# Comparative Study on Replacement of Cement by S.C.B.A (Sugarcane Bagasse Ash) & R.H.A (Rice Husk Ash)

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**Abstract:** The production of Ordinary Portland Cement(OPC) contributes to the release of harmful greenhouse gases.In an effort to reduce these emissions, this study explores biomass materials to evaluate their use as partial replacements for ordinary Portland cement.Rice husk and sugarcane bagasse are agricultural waste products and large amounts of these are currently landfilled,making them inexpensive and available.When combusted at high temperatures they form rice husk ash and sugarcane bagasse ash with pozzolanic characteristics.The high silicon dioxide levels in these products make them good options to use as partial replacement for OPC.Replacement with20% rice husk ash or 10% sugarcane bagasse ash give similar compressive strength and corrosion resistance for hardened cement paste samples compared to control OPC samples,if appropriate amounts of plasticizer are used.

**KEYWORDS:** Sugarcane Bagasse Ash, Rice Husk Ash, Pozzolanic Characteristics, Compressive Strength

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## I. INTRODUCTION

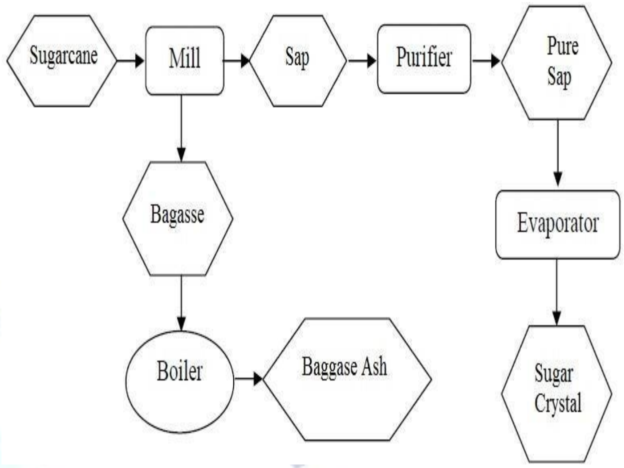
Cement concrete is the most extensively used construction material in the world. Ordinary Portland cement is recognized as the major construction material throughout the world. Portland cement is responsible for about 5 to 8% of global CO2 emission this environmental problem will most likely to be increased due to exponential demand of Portland cement [6]. Industrial wastes, such as rice husk ash, fly ash and silica fume are

being used as supplementary cement replacement materials. In addition to these, agricultural wastes such as rice husk ash, wheat straw ash, and sugarcane bagasse ash are also being used as pozzolanic materials and hazel nutshell used as cement replacement material. India is the second largest producer of sugarcane and large quantity of bagasse ash (67,000 tonnes/day) and large quantity of sugarcane bagasse is available from sugar mills. Sugarcane bagasse ash is a byproduct of sugar factories and it is produced by burning sugarcane bagasse. It was found that SCBA improves the properties of concrete and mortar such as compressive strength, water tightness in some percentage of replacement. Initiatives are taken worldwide to control and to manage the agricultural waste by replacing it with cement to make green environment. There are various studies related to use of SCBA as supplementary cementitious material in concrete and mortar. India is a major rice-producing country. Rice milling generates a byproduct known as husk.This surrounds the paddy grain. During milling of paddy, about 78% of the weight is received as rice and the rest 22% of the weight of paddy is received as a husk. The husk is used as a fuel in the rice mills to generate steam for the parboiling process. This husk contains about 75% organic volatile matter and the balance of 25% of the weight of this husk is converted into ash during the firing process, is known as Rice husk ash (RHA). This RHA in turn contains around 85%-90% amorphoussilica.

Due to the presence of silica content in rice husk ash, it is used as supplementary cementing materials to improve concrete properties (durability, strength, etc).

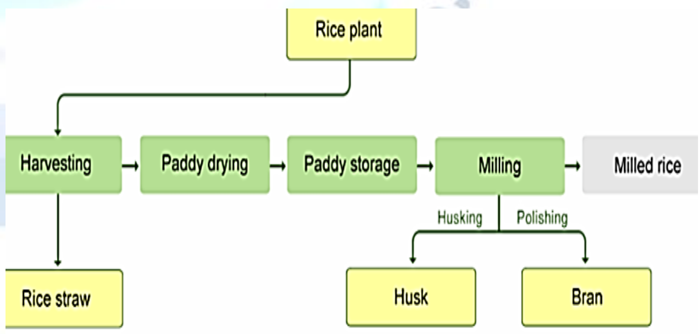
### Production of SCBA

Bagasse is a material that is bio product of sugarcane is collected from the sugarfactory. After collecting the material, it is oven-dried at 120°C for 24hours. After taking the material from the oven it is crushed to get a finepowder. The fine powder is sieved through 90microns to get fine bagasseash.




### Production of RHA

The first rice husk is collected from the rice mill and it is cleaned withwater. Washed rice husk is dried for 24hours. The dried rice husk is burned at room temperature. After it is placed in the oven for 2 hours at60°C.Remove the material from the oven and add conc. HCL of 2M in the rice huskash. Again, it is placed in the oven for 4 hours at 60°C and next in the muffle furnace for 5 hours at500°C.Then the fine rice husk ash isobtained. It is sieved through 90microns to get fine rice huskash.




### Objectives of work

- Cement is the most costlier and energy intensive component of concrete. The unit cost of concrete can be reduced by partial replacement of cement with Sugarcane Bagasse Ash and Rice Husk Ash.
- The major objective of replacement of cement by Sugarcane Bagasse Ash and Rice Husk Ash is to provide greater strength than other samples.

- Emission of Green House gases can be decreased to greater extent by the replacement of Sugarcane Bagasse Ash and Rice Husk Ash in concrete.

## II. LITERATURE REVIEW

- **Srinivasan(2016) [1]** studied the chemical and physical characterization of SCBA and partially replaced in the ratio of 0%, 5%, 15%, and 25% by weight of cement in concrete. It was found that the cement could be advantageously replaced with SCBA up to a maximum limit of 10%. Therefore, it is possible to use sugarcane bagasse ash (SCBA) as cement replacement material to improve quality and reduce the cost of construction materials has concrete.
- **Sangeetha (2017) [2]** 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.

| Physical Property | Value |
|---|---|
| **Color** | Grey with Slight Black |
| **Bulk Density** | 104.9 kg/m³ |
| **Specific Gravity** | 1.96 |
| **Fineness** | 2775 cm²/gm |
| **Average particle size** | 150.47 µm |

**Table 1.2 Chemical properties of rice husk ash**

| 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 |

- **(M.U Dabai, 2009) [3]** Investigated that compressive strength tests, which were carried out on six mortar cubes with cement replaced by rice husk ash (RHA) at five levels (0, 10, 20, 30, 40, and 50%). The results indicated that RHA can be used as a cement substitute at 10% and 20% replacement in 14 and 28 days curing age.

## III. MATERIALS AND ITS PROPERTIES

### A. Cement

Cement is the main ingredient in manufacturing of concrete. The characteristics of concrete will be greatly affected by changing the cement content. The cement used in this project is Ordinary Portland cement of 53 grade confirming to IS
12269 – 1987

### 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**

### C. Sugar Cane Bagasse 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 Bagasse Ash**

| Component | Mass% |
|---|---|
| $Si_2O$ | 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 bagasse ash**

| Component | Value |
|---|---|
| Colour | Slight Black |
| Bulk Density | 837kg/m³ |
| Specific Gravity | 1.36 |
| Fineness Modulus | 2.12 |

## IV. Experimental Works

This study investigates the effect of Sugarcane bagasse ash (SCBA) and Rice husk ash (RHA) on the compressive strength of concrete. The specific gravity of cement, bagasse ash, rice husk ash; Normal consistency, and initial & final setting time of the Ordinary Portland cement with bagasse ash& rice husk ash from 5% to 15% replacement is investigated. Workability of concrete with replacement of SCBA and RHA are investigated. M30 mixed proportion was used for concrete.

### Compressive Strength of Concrete

This study investigates the effect of Sugarcane baggage ash (SCBA) and Rice Husk Ash on compressive strength of concrete. Directly obtained SCBA and RHA was used passing through 90μ. OPC 53 grade cement was replace with SCBA & RHA at variation of 5%, 10% and 15% at w/c ratio of 0.45. M30 mix proportion was used for preparation of Concrete.

### Split Tensile Strength

Split tensile strength is the most important property of concrete. Concrete generally weak in tension. So, to improve tensile behavior of concrete, split tensile strength is important. It is also important in reducing formation of cracks in concrete. Cylinders are casted for calculating split tensile strength. The cylindrical specimens are also tested in compression testing machine. The cylinders are placed in axial direction by facing cylindrical face to the loading surface. Here the cylinder split into the two parts and reading observed on the top of the machine.

The split tensile strength has been calculated by formula

Split tensile strength ($f_{spt}$) = $2P / \Pi ld$

P = Failure load (applied load)

L= height of cylinder specimen

D=Diameter of mould

### FLEXURAL STRENGTH

Most of the beam failures are occurred due to their failure in flexural strength. It is important that prediction of flexural strength by calculating modulus of rupture for reducing failure problems in beams. The calculation of modulus of Rupture in terms of Flexural strength is the main aim in casting beam specimens. In this modulus of rupture is calculated by testing specimens in the universal testing machine. In this line of facture is the main important property in formulating the modulus of rupture.

The modulus of rupture is denoted by “$f_{cr}$”

The “f” value is mainly based on the shortest distance line fracture “a”

If $110mm>a>133mm$, $f_{cr}=3LPL / bd^2$

If $a<133zmm$, $f_{cr}=PL\ bd^2$

If $a>110mm$, the test shall be discarded.

## V. Mix Design

1)Target Mean Strength of Concrete

From IS: 10262-2009, the target mean strength for the specified characteristic cube strength is

$f^1_{ck} = fck + 1.65\ s$

Then = 30 + (5 1.65) = 43.25 N/mm2

('s' is standard deviation N/mm2 s =5, from table 1 IS 10262:2009)

2) Selection of Water-Cement Ratio The free Water Cement ratio required for the target mean strength of 43.25 N/mm2 is W/C =0.40.

3) Selection of water content:

for 20mm aggregate = 186 litres (25 to 50mm slump)

for 75mm slump = 186 + 3/100 * 186(for every 25mm increase in slump 3% water should be increased)

191.58ltrs (from table 2 IS 10262:2009)

4) Determination of Cement content:

w/c = 0.40

192/c = 0.40

c = 480kg/m3>320kg/m3 hence ok

5) Proportion of volume of coarse aggregate and fine aggregate content:

Fine aggregate = Zone 2 volume of coarse aggregate per unit volume of total aggregate for different zones of fine aggregate = 0.62 (from table 3 IS 10262:2009)
when w/c = 0.50 = 0.62 for every +/- 0.05 change in w/c ratio we have to change -/+ 0.01 change in volume of coarse aggregate per unit volume of total aggregate therefore 0.40=0.64
Fine aggregate=0.36
6) Mix calculations:
a) volume of concrete = 1m3
take cement content = 330kg/m3
b) Volume of cement = (mass of cement/specific gravity)*(1/1000) = (330/3.15)*(1/1000) = 0.104 m3
c) Volume of water = (mass of water/specific gravity)*(1/1000) = (192/1)*(1/1000) = 0.192 m3
d) Volume of aggregate = (a-(b+c)) = 1-(0.104+0.192) = 0.703 m3
e) Mass of coarse aggregate = d* volume of coarse aggregate*specific gravity of coarse aggregate = (0.703*0.64*2.74*1000) = 1232.78 kg
f) Mass of fine aggregate = d* volume of fine aggregate*specific gravity of fine aggregate = (0.703*0.36*2.74*1000) = 693.43 kg

**Grade for concrete M30**

| Grade | Mixratio | W/C ratio |
|---|---|---|
| M30 | 1:3:0.5 | 0.5 |

## VI. Results and Discussions

In this chapter the results are tabulated by calculating Fresh and Hardened properties of concrete. The compressive strength, split tensile strength and flexural strength are the main properties for determining the concrete strength. In this the strength properties are calculated by replacing Different concrete mixtures were cast and tested with different levels of cement replacement with SCBA (5 %, 10 %, 15 %, and20 %) with RHA as addition (0 %, 5 %, 10 % and 15 % by weight of cement).

**COMPRESSIVE STRENGTH:**

Compressive strength is obtained by applying crushing load on the cube surface. So, it is also called as Crushing strength. Compressive strength of concrete is calculated by casting 150mm x 150mm x 150mm cubes. The test results are presented here for the compressive strength of 7 days, 14 days and 28 days of testing. The water cured specimens are eliminated from moisture content by surface drying before testing in CTM. The detailed test results are summarized as follows

**Table 1.5 Compressive Strength for M30:**

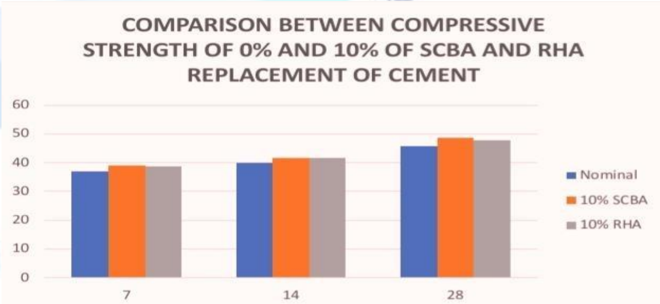
| TYPE OF MIX | 7 DAYS N/mm^2 | 14 DAYS N/mm^2 | 28 DAYS N/mm^2 |
|---|---|---|---|
| **Nominal** | 36.89 | 39.86 | 45.83 |
| **5% of SCBA** | 36.14 | 38.86 | 47.24 |
| **10% of SCBA** | 39.06 | 41.69 | 48.74 |
| **15% of SCBA** | 34.22 | 36.86 | 43.41 |
| **5% of RHA** | 37.72 | 40.73 | 46.75 |
| **10% of RHA** | 38.79 | 41.75 | 47.69 |
| **15% of RHA** | 35.86 | 38.83 | 44.78 |

**SPLIT TENSILE STRENGTH: (IS 516-1959)**

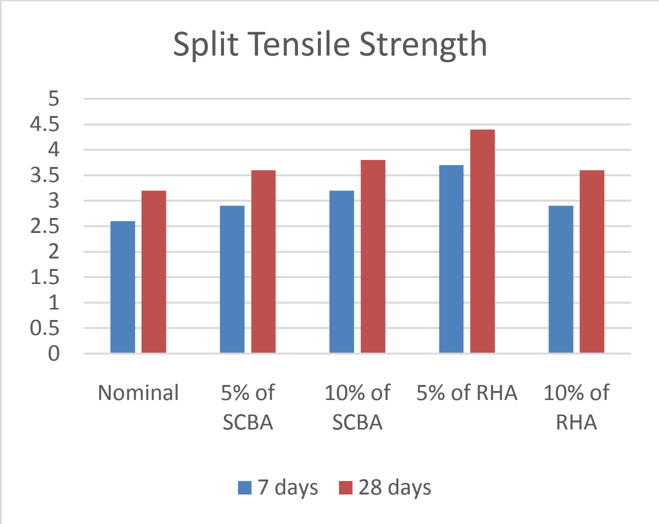
Out of all the properties of concrete, tensile strength is very important one. The tensile strength is calculated by testing cylindrical specimens of size 300mm height and 150mm diameter. Here each set of specimens are tested for 7 days and 28 days of curing. The details of test results are summarized below

Here the detailed tabulations are made for split tensile strengths and are shown below

**Table 1.6 Split Tensile strengths for M30**




| Mix name | Spilt tensile strength(N/mm2) | |
|---|---|---|
| | 7 days | 28days |
| **Nominal** | 2.6 | 3.2 |
| **5% of SCBA** | 2.9 | 3.6 |
| **10% of SCBA** | 3.2 | 3.8 |
| **5% of RHA** | 3.7 | 4.4 |
| **10% of RHA** | 2.9 | 3.6 |

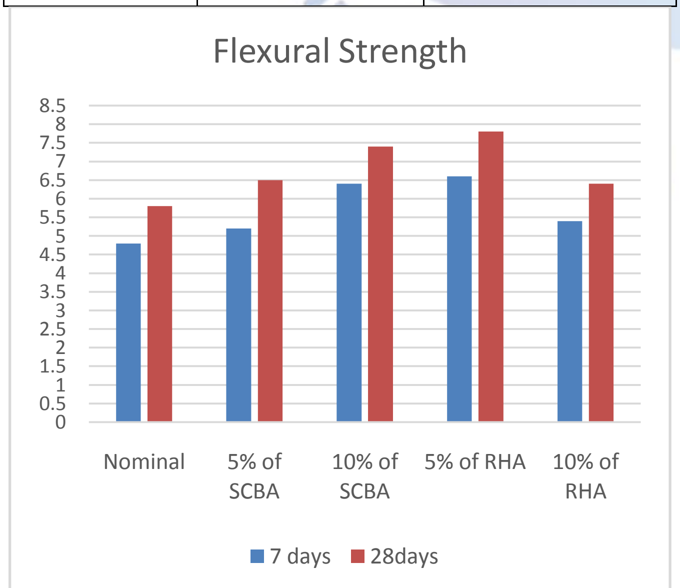



**FLEXURAL STRENGTH: (IS 516-1959):**

The modulus of rupture is the main property for the flexural members. To improve the flexural strength of concrete is one main task in present construction activities. Flexural strength for concrete is determined by casting beam specimens. The beam dimensions are of 500mm x 100mm x 100mm. The modulus of rupture values for both grades are described as follows

**Table 1.7Flexure strengths for M30:**

| Mix name | Flexural Strength(N/mm2) | |
|---|---|---|
| | 7 days | 28days |
| Nominal | 4.8 | 5.8 |
| 5% of SCBA | 5.2 | 6.5 |
| 10% of SCBA | 6.4 | 7.4 |
| 5% of RHA | 6.6 | 7.8 |
| 10% of RHA | 5.4 | 6.4 |




## VII. Conclusions and Future Work

**CONCLUSIONS**

Based on the results presented above, the following conclusions can be made

1.In M30 concrete mix, 10% replacement of cement by SCBA and RHA lead to greater strength than other samples.

2. As the percentage of sugarcane bagasse ash and Rice husk ash increases the compressive strength Of concrete tends to increase up to 10 percentage And then start's decreasing with the increase of Ash content.

3. Water requirement increased as the percentage of SCBA and RHA increased.

4. Sugarcane Bagasse Ash and Rice Husk Ash is a valuable pozzolanic material and it can potentially be used as a partial replacement for cement. And make construction cheaper.

5. The minimum compressive strength for M30 grade concrete should be 30Mpa. For factor of safety 1.5 is multiplied with compressive strength(30x1.2=45Mpa). While taking 15% replacement, the compressive strength after 28 days was found to be 43.41 for SCBA and 44.78 for RHA, which Is less than 45Mpa. Therefore, we conclude that replacement of SCBA and RHA up to 10% is suitable.

6. By using the SCBA and RHA in concrete as replacement the emission of greenhouse gases can be decreased to a greater extent.

7. RHA based sand cement block can significantly reduce room temperature. Hence use of air conditioners will be less resulting in electric energy saving.

8. Moreover with the use of rice ash, the weight of concrete reduces, thus making the concrete lighter which can be used as light weight construction material.

9. As the SCBA and RHA is waste material, it reduces the cost of construction.

**FUTURE WORK:**

From this experimental study it is clear indicated that using SCBA and RHA in concrete increase strength.

Following parameters will be study in future work:

1. To find out optimum amount of SCBA and RHA can be used in concrete for partially replacement of cement without significant loss of strength.

2. Other levels of replacement with SCBA and RHA can be researched.

3. Some test relating to durability aspects such as water permeability, resistance to penetration of chloride ions, corrosion of steel reinforcement, resistance to sulphate attack, with SCBA and RHA need investigation.

4.The study may further be extended to know the behavior of concrete whether it is suitable for pumping purpose or not as present-day technology is involved in RMC where pumping of concrete is being done to large heights.

5. For use of SCBA and RHA in concrete as a structure material. It is necessary to investigate the behavior of reinforced sugarcane bagasse ash concrete and reinforced rice husk ask concrete under flexure, shear, torsion and compression.

## REFERENCES


[1] R.Srinivasan and K.Sathiya" Experimental Study on Bagasse Ash in Concrete" International Journal for Service Learning in Engineering Vol. 5, No. 2, pp. 60-66, Fall 2010.

[2] Ganesan,K.,Raja Gopal,K.,&Thangavel,K.,"Evaluationofbagasseashassup plementary cementitious material", Cement and Concrete Composites, (2007) 29,515-524.

[3] BIS – IS 12269: 1999, "Specification for ordinary Portland cement", Bureau of Indian Standard, NewDelhi

[4] BIS –IS 383: 1970 "Specifications for Coarse and Fine Aggregates from Natural Sources for Concrete", Bureau of Indian Standards, NewDelhi.

[5] M. Siva Kumar, Dr. N. Mahendran, "Experimental Studies of Strength and Cost Analysis of Concrete Using Bagasse ASH", ISSN: 2278-0181, Vol. 2 Issue 4, April–2013.

[6] Lavanya M.R, Sugumaran.B, Pradeep.T, "An Experimental study on the compressive strength of concrete by partial replacement of cement withsugarcane bagasseash".

[7] Kawadeetal, "Effect of use of Bagasse Ash on Strength of Concrete" ISSN: 2319-8753 Vol. 2, Issue 7,July2013.

[8] Gemma Rodriguez de Sensate (2006) "Strength Development of Concrete withRice Husk Ash" Journal of Cement and Concrete Composites 28, Pg no.158-160.

[9] Abhilash, C.K.Singh , Arbind Kumar Sharma, Study of the Properties of Concrete by Partial Replacement of Ordinary Portland Cement by Rice Husk Ash, International Journal of Earth Sciences and Engineering, ISSN0974-5904, Volume 04, No 06SPL pp. 965-968, October 2011.

[10] C.Marthong (2012) "effect of rice husk ash as partial replacement of cement onconcrete properties."ISSN:2278-0181

[11] O.A. Adenuga, A.A. Soyingbe and O.E. Ogunsanmi, (2010). "the use of rice husk ash as partial replacement of cement in concrete". The Lagos Journal of EnvironmentalStudies.

[12] P.Padma Rao, A.Pradhan Kumar, B.Bhaskar Singh(2014). "a study on use of ricehusk ash inconcrete" IJEAR

[13] Method of Sampling and Analysis of Concrete" IS: 1199-1959, Bureau ofIndian Standards, NewDelhi.

[14] Recommended guidelines for concrete mix design", IS: 10262-2009, Bureau ofIndian Standards, NewDelhi.

[15] Methods for physical tests on cement (Consistency part-4, Setting timepart-5, Compressive strengthpart-6) (IS:4031-1988)