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# EFFECT OF BAGASSE ASH AND RICE HUSK ASH ADDITION AS SUPPLEMENTARY CEMENTITIOUS MATERIALS ON CHLORIDE PENETRATION AND DIFFUSION IN CONCRETE MIX(S)

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***Abstract*— All around vitality sparing and carbon decrease turns into the real issues for the developing nations. Most extreme use of assets, effective development, quality enhancements, costs have turned out to be earnest issues. Reusing is acknowledged to be one of the vital bases of manageability. Presently civil engineers are attempting to use all sort of item, regardless of whether they are metal, solid, plastic, wood, glass or even agro backwoods which can transform into beneficial products. The most ideal approach to manage such sort of squanders is to reutilize them as crude materials or modifiers. Agro waste such as rice husk, wheat straw ash and sugarcane bagasse are used as pozzolanic material (supplementary cementitious material) for the development of blended cements. In recent years cement both in mortar and concrete is the important element for infrastructure and can be used as durable construction material. Conventionally ordinary Portland cement is recognized as major construction material throughout the world. But non industrial and agriculture wastes such as blast furnace slag, fly ash and silica fumes are being used as supplementary cement replacement materials.**

**This study is a investigation efforts for the impacts of SCBA and RHA as cement replacement on the concrete properties. The grade point about this ponder might have been with assess those quality strength and durability property for concrete. This investigation indicated that displacing a portion rate of regular cement by SCBA and RHA transform in properties from claiming concrete. The properties would concentrated on 7days, 28days compressive strengths, flexural strength and splitting tensile strength from claiming break properties and durability properties (Chloride Resistance), which may be enhanced on comparison with controlled specimen.**

***Index Terms*— Bagasse Ash, pozzolanic, style Penetration, Workability, compressive strength.**

## I. Introduction

In modern era, the research throughout the world is focused on utilization of industrial or agricultural waste as source of raw material for the construction work. Reusing is acknowledged to be one of the vital bases of manageability. Presently civil engineers are also attempting to use all sort of agricultural or industrial wastes. These waste utilization would not only be economical but ecofriendly also to maintain the sustainable and pollution free environment. In recent years cement both in mortar and concrete is the important element. However the environmental aspects of cement manufacturing are responsible for about 3.5% of total worldwide waste emission from industrial sources. One effective way to reduce the environment impacts is to use mineral admixtures as a partial replacement of cement both in concrete and mortar. This will have the potential to reduce cost, conserve energy and minimize waste emission.

Sugarcane is also one of the real yields agro waste. In India just, sugarcane creation is more than 300 million tons/year that cause around 10 million tons of sugarcane bagasse ash remains as an un-used and squander material. After the extraction of all sparing sugar from sugarcane. The BA contains high measures of un-consumed matter, silicon, aluminum and calcium oxides.

Rice husk is also one of the main agricultural residues obtained from the outer covering of rice grains during the milling process. RHA can be used as aggregates and fillers for concrete and its board production are an economical substitute for micro silica /silica fumes and chemicals, soil ameliorants as insulation powder in steel mills.

## II. Literature Review

Sangeetha et al. [2017]. Studied by replacing bagasse ash in the ratio of 0%, 5%, 10%, 15% and 20% by weight of cement in four different experiment to find out maximum compressive strength and compare it with the strength of normal concrete by using grade M-30 at 7days and 28 days.

Bhargavi and babu [2016] studied influence of partial cement replacement with Sugarcane Bagasse ash in concrete subjected to different curing environments has been studied by Experimental investigation on acid resistance of concrete in HCL solution.

Subramaniyan and Sivaraja [2016] studied SCBA has been partially replaced by 0%, 10%, 20%, 30% and 40% weight of cement in concrete. Performance of concrete with these replacements in part of workability, mechanical and durability are discussed in this paper.

Kvgd [2015] in his research paper studied the concrete mixed with Bagasse ash in fixed proportions and analysing the effect of HCl on SCBA blended concrete.

Schettinoa and Holandaa [2015] concluded that study was to determine the chemical, physical and mineralogical characteristics of a sugarcane bagasse ash.

Sampaio et al.[2014] Conducted the experimental studies with analyze the mechanical behavior of concrete containing SBA from three different species of cane sugar (SP911049, SP816949 and RB92579) by testing consistency, voids, absorption, porosity and compressive strength.

Shafiq et al. [2014] studied the mechanical properties (compressive strength, splitting tensile strength and bond strength) of concrete made of 5–30%. BA showed a reasonable enhancement in the results in comparison with the 100% cement concrete.

Kulkarni [2013] studied that Bagasse ash can be utilized by replacing it with fly ash and lime in fly ash bricks.

Modani and Vyawahare [2013] In this study, untreated bagasse ash was partially replaced in the ratio of 0%, 10%, 20%, 30% and 40% by volume of fine aggregate in concrete. Fresh concrete tests like compaction factor test and slump cone test were undertaken along with hardened concrete tests like compressive strength, split tensile strength and sorptivity. In this paper we have concluded that in the purest form of bagasse ash can be effectively replaced by cement and fine aggregate upto 20%.

Sivakumar and Mahendran [2013] Architects and engineers have become aware of numerous compelling reasons to extend the practice of partial replacement of cement with waste materials such as BAGASSE ASH which exhibits pozzolanic properties in mortar and cement.

Tijore et al. [2013] In this study, bagasse ash has been chemically and physically characterized, in order to evaluate the possibility of their use in the industry.

Khan, et al.[2012] & Ganasen, et al.[2007] showed that study on use of rice-husk ash as a partial replacement of cement in concrete.

Amin, Souza et al and Aigbodion et al. studied the recycling of bagasse ash as a cement replacement in concrete, which provides a satisfactory solution to environmental concerns associated with waste management.

Santos [2010] warned that even with the advantages , which are derived from the use of pozzolanas with Portland cement, the use of the material also has some disadvantages. A good example is the requirement of the use of water-reducing additives due to the increase in water demand in the mixtures and the need for appropriate cure for the pozzolanic reaction occurs in its fullness, as in the case of fly ash.

Sales, et al. [2010] concluded that ash samples were subjected to chemical characterization, sieve analysis, determination of specific gravity, X-ray diffraction, scanning electron microscopy, solubilisation and leaching tests.

Habeeb and Fayyadh [2009] studied an experimental investigation on the influence of Rice Husk Ash (RHA) Average Particle Size (APS) on the mechanical properties and drying shrinkage of the produced RHA blended concrete.

Paula et al.(2009) showed in a study that SBA is a viable mineral addition cement source, depending on silica characteristics.

Cordeiro et al (2008) studied the behavior of the SBA as a mineral mixture in conventional and high-performance concrete with a water/cement ratio of 0.60 and 0.35, respectively.

## III. Materials & its Properties

### *A. Cement*

The physical properties of Portland-pozzolana cement were determined according to IS: 455(1989), tested according to IS: 4031(1999) and compared with the requirements of IS: 455(1989).

### *B. Rice Husk Ash*

Completely burnt rice husk ash was brought from rice mills from Jalandhar. Its physical and chemical properties are given in Table 1.1 and Table 1.2 respectively.

**Table 1.1 Physical properties of rice husk ash (G.A. Habeeb, M.M. Fayyadh)**

| Physical Property | Value |
|---|---|
| Colour | Grey with Slight Black |
| Bulk Density | 104.9 kg/m$^3$ |
| Specific Gravity | 1.96 |
| Fineness | 2775 cm$^2$/gm |
| Avg particle Size | 150.47 μm |

**Table 1.2 Chemical properties of rice husk ash (G.A. Habeeb, M.M. Fayyadh)**

| Component | % |
|---|---|
| Silica | 92.1 |
| Alumina | 0.51 |
| Iron oxide | 0.40 |
| Calcium oxide | 0.55 |
| Potassium oxide | 1.53 |
| Titanium di oxide | 0.02 |
| Manganese oxide | 0.08 |
| Phosphorous penta oxide | 0.08 |
| Sulphur tri oxide | 0.12 |

*C. Sugar Cane Bagasses Ash (SCBA)*

Sugar cane straw ashes from the combustion of sugar cane straw were obtained in an open furnace at unknown temperatures for 20 min. Once calcined, the ashes were ground and sieved to 90µm, fineness similar to Ordinary Portland cement. The Physical and Chemical Properties of SCBA are given in table 1.4 & 1.4.

**Table 1.3 Chemical Properties of Sugar Cane Bagasses Ash (Modani and Vyawahare)**

| Component | Mass % |
|---|---|
| $SiO_2$ | 62.43 |
| $Al_2O_3$ | 4.28 |
| $Fe_2O_3$ | 6.98 |
| CaO | 11.8 |
| $K_2O$ | 3.53 |
| MgO | 2.51 |
| $SO_3$ | 1.48 |
| Loss of Ignition | 4.73 |

**Table 1.4 Physical properties of sugar cane bagasses ash (Modani and Vyawahare)**

| Physical Property | Value |
|---|---|
| Colour | Slight Black |
| Bulk Density | 837 $kg/m^3$ |
| Specific Gravity | 1.36 |
| Fineness Modulus | 2.12 |

## IV. Results & Discussions

*A. Workability*

Workability is often referred to as the ease with which a concrete can be transported, placed and consolidated without excessive bleeding or segregation. Values of slump as shown below in table 1.5, which replacing of cement by SCBA and RHA in equal amount in two increments of 7% upto 35%.

**Table 1.5: Measured values of Slump**

| Mixture | Measured slump (mm) | Average Measured Slump (mm) |
|---|---|---|
| CM | 60 | **54.5** |
| MSR 7% | 57 | |
| MSR 14% | 55 | |
| MSR 21% | 53 | |
| MSR 28% | 52 | |
| MSR 35% | 50 | |

*B. Compressive Strength*

The cube were tested at 7 and 28 days as per IS 516-1959. Table 1.6 & Figure 1.1 shows that at the end of 28 days all the specimens have a compressive strength less than 38MPa.

**Table 1.6: Compressive strength of concrete cube.**

| Specimen | Compressive Strength at 7 days (MPa) | Compressive Strength at 28 days (MPa) |
|---|---|---|
| CM | 24.12 | 38.59 |
| MSR 7% | 23.32 | 36.21 |
| MSR 14% | 22.78 | 33.60 |
| MSR 21% | 21.45 | 31.73 |
| MSR 28% | 20.92 | 29.12 |
| MSR 35% | 19.90 | 27.16 |

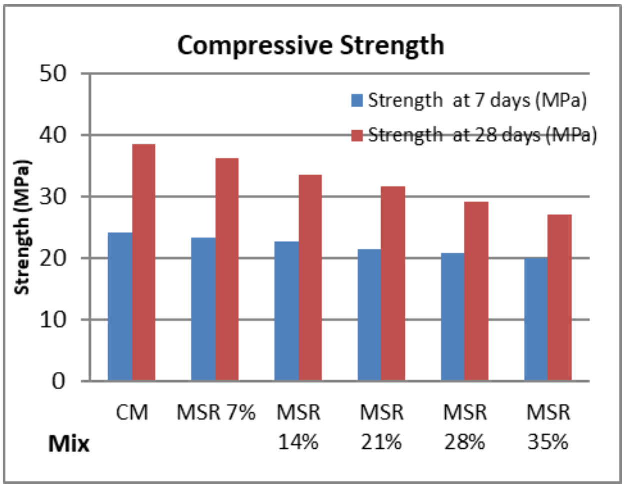


**Figure 1.1: Graph showing the 7 &28 days Compressive Strength of concrete.**

Most properties of concrete are directly related to its compressive strength. The compression test on the concrete specimens was carried out according to IS 516-1959. The samples were properly molded and cured. The specimens were loaded at a control rate in the compression testing machine. The results can be seen from the Table 1.8 and Figure-1.3. The control mixture had 28 days strength of more than 38 MPa. The specimen with 10.5% SCBA + 10.5% RHA of supplementary cementations material in concrete had 28 days compressive strength of 31.73 MPa while specimen with 14% SCBA and 14% RHA had about 29.12 MPa. The 10.5% SCBA + 10.5% RHA of supplementary cementations material sample gave good strength than the rest; the reason might be the water-cement ratio or good percentage of Silica contents in SCBA &

RHA. The mixture was very harsh and water reducing admixtures were added to get minimum slump. The strength might be due to the cement paste and the bond strength at the paste-aggregates boundary only up to 14% SCBA and 14% RHA. Variability of test method might be the reason. The rate of loading and progress of crack around the aggregate particles might be the reason of lower strength. The rest of the specimens 17.5% SCBA and 17.5 % RHA had 28 day strength less than 30MPa. Some additional cylinder samples were prepared from the mixture for and compression tests were carried out to check the accuracy but did not get appropriate results.

*C. Splitting Tensile Strength*

The splitting tensile strength of the concrete specimens was determined at 7 and 28 days following IS 5816-1999. The splitting tensile strength of concrete specimens at the end of 28 days was approximately about 2.1MPa. Table 1.7 & Figure 1.2 show the results.

**Table 1.7: Splitting Tensile Strength on Concrete Specimens.**

| Specimen | Strength at 7 days (MPa) | Strength at 28 days (MPa) |
|---|---|---|
| CM | 3.40 | 4.34 |
| MSR 7% | 3.30 | 4.12 |
| MSR 14% | 3.00 | 4.02 |
| MSR 21% | 2.85 | 3.91 |
| MSR 28% | 2.50 | 3.81 |
| MSR 35% | 2.10 | 3.50 |

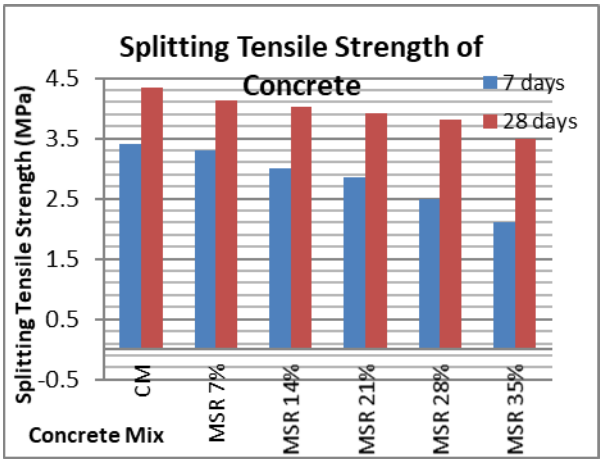


**Figure 1.2: Graph showing the 7 &28 days Splitting Tensile Strength of concrete.**

The splitting tensile test is an indirect way of estimating the tensile strength of cylindrical concrete specimens. Since the concrete is much weaker in tension than in compression, the failure would be at a much lower load than in compression. The cylinders were tested according to IS 516-1959. The results of 7 & 28 days splitting tensile strength are shown in Table 1.7 also in fig 1.2. The control mixture showed splitting tensile strength after 28 days around 4.34MPa. while all other specimens had around 3.9MPa. For the ordinary structural concrete the tensile strength is around 4.34MPa. If we analysis 3.5% SCBA + 3.5% RHA also 7% SCBA + 7% RHA concrete carefully than we find out upto this limit of pozzolanic concrete there is considerable change in tensile strength of the concrete.

*D. Modulus of Rupture*

Flexure Strength of concrete prisms by following IS 516-1959 using a third point loading on a hydraulic testing machine. Table 1.8 & Figure 1.3 show the results for the modulus of rupture for concrete mixture. All specimens have modulus of rupture for 28 days above 2.30MPa.

**Table 1.8: Flexural Strength of Concrete Specimen.**

| Mixture | Flexural Strength (MPa) at 7 days | Flexural Strength (MPa) at 28 days |
|---|---|---|
| CM | 3.41 | 4.10 |
| MSR 7% | 3.35 | 4.02 |
| MSR 14% | 3.67 | 3.91 |
| MSR 21% | 3.09 | 3.85 |
| MSR 28% | 2.67 | 3.76 |
| MSR 35% | 2.30 | 3.50 |

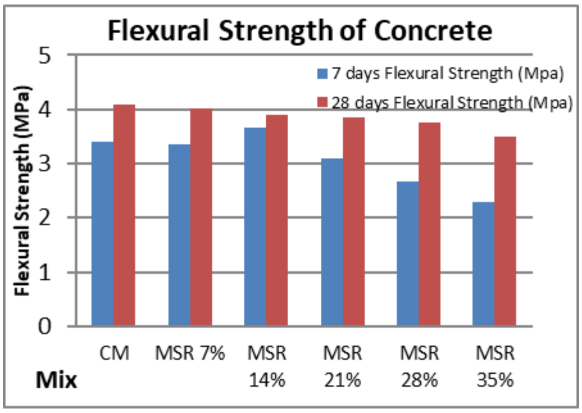


**Figure 1.3: Graph showing the Modulus of rupture for concrete beams.**

The flexural strength of concrete made with SCBA and RHA was tested according to IS 516-1959. The flexural beams were prepared, cured in the standard manner and tested using the three point loading method. The theoretical maximum modulus of rupture R is then calculated from simple beam bending formula for third-point loading shown in above equation. The testing was done after 7 & 28 days and results are shown in Table 1.8 and fig 1.3 The trend was similar to the control mixture. All the mixtures gave a modulus of rupture more than 3.50 MPa in 28 days. This test is very useful since concrete pavements tend to be loaded in bending rather than in axial tension. The flexure test gives better representation of concrete property. It can be noted that the flexure test gave higher values than the tension test, the reason may be that in tension test total volume of specimen is stressed while in flexure test only a relatively small volume of material near the bottom of the beam is subjected to high stress or presences of Alumina and Silica contents. The flexural strength for a structural concrete is around 3.90 Mpa. Fig 5.4 shows that the concrete with different % of SCBA and RHA performs well upto 10.5% SCBA + 10.5 % RHA also 14% SCBA + 14 % RHA concrete as per codal provision IS-456:2000.

*E. Resistance to Chloride attack of concrete.*

This test was conducted on 150 x 150 x 150mm cube specimens. The cubes were casted and cured in water for 28 days. Hydrogen Chloride solution of 5ml/100l is used to evaluate chloride resistance of concrete. Cubes are immersed in solution after 28 days curing, and are tested for compressive strength at 7, 14 and 28 days. Test results are given below in table 1.9 and figure as shown in 1.4.

**Table 1.9: Compressive strength of concrete mixes after immersion in HCl solution.**

| MIX | Control (28 Days) | 7 Days Compressive strength (Mpa) after Immersion in HCl. | 14 Days Compressive strength (Mpa) after Immersion in HCl. | 28 Days Compressive strength (Mpa) after Immersion in HCl. |
|---|---|---|---|---|
| CM | 38.59 | 37.12 | 35.12 | 34.24 |
| MSR 7% | 36.21 | 35.11 | 34.11 | 32.31 |
| MSR 14% | 33.60 | 34.01 | 33.86 | 31.43 |
| MSR 21% | 31.73 | 32.97 | 30.55 | 29.87 |
| MSR 28% | 29.12 | 30.33 | 27.16 | 26.31 |
| MSR 35% | 27.16 | 27.07 | 25.96 | 22.33 |

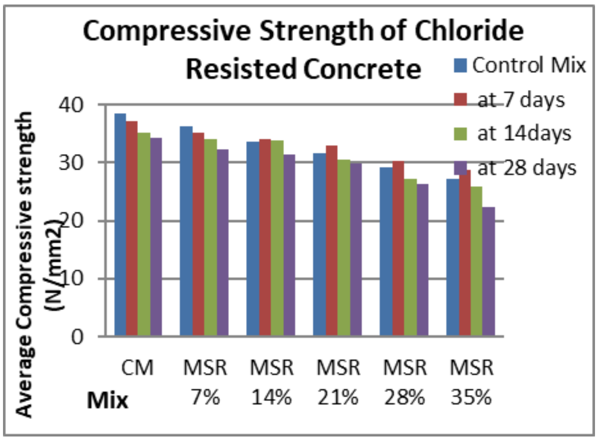


**Figure 1.4: Graph showing the 7, 14 &28 days Resistance to Chloride attack of concrete.**

The compressive strength was determined from concrete cubes at 28 days. As stated earlier, the values in the case of those specimens subjected to Chloride Resistance represents a residual strength. Figure 1.4 shows that concrete made with SCBA and RHA retains its strength up to a 10.5% SCBA + 10.5% RHA upto 7 days also 7% SCBA + 7% RHA upto 28 days . Strength decreases afterwards may be due to the bond strength between the particles of concrete.

## V. CONCLUSIONS & RECOMMENDATIONS

The main aim of this research was to study the behavior of concrete and changes in the properties of concrete made up of SCBA and RHA by replacing the use of Portland cement. SCBA and RHA is a waste product and used in concrete will might prove an economical and environmentally friendly solution. The demand for cement is increasing rapidly and so as the demand of concrete. Thus, it is becoming more important to find suitable alternatives for cement to save environment in the future.

Although literature review was conducted to study and investigate the properties of SCBA and RHA. The results showed that it has properties somewhat similar to Portland cement and it would not cause significant harm if incorporated into concrete. A comparison was made between concrete having Portland cement and concrete with various percentages of SCBA and RHA replaced by volume of cement. The results of this research were encouraging, since they show that using SCBA and RHA in concrete has some negative effects on mechanical properties after certain addition of SCBA and RHA on the short term properties of hardened concrete.

The reasons for change in the strength of concrete when SCBA and RHA were used are as follows:

1) Lake of proper bonding between SCBA and RHA particles and the cement paste.

2) Increase in strength of concrete with SCBA and RHA upto certain limit might be due to presence of Silica and Alumina contents in these wastes.

3) The RHA and SCBA used in this study is efficient as a pozzolanic material; it is rich in amorphous silica (88.32%). The loss on ignition was relatively high (5.81%). Increasing RHA fineness increases its reactivity.

4) Due to replacement of cement by the SCBA and RHA, the weight was reduced.

5) Due to non-uniform distribution of SCBA and RHA particles in the concrete, non-homogeneous samples are may be produced, which in turn results in reduction in concrete strength.

## VI. Some Limitations of testing methods

It ought to be remembered that the majority of the examination was directed in the research center condition. There are odds of test blunder which impacts the after effects of the tests.

The tests for solidified cement are defenseless to variety as per the example sizes, distinction in geometry and rate of stacking, temperature at time of testing and different elements. It ought to be remembered that little solid examples do no especially speak to the quality of cement in the structure; they just give relative information.

## VII. Suggestions for future research

1) A much more extensive field study on a concrete structure made with SCBA and RHA used in the mixture should be conducted and changes in durability and mechanical properties should be investigated and correlated to laboratory results.

2) Further investigation on resistance of concrete with SCBA and RHA to attack by sulfates; alkali silica reactions, carbonation, sea water attack, harmful chemicals and resistance to high temperatures are needed.

3) The behavior of SCBA and RHA concrete under corrosive environments and its fire resistance capacity should also be investigated. The results of such studies would directly benefit the construction industry and cost effective solution.

4) The long term behavior of concrete with SCBA and RHA should be studied and its compatibility with reinforcing steel should be analyzed in the future.

5) It is also suggested to do Petrographic examinations of concrete samples with SCBA and RHA to get insight of the actual behavior of concrete. The relationship between entrained air and entrapped air in concrete should be studied.

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