EXPERIMENTAL INVESTIGATION ON STRENGTH AND DURABILITY OF CONCRETE INCORPORATED WITH MINERAL ADMIXTURES

Indu Sahu[1], Deepti Hazari[2]

[1]*Department of Civil Engineering, Bhilai Institute of Technology, Durg, India*
[2]*Department of Civil Engineering, Bhilai Institute of Technology, Durg, India*

ABSTRACT - The general perspective on this paper is to consider the Strength and Durability of Concrete by replacing cement by different percentage with different Mineral Admixtures. Use of different strengthening cementitious materials significantly influences Fresh and Hardened properties of Concrete. This examination assessed the impact of residual sugarcane bagasse and Rice husk ash remains in the mechanical properties of concrete and strength. The fundamental design was to enhance the sugarcane bagasse debris (SCBA) and Rice husk ash (RHA) content toward sulfate assault of concretes to look at Durability. Trials were estimating Workability, compressive strength and weight reduction of concrete cube in a sulfate arrangement.

Keywords - Sulfate Attack, Concrete, Strength, Durability, Mineral Admixture.

1. INTRODUCTION

For quite a while, concrete was viewed as truly durable material requiring a next to zero maintenance. The assumption that is generally evident, aside from when it is exposed to highly aggressive environment. We fabricate concrete designs in exceptionally polluted urban and industrial zones aggressive marine conditions, harmful sub-soil water in seaside zone and numerous other unfriendly conditions where different materials of development are discovered to be non-durable. Since the utilization of concrete lately, have spread to profoundly unforgiving and antagonistic conditions, the previous impression that concrete is a truly durable material is being undermined, especially by virtue of premature failures of number of constructions in the recent past.

Rice plant is one of the plants that absorbs silica from the soil and assimilate it into its structure throughout the growth (Smith et al., 1986). Rice husk is the surface covering of the grain of rice plant with a high attentiveness of silica, usually more than 80-85%. Exterior soils from tank beds, agricultural fields and village frequent lands have been excavated and washed to produce a kind of synthetic sand in order to meet the enormous demand known as filtered sand. Only source materials with suitable strength, durability and shape characteristics should be considered. Production generally involves screening and possible washing. Separating into discrete fractions, recombining and blending may be necessary.

Consequently the consumption of Rice Husk Ash (RHA) & Sugarcane Bassage Ash (SCBA) in concrete for the replacement of cement environmentally and economically beneficial.

2. EXPERIMENTAL PROGRAM

The aspire of this experimental program is to estimate and compare the properties of concrete made from adding together of Rice husk ash and sugercane Baggase ash as a replacement of Ordinary Portland cement to save our environment from these solid wastes.

These materials will be used independently as a replacement of cement in different proportions. These tests will be carried out to estimate the mechanical property i.e. compressive strength up to 7 days, and 28 days. In the work, M-20 grade concrete will be developed by replacing cement via 10%, 15%, 20%, of environmental wastes rice husk ash and bagasse ash. The strength on concrete made with rice husk ash and bagasse ash will be compared with normal concrete.

2.1. Material Used

a) Cement

PPC (Portland Pozzolana Cement) is used to complete the test procedure. Portland Pozzolana cement is integrated cement which is formed by synthesize Ordinary Portland Cement (OPC) cement with pozzolanic materials in a certain proportion. It is commonly known as PPC cement (Portland Pozzolana Cement).

b) Fine aggregate

Fine aggregates are materials passing through as IS sieve which is less than 4.75mm. They are filler materials between the coarse aggregate. The most important function of the fine aggregate is to provide workability and uniformity in the mixture.

c) Coarse aggregate

Material which is held on BIS test sieve no.4.75mm is termed as a coarse aggregate.

form the main matrix of the concrete. The broken stone is by and large utilized as a coarse aggregate. As per IS 383:1970 coarse aggregate, maximum size 20 mm is suitable for concrete work.

d) Rice Husk Ash (RHA)

Rice Husk is one of the essential agriculture wastes obtained from the outer covering of rice grains and the processing procedure. The rice husk has no useful application and is treat as a waste material that creates the pollution crisis. It has been utilized usually as fuel for rice plants and electric power plants as a convincing procedure to reduce the amount of the rice husk waste and using it as a source of energy. After being used as a source of heat energy in plants and industries, it turns into Rice Husk Ash, which is again a environmental polluting matter if left free in the open environment.

e) Sugarcane Bagasse Ash (SCBA)

Sugarcane bagasse ash is a byproduct of sugar factories found after burning sugarcane bagasse which itself is found after the extraction of all economical sugar from sugarcane. The discarding of this material is previously causing environmental troubles around the sugar factories.

f) Water

Water is the key constituent, which when mixed with cement, forms a paste that binds the aggregate simultaneously The water causes the hardening of concrete through a process called hydration. The role of water is important because the water to cement ratio is the most critical factor in the production of "perfect" concrete.

2.2 Mix Proportion

The concrete prepared for the experimental procedure is of M-20 grade nominal mix (1 : 1.5 : 3). Water cement ratio is kept constant at 0.55 as prescribed by IS code 456:2000. Cement of density 1440 kg/m^3 will be used. Fine aggregate of density 1540 kg/m^3 and Coarse aggregate of density 1600 kg/m^3 is used. For making blends containing Rice husk ash (RHA) AndSugarcane Bagasse ash (SCBA) is replaced with cement in some percentage by weight. Table below shows the various mix proportions for the M20 grade concrete for the experimental procedure.

Table 2.1 Mix (1) Plain Concrete

Cement (per m^3)	Fine Aggregate (per m^3)	Coarse Aggregate (per m^3)	Water (per m^3)
411 Kg	706.5 Kg	1369.5 Kg	226.05 Kg

Table 2.2 Mix (2) Concrete with 10% RHA+Dr Fixit-(CRHA10)

Cement (per m^3)	Fine Aggregate (per m^3)	Coarse Aggregate (per m^3)	Water (per m^3)	RHA %
370	706.5 Kg	1369.5 Kg	224.206 Kg	41 Kg

Table 2.3 Mix (3) Concrete with 15 % RHA + Dr Fixit-(CRHA15)

Cement (per m^3)	Fine Aggregate (per m^3)	Coarse Aggregate (per m^3)	Water (per m^3)	RHA%
349.35 Kg	706.5 Kg	1369.5 Kg	224.206 Kg	61.65 Kg

Table 2.4 Mix (4) Concrete with 20 % RHA + Dr Fixit-(CRHA20)

Cement (per m^3)	Fine Aggregate (per m^3)	Coarse Aggregate (per m^3)	Water (per m^3)	RHA % + SCBA%
329 Kg	706.5 Kg	1369.5 Kg	224.406 Kg	82 Kg

Table 2.5 Mix (5) Concrete with 10 % SCBA + Dr Fixit-(CSCBA10)

Cement (per m^3)	Fine Aggregate (per m^3)	Coarse Aggregate (per m^3)	Water (per m^3)	RHA % +SCBA% +SF%
370 Kg	706.5 Kg	1369.5 Kg	224.406 Kg	41 Kg

Table 2.6 Mix (6) Concrete with 15% SCBA + Dr Fixit-(CSCBA15)

Cement (per m^3)	Fine Aggregate (per m^3)	Coarse Aggregate (per m^3)	Water (per m^3)	RHA %
349.35 Kg	706.5 Kg	1369.5 Kg	224.406 Kg	61.65 Kg

Table 2.7 Mix (7) Concrete with 20 % SCBA + Dr Fixit-(CSCBA20)

Cement (per m^3)	Fine Aggregate (per m^3)	Coarse Aggregate (per m^3)	Water (per m^3)	RHA %
329 Kg	706.5 Kg	1369.5 Kg	224.406 Kg	82 Kg

2.3 Preparing Mix and Casting

For casting of samples all the moulds were cleaned and oiled appropriately. Moulds were fixed and tightened to the right measurement before casting of concrete moulds. Proper care was taken that there is no gaps left from the places where there is chance of spilling out of slurry. Solid mix was prepared by hand blending. All the ingredients were mixed properly and completely in different proportions as per the mix proportion.

Cubes cleaned and oiled moulding cubes were put on the vibrating table separately and filled in three layers with 25 blows of compaction in each layer. Vibration was stopped as soon as slurry showed up on the top surface of the mould. The specimens were kept in the steel mould for 24 hours at suitable condition.

After 24 hours of moulding cubes, the cubes were de-moulded with consideration so no edges were broken and the de-moulded cubes were kept in the curing tank at the suitable temperature for curing. The cubes were left for curing for 7 days, 21 days and 28 days respectively.

Fig 1- Mixing, Moulding, Remoulding,

2.4Durability Test Resistance Against Acid Attack

For acid attack test concrete cube of size 150 ´ 150 ´ 150 mm are prepared for various percentages of silica fume addition. The specimen are cast and cured in mould for 24 hours, after 24 hours, all the specimen are demoulded and kept in curing tank for 7-days. After 7-days all specimens are kept in atmosphere for 2-days for constant weight, subsequently, the specimens are weighed and immersed in 10% sulphuric acid (H_2SO_4) solution for 7, 28 days.. After 7, 28-days of immersing in acid solution, the specimens are taken out and were washed in running water and kept in atmosphere for 2-day for constant weight. Subsequently the specimens are weighed and loss in weight and hence the percentage loss of weight was calculated.

3. RESULT

3.1 Slump cone test

Slump test is a test conducted that measures the workability of concrete. It gauges the consistency of concrete in that particular cluster. The test is performed using the slump cone apparatus to check the consistency of fresh concrete. Table and figure below shows slump cone test results for each sample and line diagram of comparison of slump.

Table 3.1 Slump cone test Results

S. No	**Remark**	**Slump Value (mm)**
1.	No replacement	38mm
2.	10 % Cement Replaced by RHA	42mm
3.	15% Cement Replaced by RHA	43mm
4.	20% Cement Replaced by RHA	43mm
5.	10 % Cement Replaced by SCBA	45mm
6.	15% Cement Replaced by SCBA	47mm
7.	20% Cement Replaced by SCBA	48mm

3.2 Compressive Strength Test

The compressive strength of the material or structure is the limit of the material or structure to withstand loads or pressure which has the tendency to lesson size. It is obtained by plotting force against deformation. Compressive strength test has been performed at 7 days, and 28 days aging of the concrete specimens after its curing. Table and Figure below shows the compressive strength of the concrete blocks at 7th day, and 28th day.

Table 3.2 Compressive Strength Test Result at 7th day

S. No	**Remark**	**Compressive Strength (N/mm²)**
1.	No replacement	14.733
2.	10 % Cement Replaced by RHA	14.33
3.	15% Cement Replaced by RHA	15.23
4.	20% Cement Replaced by RHA	15.55
5.	10 % Cement Replaced by SCBA	16.86
6.	15% Cement Replaced by SCBA	16.55
7.	20% Cement Replaced by SCBA	16.06

Table 3.3 Compressive Strength Test Result at 28th day

S. No	**Remark**	**Compressive Strength (N/mm²)**
1.	No replacement	19.66
2.	10 % Cement Replaced by RHA	20.67
3.	15% Cement Replaced by RHA	21.01
4.	20% Cement Replaced by RHA	21.53
5.	10 % Cement Replaced by SCBA	23.00
6.	15% Cement Replaced by SCBA	21.54
7.	20% Cement Replaced by SCBA	22.00

3.4 Durability Test (Acid test)

The mass change of a sample as a percentage of the initial mass is a widely used indicator for assessment of the deterioration of concrete subjected to acid attack.

Table 3.4 Acid Test Result

Sample	**Cube Weight Before Acid**	**Cube Weight After Acid**	**% Loss Of Weight**
Plain concrete	8.7	8.1	2.29
RHA10	**8.7**	**8.3**	**4.5**
RHA15	**8.6**	**8.4**	**3.4**
RHA20	**8.4**	**8.2**	**2.3**
SCBA10	**8.7**	**8.3**	**4.5**
SCBA15	**8.6**	**8.2**	**4.6**
SCBA20	**8.5**	**8.2**	**3.5**

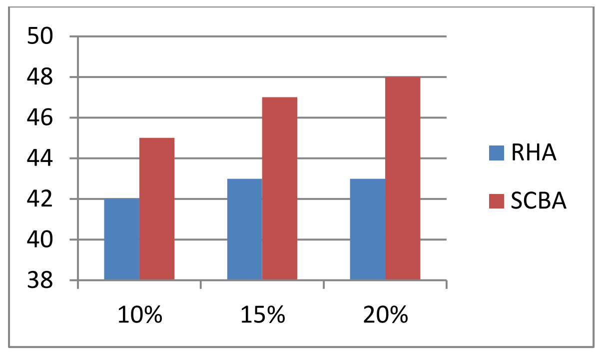

Fig 2- Slump value comparison between RHA & SCBA

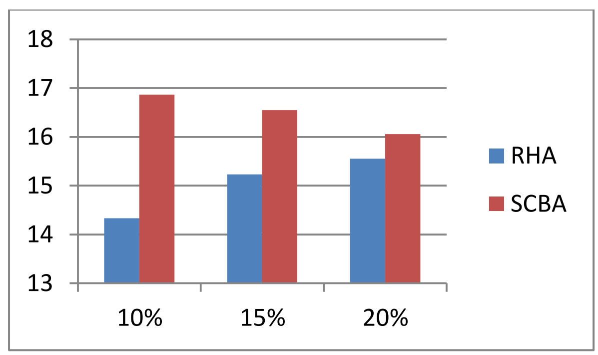

Fig 3 – Comparison of Compressive Strength of Concrete at 7th Day

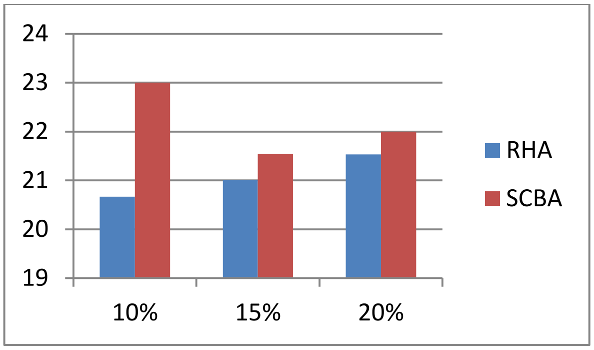

Fig - Comparison of Compressive Strength Of Concrete at 28th Day

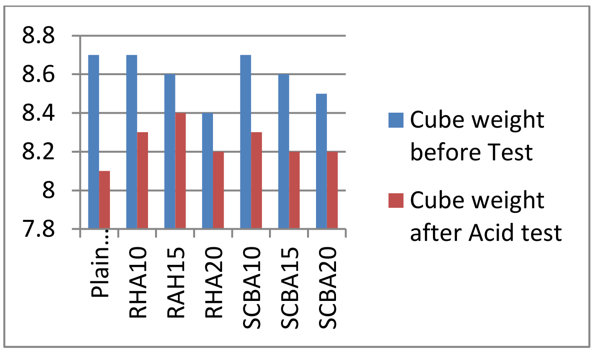

Fig4 – Comparison of cubes weight after Acid Test

4. *CONCLUSIONS*

- By supplanting the cement by Rice Husk Ash (RHA) and Sugarcane Bagasse Ash (SCBA) in various extents and a variety of proportions. processes are on the reason of current investigation, following conclusions are drawn.
- The Specific surface area of RHA is 420 m2/kg more than 330 m2/Kg of Cement. The workability of RHA Concretes have diminished in contrasted and traditional concrete. It is construed that reduce in workability is because of high surface area of RHA. Compressive Strength of all concrete blend were studied and compared with fresh concrete.
- The compressive strength test accomplished that there was a convinced increase in compressive strength in some concrete mix which was nearer to referral concrete, whereas, in some mix design the strength decreased ; this is often due to the utilization of Rice husk ash (RHA), Sugarcane Bagasse Ash (SCBA) and in the cement concrete mix in replacement of cement in different proportions.
- In concrete cement can be replaced with 20% RHA without sacrificing strength. The Addition of 20% RHA shows advanced resistance against sulphate attack for continuous soaking environment. For sulphate attack it has been observed that there is an increase in resistance
- As we understand that all the products i.e. Rice husk ash (RHA), Sugarcane Bagasse Ash (SCBA) and Fly Ash (FA) are wastes of various industries which are available in large number in our state and country and they cause major problem to the environment when left free. Their utilization in construction industry will be helpful in controlling its ill effect on the environment.
- The disposal is already a serious problem to the industries producing them, so using them efficiently in the field of construction will help disposing them off the environment. Finally it concludes that environment wastes can be the innovative supplementary cementitious construction material but judicious decisions are to be taken by engineers using them.

5. REFFERENCES

1) Banerjee,H.D, Sen,S. and Archarya, H.N. Investigations on the production of silicon rice husks by the magnesium method. Mat. Sci. and Eng.52, (1982) 173-179.

2) Ritesh Pandey, Santosh K. Sar, Ashish Kumar Bhui, Feasibility of installating rice husk power plant in Chhattisgarh to meet sustainable energy demands.,(2012)

3) Marcela M.N.S. de Soares, Dayana C.S. Garcia, Roberto B. Figueiredo, Maria Teres P. Aguilar, Paulo R. Cetlin, Comparing the pozzolanic behavior of Sugar-cane bagasse ash to amorphous and crystalline SiO2.(2016)

4) K.T.N Ganesan, K.Rajagopal, Rice husk ash blended cement: assessment of optimal level of replacement for strength and permeability properties of concrete, construction building Material. 22 (2008) 1675-1683

5) P.K.Mehta, Properties of blended cements made from rice husk ash. ACI Mater.J. 74(74) (1977) 440-442

6) Hwang, C.L. and Chandra, S. (2016). The Use of Rice husk ash in concrete. (2016)

7) Fapohunda Christopher, Akinbile Bolatito, Shittu Ahmed, Structural and properties of mortar and concrete with rice husk ash as partial replacement of

ordinary Portland cement.(2017)

8) Stroeven, P., Bui, D.D., Sabuni, E., 1999. Ash of vegetable waste used for economic production of low to high strength hydraulic binders. Fuel 78 (2), (1999), 153-159.

9) Nehdi, M.Duquette, J., EI Damatty. A.,2003. Performance of rice husk ash produced using a new technology as a mineral admixture in concrete. Cem.Concr. Res. 33 (8),(2003) 1203-1210.

10) Bui, D.D., Hu, J., Stroeven, P., 2005. Particle size effect on the strength of rice husk ash blended gap-graded Portland cement concrete. Cement concrete composition.27(3) (2005), 357- 366.

11) Ganesan, K., Rajagopal, K., Thangavel. K., Rice husk ash blended cement : assessment of optimal level of replacement for strength and permeability properties of concrete construction building material,22 (8) (2008) 1675-1683.

12) Nair, D.G., Fraaij, A.,Klassen, A.A.K., Kentgens, A.P.M., A structural investigation relating to the pozzolanic activity of rice husk ashes. Cem.Conr.Res. 38, (2008) 861-869.

13) Nguyen, V.T., Ye,G.Van., Breugel, K., Copuroglu, O., b. Hydration and microstructure of ultra high performance concrete incorporating rice husk ash. Cem.Conr. Res 41(11), (2011) 1104-1111.

14) Kumar Prusty, Sanjaya Kumar Patro, S.S. Basarkar. Concrete using agro-waste as fine aggregate for sustainable built material- A review. (2016).