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Effect of Cement Replacement by Sugarcane Bagasse ASH and Glass Powder on Mortar and Concrete

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Abstract: ***Agricultural and industrial by-products are commonly used in concrete production as cement replacement material as mineral 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. Utilization of these waste products in the industry has been the focus of Research for economical, environmental, and technical reasons.***
Sugarcane Bagasse Ash (SCBA) and glass powder is one of the promising material, with its potential proved to be used as a partial replacement of cement as well as mineral admixtures for producing concrete; properties of such concrete depend on the chemical composition, fineness, specific surface area of SCBA and glass powder. An experimental investigation was carried out to examine the impact of replacing cement by bagasse ash and glass powder to the mechanical and physical properties of pastes and mortars, fresh and harden concrete such as consistency, setting time and workability. Sugarcane Bagasse Ash and waste glass powder used by replacing OPC at 5%, 10% 15% , 20%, 25% and 30%. Its found that The strength increases with addition of Sugarcane Bagasse Ash and waste glass powder at 5%, 10% 15% and 20% after that declines at 25% and 30%.
Keywords: ***Bagasse Ash, Glass powder, Workability, OPC***

I. INTRODUCTION

Utilization of agricultural, industrial and agro- industrial by-products in concrete production has become an attractive area to the researchers worldwide. Utilization of such wastes as cement replacement materials also as mineral admixture can reduce the cost of concrete and also minimize the negative environmental effects associated with the disposal of these wastes. Silica fume, rice husk ash, fly ash, and ground granulated blast furnace slag are well established pozzolans because of high silica contents in their chemical composition. The calcium hydroxide (unfavorable product from the cement hydration) released during the hydration of Portland cement reacts with the silica content present in the pozzolans and water to form additional calcium silicate hydrate which is responsible for the improvement in strength in cementations mediums.

Bagasse is the waste produced after juice extraction in sugar industry, which is usually used as a fuel for boilers in the sugar mills and alcohol factories which produce high amounts of ash annually. Previously the sugar cane bagasse(SCB) was burnt as a means of solid waste disposal, with increasing of the cost of natural gas, electricity, and fuel oil and with calorific properties of these wastes; since last decade the SCB has been used as the principal fuel in cogeneration plants to produce electric power.

The term glass contains several chemical diversities including soda-lime silicate glass, alkali-silicate glass and boro-silicate glass. To date, these types of glasses glass powder have been widely used in cement and aggregate mixture as pozzolana for civil works. The introduction of waste glass in cement will increase the alkali content in the cement. It also help in bricks and ceramic manufacture and it preserves raw materials, decreases energy consumption and volume of waste sent to landfill. As useful recycled materials, glasses and glass powder are mainly used in fields related to civil engineering, for example, in cement, as pozzolana(supplementary cementitious materials), and coarse aggregate. Their recycling ratio is close to 100%, and it is also used in concrete without adverse effects in concrete durability. Therefore, it is considered ideal for recycling

Recently, Glasses and its powder has been used as a construction material to decrease environmental problems. The coarse and fine glass aggregates could cause ASR(alkali-silica reaction) in concrete , but the glass powder could suppress their ASR tendency, an effect similar to supplementary cementations materials (SCMs). Therefore, glass is used as a replacement of supplementary cementitious materials.

A. Almir Sales, Sofia Araújo Lima, "Use of Brazilian sugarcane bagasse ash in concrete as sand replacement"[1]

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Researchers conducted study on ash collected from four sugar mills in the region of São Carlos, SP, Brazil, which is one of the world's largest producers of sugarcane. The ash samples were subjected to chemical characterization, sieve analysis, determination of specific gravity, X-ray diffraction, scanning electron microscopy, and solubilization and leaching tests. Mortars and concretes with SBA as sand replacement were produced and tests were carried out: compressive strength, tensile strength and elastic modulus. The results of their study indicated that the SBA samples presented physical properties similar to those of natural sand.

B. *Anurag Shrivas, Devansh Jain, Rajesh Joshi, "Application of Different Waste in Concrete as a Partial Replacement of Cement"*[2]

In this study paper they conduct research on compressive quality and workability of rice husk ash, Wheat Straw Ash, Fly Ash, Glass powder, Sugarcane Bagasse Ash, Paper Pulp as a fractional substitution for OPC in cement. When Sugarcane Bagasse Ash replaced cement in concrete, its 10% mix gives better compressive strength. Paper Pulp possess lower compressive strength, its only 10% mix are useable. When cement is replaced by these waste material upto 30%. By using these waste material INR 94.5/- can be saved on per bag of cement i.e. 30% of the cost.

C. *B. Naga Niranjan Kumar, M. Ashok Kumar, " Influence of Glass Powder on The Properties of Concrete"*[3]

Study made on glass powder binder with partial replacement of cement. They focused on the strength effect of replacement of cement by glass powder, the cement was replaced at 10%, 20% 30%. The compressive strength of concrete cubes was tested for 3, 7, 28 days were found. The highest replacement level is 20% by WGP (waste glass powder).

D. *Dhanaraj Mohan Patil1,Keshav K. Sangle, " Experimental Investigation of Waste Glass Powder as Partial Replacement of Cement in Concrete"*[4]

In this study, waste glass powders had been used as replacements to the concrete ingredient i.e. cement and the mechanical properties like compressive strength were measured. Researchers' were studied the size effect of glass powder on strength of concrete. For checking strength effect of replacement of cement by glass powder, the cement was replaced at 10%, 20% and 30%. For study of size effect of glass powder the powder is divided in to two grades one is glass powder having size less than 90 micron and another is glass powder having particle size ranges from 90 micron to 150 micron. Finding if there study, Initial strength gain was very less due to addition of GLP on 7th day but it increases on the 28th day. It was found that 20% addition of GLP gives higher strength. And also GLP size less than 90 micron was very effective in enhancement of strength.

II. MATERIALS AND METHODOLOGY

Concrete is a composite material composed of coarse granular material (the aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space among the aggregate particles and glues them together. In this experimental investigation, cement was replacement by sugarcane bagasse ash and glass powder (GLP) having particle size less than 90 μm. The sugarcane bagasse ash and waste glass powder was replaced by 5% to 30% at interval of 5% each and mix design prepared. For this study M25 grade of concrete was used. Mix design carried out for M25 grade of concrete as per IS10262:2009.

III. RESULT AND DISCUSSION

In the experimental program, following tests are conducted on cement

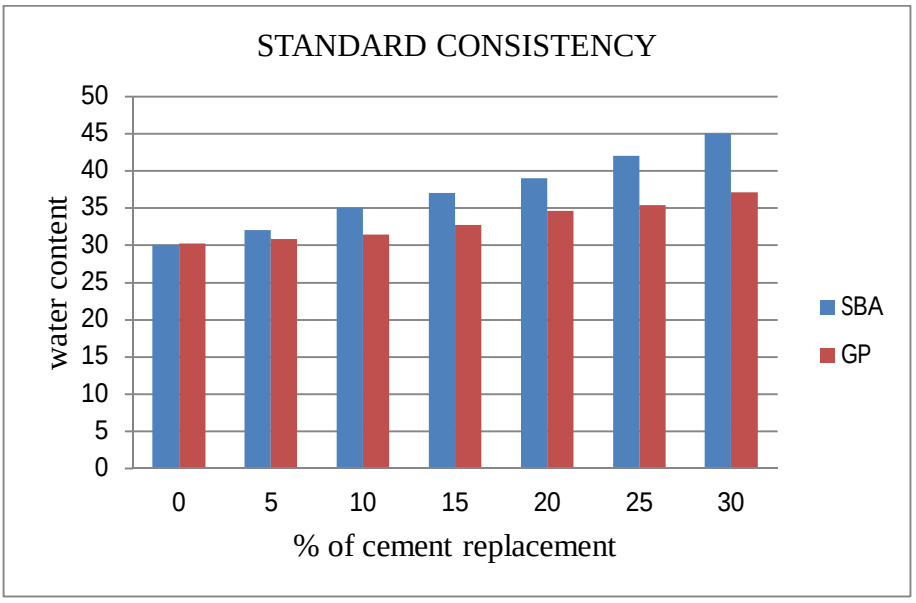
1) Consistency
2) Initial and final setting time

Also in the experimental program, workability test is conducted on concrete

A. *standard Consistency Test*

The objective of conducting this test is to find out the amount of water to be added to the cement to get a paste of normal consistency. 500 grams of cement was taken and made into a paste with a weighed quantity of water (% by weight of cement) for the first trial. The paste was prepared in a standard manner and filled into the vicat mould plunger, 10mm diameter, 50mm long and was attached and brought down to touch the surface of the paste in the test block and quickly released allowing it to sink into the paste by its own weight. The depth of penetration of the plunger was noted. Similarly trials were conducted with higher water cement ratios till such time the plunger penetrates for a depth of 33-35mm from the top. That particular percentage of water which allows the plunger to penetrate only to a depth of 33-35mm from the top is known as the percentage of water required to produce a cement paste of standard consistency.

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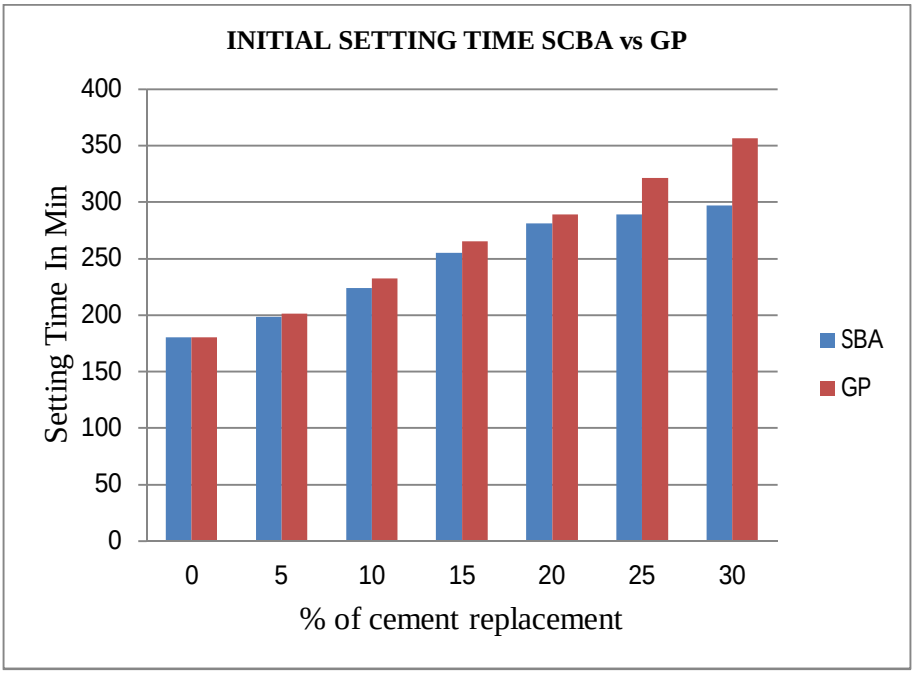


Graph 3.1 Standard Consistency of cement with partially Sugarcane Bagasse Ash vs Glass Powder Replacements

From above results we conclude that the standard consistency increase with increase in the proportion of sugarcane baggash ash and waste glass powder. Standard consistency increased from 30% for normal OPC cement to 45% for mix with 30% replacement of cement with sugarcane baggash ash. Standard consistency increased from 30% for normal OPC cement to 37% for mix with 30% replacement of cement with waste glass powder. This shows that requirement of water increases as the percentage of glass powder increases.

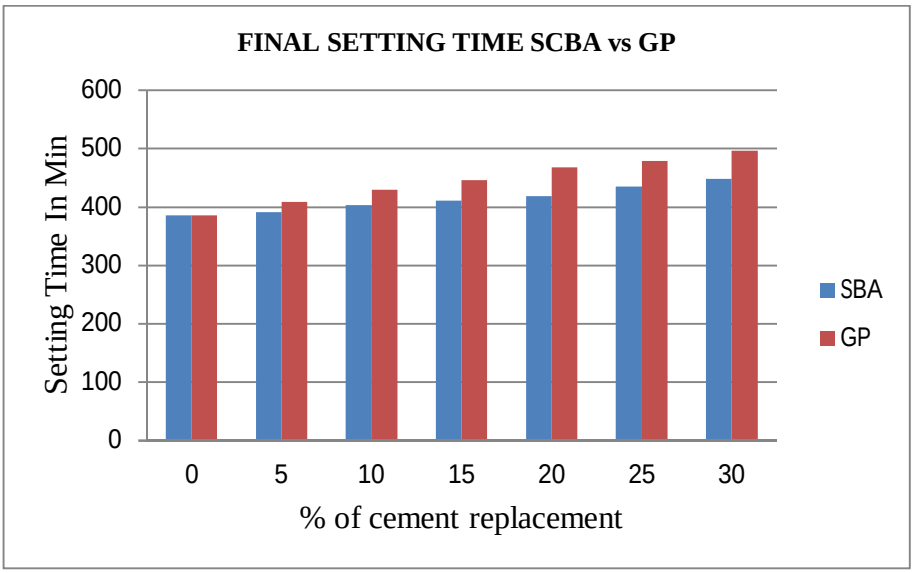
B. Setting Time Of Cement Paste

For convenience, initial setting time is regarded as the time elapsed between the moments that the water is added to the cement, to the time that the paste starts losing its plasticity. The final setting time is the time elapsed between the moment the water is added to the cement, and the time when the paste has completely lost its plasticity and has attained sufficient firmness to resist certain definite pressure.



Graph 3.2 Initial setting time of cement with partially Sugarcane Bagasse Ash vs Glass Powder Replacements

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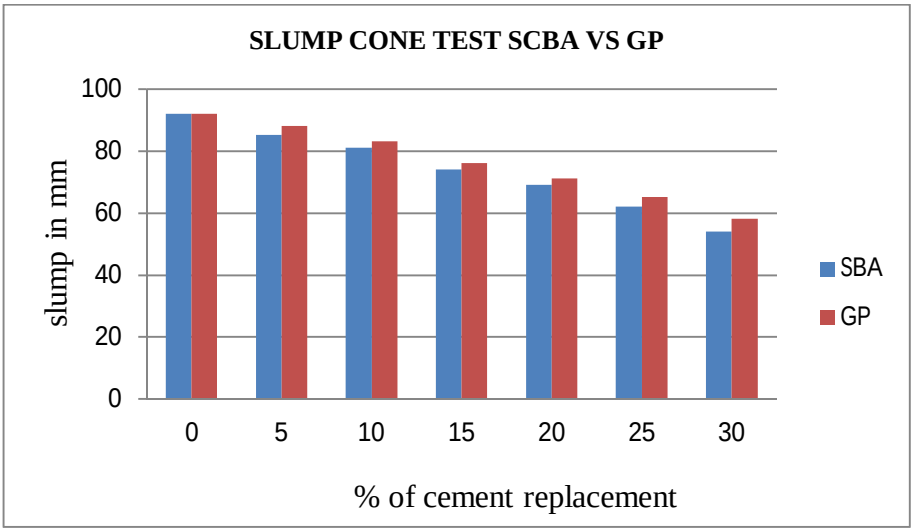


Graph 3.3 Final setting time of cement with partially Sugarcane Bagasse Ash vs Glass Powder Replacements

From above results we conclude that the setting time initial and final both increase with increase in the proportion of sugarcane baggash ash and waste glass powder. Initial setting time increased from 180 min for normal OPC cement to 297min for mix with 30% replacement of cement with sugarcane baggash ash. Initial setting time increased from 180 min for normal OPC cement to 356 min for mix with 30% replacement of cement with waste glass powder.

C. Workability Test

The workability of concrete is one of the functions of the relative magnitudes of various concrete mix constituents. Slump Test is one of the tests which measure the parameters close to workability and provide useful information about it. It is the most commonly used method of measuring consistency of concrete which can be employed either in lab or at the site. From this test, slump is deduced by measuring the drop from the top of the slumped fresh concrete. Additional information on workability of concrete can be obtained by observing the shape of the slump in concrete.



Graph No.3.4 : workability of concrete, with partially Sugarcane Bagasse Ash vs Glass Powder Replacements

From above results it is concluded that the workability decrease with increase in the percentage of sugarcane baggash ash and waste glass powder used as partially replacement of cement. Slump value decreased from 92mm for normal OPC cement to 54 mm for mix with 30% replacement of cement with Sugarcane Bagasse Ash. Slump value decreased from 92mm for normal OPC cement to 58 mm for mix with 30% replacement of cement with waste glass powder

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IV. CONCLUSION

Experimental investigation following conclusions are made

A. For consistency , compare with control mix it increases upto 50 % for SCBA and 23% for GP, when replaced upto 30% of cement.

B. For initial setting time , compare with control mix it increases upto 65 % for SCBA and 97% for GP, when replaced upto 30% of cement. Similarly final setting time , compare with control mix increases upto 16 % for SCBA and 29% for GP, when replaced upto 30% of cement.

C. For workability, compare with control mix it reduces upto 58% for SCBA and 63% for GP, when replaced upto 30% of cement. Another comparison between SCBA and GP, then workability of SCBA reduces 8% more than GP, when replaced upto 30% of cement.

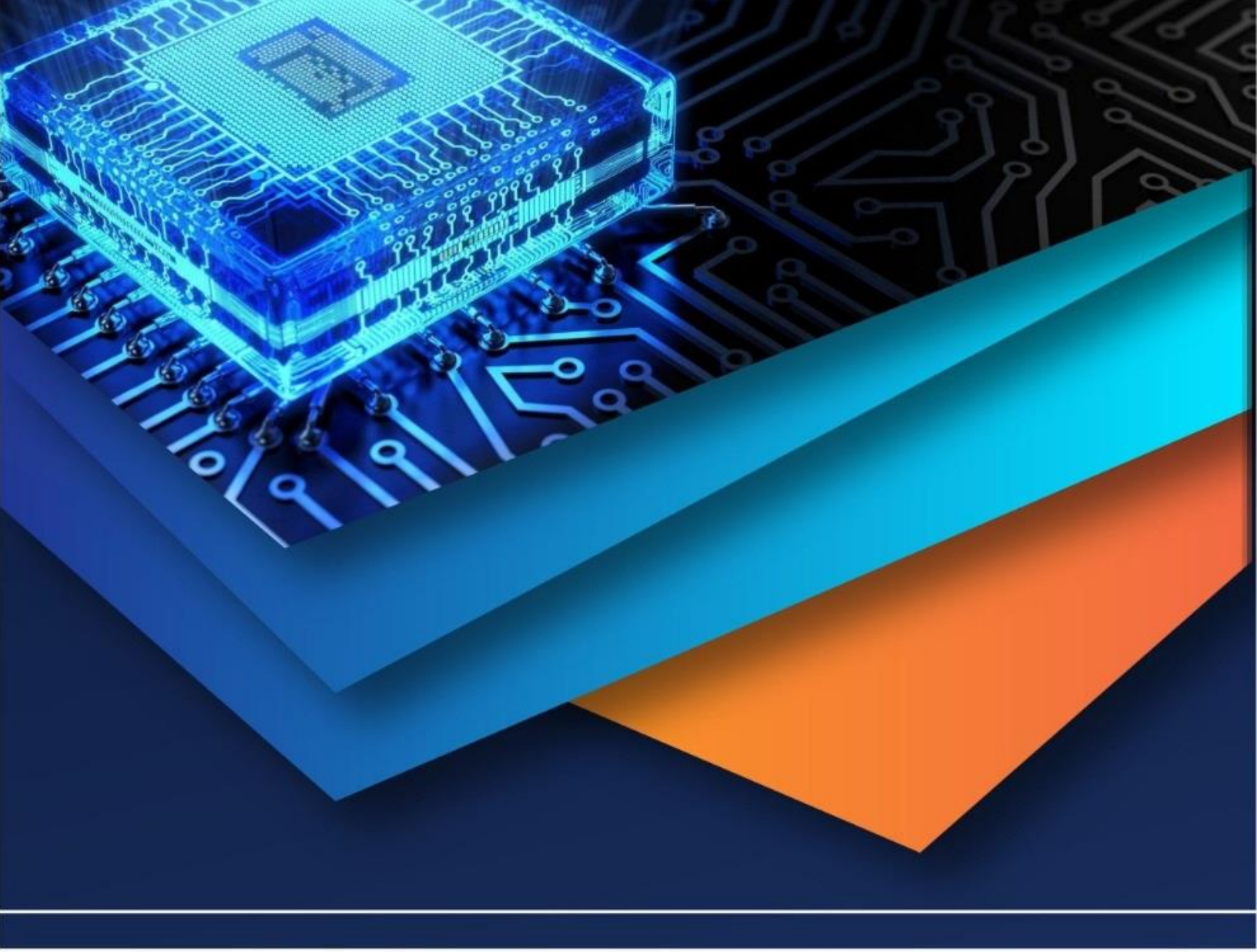
D. workability decrease with increase in the percentage of Sugarcane Bagasse Ash waste glass powder used as partially replacement of cement.

E. As compared to SCBA and GP, overall performance of glass powder is better than SCBA in all manners like workability, and all the strength.

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