EFFECT OF PARTIALLY REPLACED RICE HUSK ASH ON COMPRESSIVE STRENGTH OF M SAND CONCRETE

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Abstract : Concrete industry provides an ideal method to utilize a number of waste materials, which are socially acceptable, available easily, and economically within the buying capacity of any man. Presence of such materials in cement concrete reduces the carbon dioxide emission and also improves workability and durability. This paper presents the details of an experimental investigation carried out to use Rice Husk Ash as a partial replacement to Cement and use of M sand as a complete replacement of natural sand in Concrete in an attempt to investigate the Compressive strength of concrete. For control concrete, IS method of mix design is adopted and considering this a basis, mix design for replacement method has been made. Four different replacement levels of Rice Husk Ash namely 5%, 10%, 15% and 20% are chosen for the study to utilize Rice Husk ash and M sand in the production of Concrete. Cubes of 150 x 150 x 150 mm were cast, cured for 7 days and 28 days and then tested to record the compressive strengths to compare with control concrete. The results have been analyzed and useful conclusions have been drawn.

***IndexTerms* - M Sand, Rice Husk Ash**

I. INTRODUCTION

Cement concrete is mouldable and very strong construction material. Concrete consists of cement, fine aggregate, coarse aggregate and water. When the cement chemically reacts with water (hydration), it will form binding property. One of the major construction materials is OPC. Today's researchers are more focusing on utilization of Agricultural waste and Industrial waste. Agriculture waste like rice husk ash, wheat straw ash, sugarcane bagasse ash are pozzolanic material can be partially replaced with cement. Industrial wastes like fly ash, blast furnace slag and silica fume can be partially replaced with cement.

Cement production emits CO_2 and forms greenhouse gases; cement alone is responsible for about 5% of global warming. The utilization of Rice husk ash (RHA) is not only reducing the cost of construction but also keep the environment pollution free. Rice production has resulted India as one of the leading producers of rice. Throughout the world rice paddy about 600 million tons is being produced, accounting for an annual production of 120 million tons of rice husk. The husk produced during the processing of the rice is either burnt or dumped as a waste material in most of the cases. Rice husk ash contains 90%-95% of reactive silica. It is estimated that the word rice harvest is about 588 million tons per year and India is the second largest producer of rice in the world with a production of 132 million tons per year annually. Extensive research has been carried out on the use of amorphous silica in the manufacture of concrete. Most of these studies have been performed in order to find the effectiveness of RHA as a pozzolan by concentrating on the amount of ash present in the mix and on the enhanced characteristics resulting from its use. Rice Husk Ash was burnt for approximately 72hours in the air in an uncontrolled burning process. The temperature was in the range of 400-600℃. The ash collected was sieved through BS standard sieve size 425 μ m and its colour was grey.

Manufactured sand (M-Sand) is a substitute of river sand for concrete construction. Manufactured sand is produced from hard granite stone by crushing. The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material. The size of manufactured sand (M-Sand) is less than 4.75mm. Manufactured sand is an alternative for river sand.

Due to fast growing construction industry, the demand for sand has increased tremendously, causing a deficiency of suitable river sand in most part of the word. Due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M-Sand is its availability and transportation cost.

Since manufactured sand can be crushed from hard granite rocks, it can be readily available at the nearby place, reducing the cost of transportation from far-off river sand bed. The utilization of M-Sand is not only economical but also reduces the environmental pollution.

The experimental investigation examines the physical properties of concrete at the age of 7 and 28 days of curing. The experimental tests are compressive strength test at 7 and 28 days of curing.

Crusher dust and Rice Husk Ash are the two prominent industrial wastes, which are producing in huge quantities. In the recent times application of these two industrial wastes, have been gaining importance. In the present study, various percentages of crusher dust were added to Rice Husk Ash and tests like compaction, strength tests were performed. From the test results, Revanth Kumar.P et.al (2016) identified that increasing percentage of crusher dust increases strength values. 30% replacement of Rice Husk Ash by crusher dust can be used as geotechnical construction material.

G.A. Habeeb et.al (2009) reports 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. Locally produced RHA with three deferent APS (i.e., 31.3, 18.3, and 11.5 μm, respectively) were used to replace cement by 20 % of its weight. Mixture proportioning was performed to produce high workability RHA mixture (200-240 mm slump) with target strength of 40 MPa. Incorporation of RHA in concrete resulted in increased water demand, for the mechanical properties, inclusion of RHA provided similar or enhanced mechanical properties when compared to the control Ordinary Portland Cement (OPC) mixture, with finer RHA giving better improvement. Fine RHA exhibited the highest shrinkage value due to the effect of microfine particles which increases its shrinkage values considerably.

Gemma Rodríguez de Sensale et.al (2006) presents a study on the development of compressive strength up to 91 days of concretes with rice-husk ash (RHA), in which residual RHA from a rice paddy milling industry in Uruguay and RHA produced by controlled incineration from the USA were used for comparison. Two different replacement percentages of cement by RHA, 10% and 20%, and three different water/cementicious material ratios (0.50, 0.40 and 0.32), were used. The results are compared with those of the concrete without RHA, with splitting tensile strength and air permeability. It is concluded that residual RHA provides a positive effect on the compressive strength at early ages, but the long term behavior of the concretes with RHA produced by controlled incineration was more significant. Results of splitting tensile and air permeability reveal the significance of the filler and pozzolanic effect for the concretes with residual RHA and RHA produced by controlled incineration.

II. Materials Used

The details of various materials used in this investigation are given in the following sections.

2.1. Cement Used

Ordinary Portland cement of 43 grade of Ultratech brand conforming to IS: 12269 standards was used in this investigation. The specific gravity of the cement was 3.10. The initial and final setting times were found as 60 minutes and 270 minutes respectively.

2.2. Fine Aggregate Used

M-sand is used as a Fine aggregate which were collected in an around Ballari conforming IS 383-1970 passing 4.75 mm and are with the following properties

Table 1: Physical properties of Fine Aggregate

Sl. No.	Characteristics	Test results	Recommended values	IS Standards
1	Specific gravity	2.77	2.5-2.9	IS 383-1970
2	Fineness modulus	3.079	2-4	IS 383-1970
3	Bulk density	1580	1520-1680	IS 2386-3-1963

2.3. Coarse-aggregate Used

Crushed granite aggregate available from local sources has been used. To obtain a reasonably good grading, 76% of the 12mm size aggregates and 24% of 20 mm size aggregates are used in the production of concrete. The specific gravity of coarse aggregate is 2.69.

2.4. Water Used

Potable fresh water available from local sources was used for mixing and curing of mixes.

2.5. Rice Husk Ash

Properties of RHA is as follows

Table 2: Chemical Composition of Rice Husk Ash

SL.NO	Chemical Compound	Abbreviation	Percentage (%)
1	Silica	SiO_2	67.2
2	Aluminium Oxide	AL_2O_3	5.98
3	Ferric Oxide	Fe_2O_3	2.08
4	Calcium oxide	CaO	2.72
5	Magnesium Oxide	MgO	2.36
6	Sodium Oxide	Na_2O	0.91
7	Potassium oxide	K_2O	3.65
8	Loss on ignition	L.O.I	13.9
9	Sulphide Oxide	SO_3	1.01

III. Methodology

The main aim of the experimental program is to study the physical properties of concrete. Cement is partially replaced with Rice Husk Ash in the proportion of 0%(Referance mix), 5%, 10%, 15% and 20% by weight. Fine aggregate which are used in the project were completely replaced by M sand which is denoted by 100%.

The materials (Cement, CA and FA) are weighed and dry mixed thoroughly after the measured amount of water for Water cement ratio of 0.5 is added and the material is mixed thoroughly until it becomes uniform. Replacement of cement by RHA from

0% to 20% by weight is done and M sand is used as Fine Aggregate. Concrete produced are filled in 150mm× 150mm × 150mm moulds. After 24 hours of casting, the specimens are de-molded and kept for curing.

The specimens were tested at different ages (7 and 28 days of curing) for compressive strength in accordance with Bureau of Indian Standards. The compressive load was applied at a rate of 1.2 kN/sec using a compressive testing machine having a capacity of 2000 KN as shown in figure.1. For each trail, 3 cubes were cast and tested at the age of 7 and 28 days. The average values of compressive strength were adopted in each case.

Fig 1: Compressive strength testing of concrete

IV. DISCUSSIONS OF TEST RESULTS

4.1.Effect of age on compressive strength of concrete w.r.t different % replacement of rice husk ash:

Table 1 represents tabulated values of the compressive strength of Rice husk ash concrete w.r.t age

Table.1 Compressive strength of Rice husk ash concrete w.r.t age

Percentage of RHA	AGE (Mpa)	
	7days	28days
0% RHA	23.11	27.00
5% RHA	23.60	27.60
10% RHA	25.82	28.07
15% RHA	17.70	26.00
20% RHA	14.96	24.00

Figure 2 represents the Effect of age on compressive strength of concrete w.r.t different % replacement of rice huskash

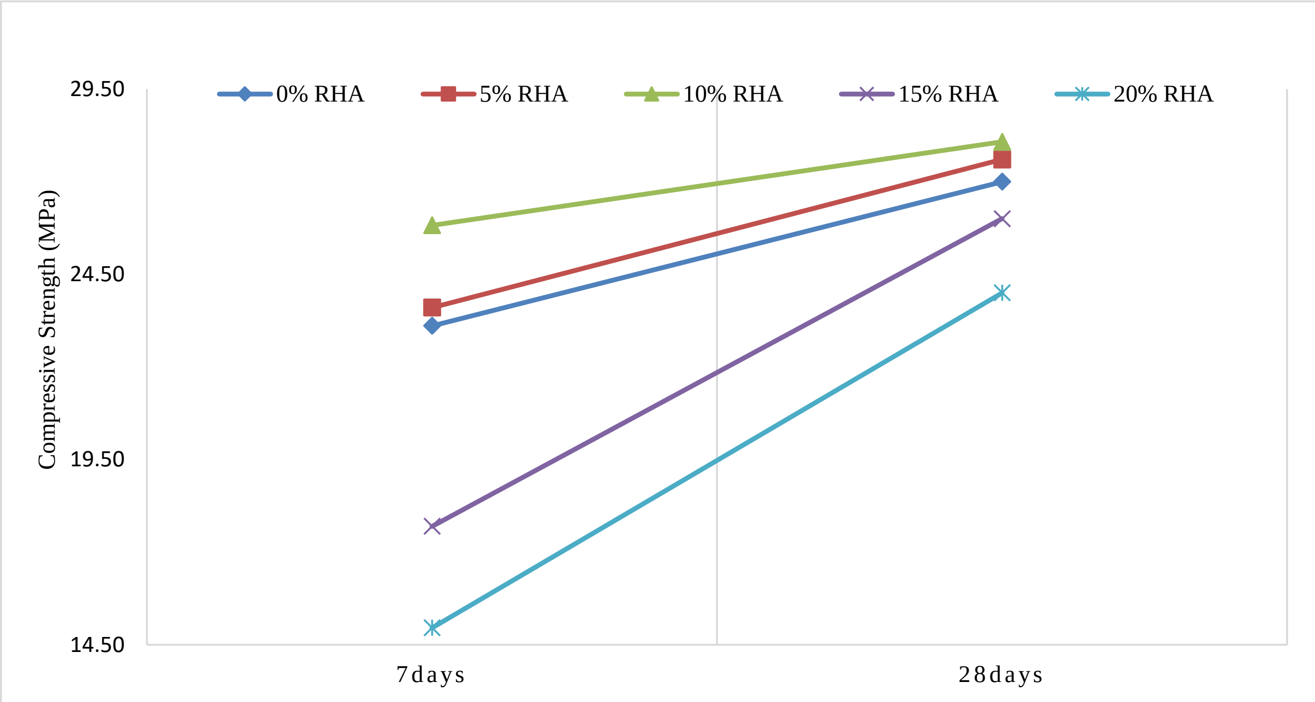

Fig.2 Effect of age on compressive strength of concrete w.r.t different % replacement of rice husk ash.

From this figure, it can be observed that the compressive strength increases for all the percentages of replacement of Rice Husk Ash from 7days to 28days, but the early strength gain is maximum for 10% replacement of cement by Rice Husk Ash and it increases by 8% for 28days. The early strength gain is minimum for 20% replacement of cement by Rice Husk Ash, but it increases by 37.67% for 28days. Though the early strength gain of 20% replaced concrete is less it has a significant rise in Compressive strength by 28 days while compared to 14.41% increase of ordinary concrete. It can also be observed that the replacement of river sand by M sand yields good results compared to the ordinary concrete w.r.t age of concrete.

4.2. Effect of percentage replacement of Rice Husk Ash on the Compressive strength of concrete:

The variation of compressive strength (after 28 days curing) with varying percentage of Rice Husk Ash are presented in Figure. 3

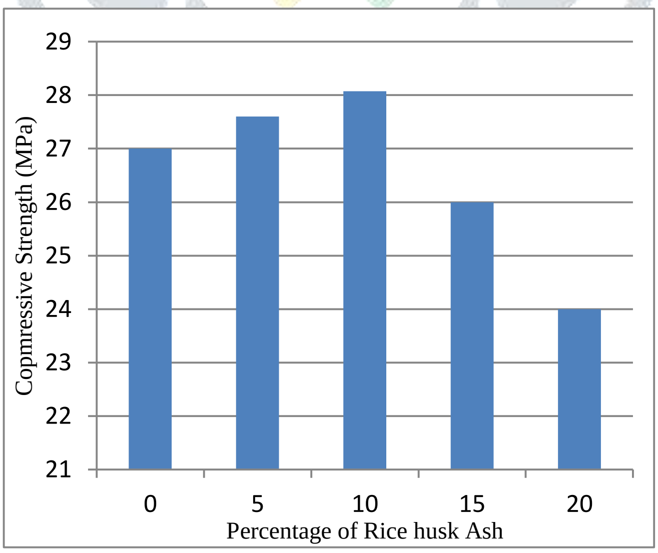

Fig.3 The variation of compressive strength (after 28 days curing) with varying percentage of Rice Husk Ash

From this figure, it can be observed that the compressive strength increases with increase in percentage of Rice Husk Ash, this is due to the higher fineness of Rice Husk Ash which might have allowed the Rice Husk Ash particles to increase the reaction with $Ca(OH)_2$ to give more calcium silicate hydrate (C-S-H) resulted in higher compressive strength. This is true for 5% and 10%

replacement of cement by Rice Husk Ash. Further with every increase in Rice Husk Ash replacement by 5%, it resulted in the decrease of compressive strength. The maximum compressive strength was achieved for 10% replacement of cement by Rice Husk Ash and was decreased by 7.39% and by 14.51% with every 5% increase in Rice Husk Ash respectively. It can also be observed that the replacement of river sand by M sand yields good results compared to ordinary concrete along with replacement of cement by Rice Husk Ash.

V. Conclusions

The present investigation establishes the superiority concrete produced with partial replacement of cement by Rice Husk ash to stand well compared to ordinary concrete. The important conclusions of the present paper are summarized below.

1. The compressive strength of the concrete with partial replacement of rice husk ash increases with increasing the percentage of rice husk ash to some extent.

2. Rice husk ash can be added to cement concrete as partial replacement of cement up to 10% without any significant reduction in any of the property of concrete. This will result in the reduction in the cost of concrete to some extent.

3. The early strength gain is maximum for 10% replacement of cement by Rice Husk Ash.

4. Though the early strength gain of 20% replaced concrete is less it has a significant rise in Compressive strength by 28 days while compared to ordinary concrete.

6. It can also be observed that the replacement of river sand by M sand yields good results compared to ordinary concrete.

6. Rice husk ash is environment polluting material and is best supplementary material for cement replacement as it is easily available in rice producing areas.

7. By using this Rice husk ash in concrete as the replacement the emission of greenhouse gases can be decreased to a greater extent. As a result, there is a greater possibility to gain number of carbon credits.

8. The technical and economic advantages of incorporating Rice Husk Ash in concrete should be exploited by the construction and rice industries, more so for the rice growing nations of Asia.

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