graph – I: Compressive strength of concrete cubes of varying percentage of SCBA exposed to different Temperature.

V CONCLUSIONS

1. SCBA concrete performed better when compared to ordinary concrete up to 10% replacement of sugar cane bagasse ash than at 0% replacement.

2. The compressive strength of concrete with 5%, 10%, 15%, 20% and 25% weight replacement of cement with SCBA and exposed to different temperature results in a increase of strength at 200^0c than at room temperature, and gradual decrease of strength till 600^0c and sudden decrease of strength at 800^0c.

4. Both SCBA and normal concrete showed increase of strength when cubes exposed to 200^0c.

5. The Results show that 20% SCBA can be replaced with cement, so that there is no loss of strength and also economical.

6. 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 elevated temperature but till 600^0c only.

REFERENCES

[1] Mrs.U.R.Kawade, Mr.V.R.Rathi, Miss Vaishali and D. Girge, Effect of use of Bagasse Ash on Strength of Concrete, *International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, Issue 7, July 2013.*

[2] R.Srinivasan and K.Sathiya, Experimental Study on Bagasse Ash in Concrete, *International Journal for Service Learning in Engineering Vol. 5, No. 2, Fall 2010 ISSN 1555-9033.*

[3] Lavanya M.R, Sugumaran.B and Pradeep.T, An Experimental study on the compressive strength of concrete by partial replacement of cement with sugarcane bagasse ash, *International Journal of Engineering Inventions ISSN: 2278-7461, ISBN: 2319-6491 Volume 1, Issue 11 (December2012).*

[4] T. shafana and R.venkatasubramani, A study on the Mechanical Properties of Concrete with partial replacement of Fine aggregate with Sugarcane bagasse ash, *International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 03, No. 01, January 2014*.

[5] IS456-2000, Plain and Reinforced Concrete- Code of Practice.

[6] IS2386-1963, Methods of test for aggregates for concrete.

[7] IS383-1970, Specification for Coarse and Fine Aggregates from Natural Source for Concrete.