Utilization of Rice Husk Ash in concrete as cement replacement

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ABSTRACT: *Rice husk ash (RHA) is an agricultural based pozzolanic material, generated by rice mills in huge quantities. This paper summarizes the experimental work of concrete in which ordinary Portland cement (OPC) cement were replaced by Rice husk ash (RHA). Partial replacement of OPC cement was carried out at 0% to 20% in steps of 5% and compared with 0% replacement. In this work different tests were performed as slump test, compaction factor, compression test and split tensile test to find the suitable percentage replacement of cement by RHA. Compression and split tests were performed for 7days and 28 days of curing and result shows some variation in both tests in every proportion. After performing tests, the results suggest that up to 15% replacement of RHA for cement is suitable for making concrete.*

Keywords- *concrete; workability; compressive strength; split tensile strength*

I. INTRODUCTION

Due to the wide use of concrete the cost of building materials increasing very quickly in some parts of the world also in developing country like India so only the industries, business cooperation, government and few individual can afford it. This rising cost can however be reduced by use of alternative building materials that are locally available and cheap. Some industrial and agricultural waste products may be use as building material. There are different wastes available in large quantities that have properties to make concrete. Rice husk is one of them; Rice husk is a byproduct of agricultural waste generated in rice mills. During milling of paddy 80% weight found out as rice and remaining 20% weight received as husk. This husk is used as fuel in industries to generate steams and other purposes. This husk contains about 75 % organic fickle matter and the remaining 25 % of the weight of this husk is converted into ash during the firing process, this ash is known as rice husk ash (RHA).

From the 20th century, there had been an increase in the economic consumption of mineral admixtures by the cement and concrete industries. The increasing demand for cement and concrete is conformed to by partial replacement of cement. Significant cost savings can result when by-products are used as a partial replacement for the energy acute Portland cement. The use of by-products also reduces the pollution and proved as an environmental friendly method of disposal of large quantities of waste materials that would otherwise pollute land, air and water.

Typically RHA contains 80 – 90% of amorphous silica, 1-2 % Potassium oxide (K2O) and remaining being sunburn carbon. The RHA can be blended with ordinary Portland cement to produce concrete. In this present study, Ordinary Portland cement was replaced by rice husk ash at different percentage to find out the suitable percentage of rice husk ash with the help of compressive and split tensile strength.

II. APPLICATION OF RHA

RHA is a carbon neutral green product. Lots of modes are being thought of for disposing them by making commercial use of this RHA. RHA is a good pozzolanic material and can be used in a big way to make special concrete mixes. There is a growing demand for fine amorphous silica in the production of special cement and concrete mixes, high performance concrete, high strength, low permeability concrete, for use in bridges, marine environments, nuclear power plants etc.

This product can be used in a variety of applications like:

- high performance concrete
- In making green concrete
- Ceramic glaze
- Roofing shingles
- Water proofing chemicals

- Refractory
- Refractory
- specialty paints
- oil spill absorbent
- flame retardants
- insulator

III. ADVANTAGES OF RHA

- RHA provides high compressive strength to the concrete.
- RHA gives long durability to the concrete.
- It also helps in cutting down the pollution in environment.
- RHA can be used as a partial substitute for Portland cement in amorphous form and as an admixture in high performance concretes and high strength.
- It also imposes the cost of concrete.

IV. INGREDIENTS

1. Cement:
   In present work Ordinary Portland Cement (OPC) from a single lot was used throughout the course of the investigation. All the tests were carried out as per recommendations of IS: 4031-1988. Cement was carefully stored to prevent deterioration in its properties due to contact with the moisture. The physical properties of the cement as determined from various tests conforming to Indian Standard are listed in Table1.

Table I. Physical and Mechanical Properties of Ordinary Portland cement

S.No.	Properties	Observations
1.	Fineness	4 %
2.	Standard consistency	26 %
3.	Initial setting time	37 minutes
4.	Final setting time	460 minutes
5.	Compressive strength (28 days)	47 MPa

2. Fine Aggregate:
   The sand obtained from river beds or quarry is used as fine aggregate. The fine aggregate along with the hydrated cement paste fill the space between the coarse aggregate. The physical properties of river sand was done according to IS 2386-1963.
   The important properties of aggregate are as follows -
   a) Shape and texture
   b) Size gradation
   c) Moisture content
   d) Specific gravity
   e) Unit weight
   f) Durability and absence of deleterious materials.

Table II. Physical properties of fine aggregate

S.No.	Properties	Observations
1	Fineness modulus	2.481
2	Specific gravity	2.626

3. Coarse Aggregate:

Aggregate occupy 70 to 80% of the volume of the concrete. Coarse aggregate is the important constituent in concrete. The aggregate retained at 4.75 mm is considered as coarse aggregate. It can be found from original bed rocks or crushing of boulders. Coarse aggregates are available in different shape like Irregular, Rounded, Flaky, Angular. It should be free from dirt content and any organic impurities.

Table III. Physical properties of coarse aggregate

S.No.	Properties	Observations
1	Fineness modulus	3.5655
2	Specific gravity	2.6891

4. Rice husk ash

For the Present investigation, Rice husk ash was obtained from Rampur (Radico khaitan Ltd company Shivapuram colony Rampur Utter Pradesh).

Table IV. Chemical composition of RHA

S.No.	Constituents	Percentage value
1	Fe2O3	0.54
2	K2O	0.1-2.54
3	SiO2	62.5 - 97.6
4	CaO	0.1 - 1.31
5	MgO	0.01 - 1.96
6	Na2O	0.01 - 1.58
7	P2O5	0.01 - 2.69
8	SiO3	0.1 – 1.23
9	Carbon	2.71 – 6.42

5. Water:

In this work, potable water was used for mixing and curing of concrete. The ph value of water used in mixing and curing was in the range of 7.

V. EXPERIMENTAL PROCEDURE

The test performed for testing the Compressive strength of concrete using rice husk ash. Various cubes were made with various percentage of rice husk ash by weight of cement and tested. Five concrete cube specimens for the test is made for each M-20 with 0%, 5%, 10%, 15%, 20% rice husk ash composition. Compressive strength test is conducted on hardened concrete as it is an easy test to perform and also most of the suitable characteristic property of concrete. Sometimes, the compressive strength of concrete is checked using the parts of beam tested in flexure. The cube specimen is of size 150×150×150mm.

The step by step procedure is described below-

- First of all the moulds of cast iron, thick enough to prevent deformation, is used to prepare the specimen of size 150×150×150mm.
- During the time of placing of concrete in the moulds it is compacted with the tamping rod with not less than 25 strokes per layer.
- Then these moulds are placed on the vibrating table and are compacted until the specified condition is attained.
- The test specimens are stored in dry place free from vibration and at a temperature of 27degree +_2degree C for 24 hrs from the addition of water to the dry ingredients.

- After 24 hrs period, the specimen are submerged in water for curing and kept there until taken out just prior to test. The specimens should not to be allowed to become dry at any time until they have been tested.
- The cube is then taken out of the curing tank and placed in the compression testing machine so to find the Maximum load at which the concrete fails by compression.

VI. EXPERIMENTAL RESULTS

Various tests, such as slump test, compacting factor test, compression test and split tensile strength tests have been conducted on fresh and hardened concrete to determine the mechanical properties of concrete.

1. Results for fresh concrete

The slump test and compacting factor test was conducted on fresh concrete with different percentage of w/c ratio as given in below tables 5 and 6.

Table V. Results for slump and compacting factor for 0% RHA

SR.NO	W/C ratio	Slump(mm)	Compacting factor
1	.40	0	.81
2	.45	0	.72
3	.50	5	.73
4	.55	20	.70
5	.60	35	.69

Table VI. Results for slump and compacting factor for 5% RHA

SR.NO	W/C ratio	Slump(mm)	Compacting factor
1	.40	0	.84
2	.45	0	.74
3	.50	0	.72
4	.55	10	.71
5	.60	20	.68

2. Results for hardened concrete

The compressive strength test was done on 150mm×150mm×150mm concrete cubes after the curing period of 7 days and 28 days. Five cubes were tested for each curing period. The compressive strength of all cubes is showing in table 7 & Fig 1 and split tensile strength showing in table 7 & Fig 2.

Table VII. Results for compressive strength of hardened concrete

SR.NO	RHA percentage	Compressive strength at 7 days (MPa)	Compressive strength at 28 days (MPa)
1	0%	11.76	19.87
2	5%	12.69	22.15
3	10%	12.87	23.46
4	15%	14.02	25.87
5	20%	11.00	17.57

Table VIII. Results for split tensile strength of hardened concrete

SR.NO	RHA percentage	Split tensile strength at 7 days (MPa)	Split tensile strength at 28 days (MPa)
1	0%	2.31	2.68
2	5%	2.03	2.73
3	10%	2.26	3.36
4	15%	1.79	2.87
5	20%	1.43	2.19

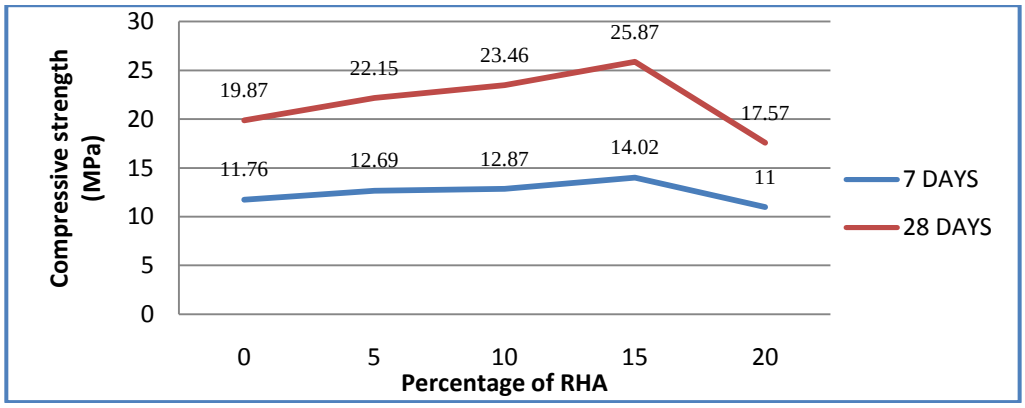

Fig 1: Results for compressive strength of hardened concrete

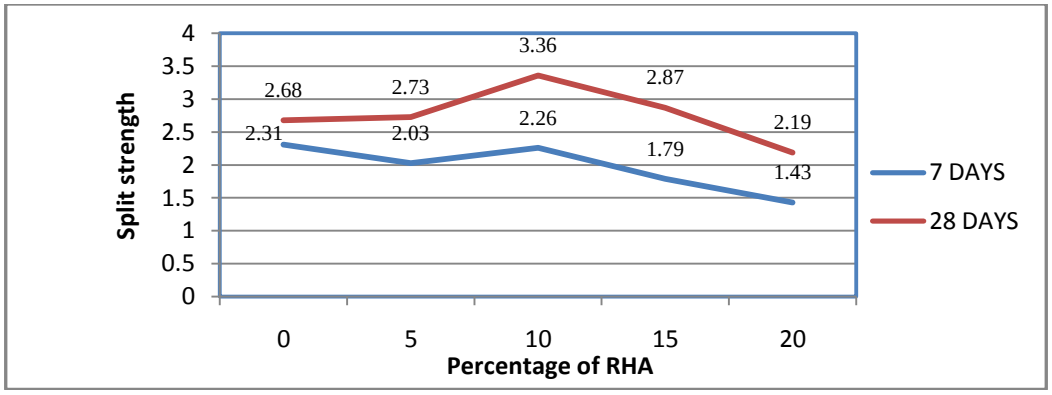

Fig 2: Results for split tensile strength of hardened concrete

VII. CONCLUSION

The workability of concrete made with 5% RHA has found to be decreased with increased w/c ratio when compared to normal concrete and compacting factor also found decreased with increased w/c cement ratio when compared to normal concrete. The compressive strength of concrete increased with increase the percentage of RHA up to 15% after 7 and 28 days curing and found decreased after 15% of RHA.

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