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RICE HUSK ASH-AN EXCELLENT CEMENT REDUCER

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Abstract- In present era construction industries are one of the fastest growing industries in the world as a consequence of this demand of construction materials increasing day by day. For sustainable future pozzolanic materials produced from the waste materials can be used as partial replacement of cement for minimizing environmental risks and to improve the mechanical and durability properties of concrete. In this study efforts has been made to use rice husk ash (RHA) as partial replacement of cement because of its high pozzolanic behavior. RHA blended concrete is analyzed on three parameter i.e. compressive strength, workability and water absorption at different level of RHA replacement percentage i.e. 5%, 10%, 15%, 20%, 25%and 30%. It was observed in this study that 25% of RHA replacement in OPC cement is optimum limit without affecting the strength of concrete. It was also observed that the workability of concrete decreases with increase in RHA content. The percentage water absorption increases with increase in RHA content at the age of 28 days of curing but at the age of 90 days of curing the water absorption percentage is reduced.

Keywords: Rice husk ash, compressive strength, workability, water absorption, Ordinary Portland cement (OPC)

I. INTRODUCTION

Concrete is considered as heterogeneous material which is made by a suitable combination of cement, fine aggregate, coarse aggregate and water. Because of its advanced properties concrete is used for construction over the years. Due to excessive and uncontrolled use of concrete it also creates some serious environmental problem. Cement producing industries are ranked to third place for producing anthropogenic pollutants in our environment. Therefore, for saving the environment, it is important to find out alternatives to either reduce the cement content in concrete or to eliminate the cement from concrete. In today's world conversion of resources and environment for sustainable future has been one of the biggest challenges. There is only one possible solution of such kind of problems i.e. to limit the non renewable resources consumption and minimizing the waste materials.

India has largest cultivation area for paddy production. Almost 125 billion ton of paddy is produced every year in India. Rice husk is an agro waste material which is very difficult of dispose and produces some serious environmental concern to land and atmosphere. Because of its high calorific value rice husk can be used in boilers as fuel. After burning 1 ton of rice husk produces 40 to 45 kg of rice husk ash. In various parts of world many researchers concluded that rice husk ash is suitable for partial replacement of cement because of its high silica content. Silica content of rice husk ash depends on the burning process. Silica content will increase up to 90% to 95% or more when rice husk is burnt under high temperature and controlled environment. The average particle size of cement is approx. 35 micron whereas the average particle size of rice husk ash is 25 micron. Voids may be reported in concrete when proper curing is not done. Because of smaller particle size rice husk ash fill the interstices between cement and aggregates to improve the strength and density of concrete. As a consequence of improved density RHA also offers an excellent chemical resistance.

In present study efforts have been made to observe the effect of rice husk ash on compressive strength, workability and water absorption of concrete. For compressive strength 28 days curing is done and for water absorption 28 days and 90 days curing is done to analyze the long term effect of rice husk ash on water absorption.

II. LITRETURE REVIEW

RHA that produce from the burning of the rice husk can contain up to 95% of silica content that acceptable as pozzolanic material to be as partial replacement for cement in concrete (Basha and Muntohar, 2003). Pozzolanic materials are siliceous and aluminous material which in them, possess cementitious component, chemically reacts with calcium hydroxide (Tashima et al, 2010). According to Salas et al., 2011, Rice Husk ash was found to inherit the good pozzolanic material as a replacement of natural mineral pozzolanic material. This lignocelluloses pozzolanic material can be formed from raw Rice Husk when burnt in control temperature of above 500 °C (Kamal et al, 2010). Silica content in the ash is mainly dependent on the burning process. At a higher burning temperature production of silica can be increased (Sivaraja and Kandasamy, 2011).

III. MATERIALS AND METHODOLOGY

A. Cement

Ordinary Portland cement of grade 53 is used in this investigation. The cement is supplied by single manufactures and of same batch throughout the investigation. The details of cement properties are summarized in Table 1.

Table 1: Properties of Cement

Test parameters	**Observed Value**	**Permissible range according to IS:12269:1999**
Specific gravity	3.12	3.10-3.15
Normal consistency	34%	30-35
Initial setting time	57 min.	Not less than 30 min.
Final setting time	255 min	Not more than 600 min.
Compressive strength (Mpa) 7 days 28 days	 34 56	 53

B. Fine aggregate

Locally available Yamuna river sand is used throughout the investigation. The zone of sand is confirmed to zone 3rd according to IS: 383-1970. The properties of sand are summarized in table 2.

Table 2: Properties of Fine Aggregate

Properties	**Test values**
Specific gravity	2.54
Fineness modulus	2.4
Water absorption	1.6%
Zone of sand	3rd

C. Coarse aggregate

Well graded crushed stones of maximum size 20mm are used in this investigation. Two sizes of coarse aggregates i.e. 20mm and 10mm is mixed in a proportion of 60:40 is used for this study. The detailed properties of coarse aggregate are summarized in table 3.

Table 3: Properties of Coarse aggregates

Properties	**Test values**
Specific gravity	2.69
Water absorption	0.8%
Fineness modulus	7.14

D. Rice husk ash

In present study rice husk ash is obtained by burning rice husk at temperature of 650^0 C in a control environment. The burnt rice husk ash is sieved by 63 micron sieve before using is as a replacement of cement in concrete mix.

E. Water

Normal potable water free from any contamination is used to fluidize the mix and to provide adequate workability is used IN present study.

F. Mix proportion

Multiple design mix attempts were made to design M 25 grade of concrete. The most suitable proportion is tabulated in table 4.

Table 4: Mix Design Proportions

Material	cement	Fine aggregate	Coarse aggregate	w/c ratio
Quantity/ m^3	380 kg	521.1 kg	1219 kg	0.48

G. Sample Preparation

First of all 70% of total water content in poured in the mechanical mixer and then all the materials were poured. Then all the materials were mixed for 3 min. thereafter remaining 30% of water is poured and all the materials were mixed for another couple of minutes. Thereafter the slump of batch is taken. Next the concrete is placed in the moulds in 3 layers and then vibrated layer by layer on vibrating table. After 24 hours moulds were removed and cubes were transferred in curing tanks. The same process is repeated of 5%, 10%, 15%, 20%, 25% and 30% of RHA replacement. The concrete cubes were cured for 7 days and 28 days.

H. Slump Test

This test is used as a measure of workability of concrete. The test was carried out by using a slump cone of standard dimensions as per IS: 1199: 1959. Concrete mix is poured in 3 layers in slump cone and each layer is compacted by using a tempting rod with 25 numbers of strokes. Then the slump cone mould is removed carefully and slowly in upward direction. The difference between height of mould and highest point of concrete is considered as slump value of concrete.

I. Water Absorption Test

Three concrete cubes were dried in thermostatically controlled oven at a temperature of 105^0C for 72 hrs. Then specimens are cooled for 24 hrs in air tight container and weighted. Thereafter specimens were immersed in water for 30 min. and then removed from the water tank then samples were dried by a cotton cloth till the saturated surface dry condition is obtained then specimens are weighted again. The weight difference between surface dry condition and oven dried condition is considered as water absorption of specimens.

J. Compressive strength

The compressive strength of specimens is determined after 7 and 28 days of curing respectively with surface dried conditions as per as IS 516-1959. Mould size is 150*150*150 is used for this purpose. Three specimens are to be tested and mean of compressive strength of all these specimens is considered as compressive strength of specified category.

IV. RESULTS AND DISCUSSION

The average slump values of concrete having different level of RHA replacement is shown in fig.4. It was observed during this study that the average slump value decreases with increase in RHA content. At 0% RHA average slump value is 55 mm whereas it decreases slightly and comes at a level of 49mm in case of 5% RHA. At the level of 10%, 15%, 20% slump value is noted as 43mm, 35mm and 27mm respectively. The reason behind the decrement in slump is increase in pozzolanic content in concrete because pozzolanic materials require more water for coming in action.

Table 5 indicates that water absorption of RHA blended concrete increases with increase in content of RHA at the age of 28 days. This is because of hydroscopic nature and fineness of RHA. But a considerable decrement was also observed in water absorption percentage when curing time is increased to 90 days. Therefore it can be concluded that prolonged curing of RHA blended concrete will lead to decrease in amount of permeable voids.

Compressive strength of RHA blended concrete is tabulated in table 6. It was observed that compressive strength increases up to level of 20% RHA and thereafter it shows a decrement in compressive strength. It was also observed that at 25% of RHA the compressive strength is almost equal to control concrete and at 30% replacement it shows less strength than that of control concrete. Therefore it can be concluded that 25% replacement of cement with RHA seems to be optimum limit of replacement for M25 grade of concrete. The reason behind the improvement in compressive strength is the presence of amorphous silica in rice husk ash which makes it an excellent pozzolanic material.

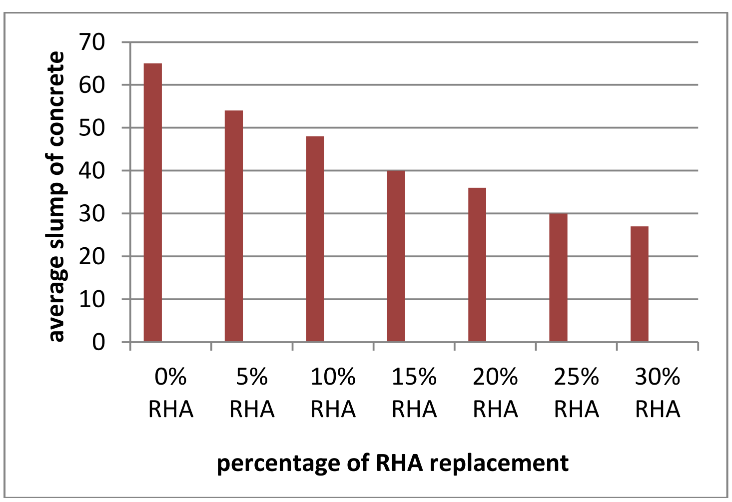

Fig.1Workability of Concrete at Different Level of RHA Replacement

Table 5: Compressive Strength of Concrete at Different RHA level

RHA (%)	7 days compressive strength	28 days compressive strength
0	27.3	37.2
10	27.8	39.9
15	28.2	41.4
20	29.9	41.8
25	27.2#	37.6#
30	26.1	35.2

Table 6: Percentage Water Absorption in concrete

RHA (%)	28 days water absorption (%)	90 days water absorption (%)
0	4.69	3.72
10	4.78	3.19
15	4.99	3.17
20	5.48	3.09
25	5.72	2.25

#equivalent to control concrete

V. CONCLUSION

1. By analyzing the results it can be concluded that with increase in RHA the workability of concrete is reduced because pozzolanic materials requires more water because of its hydroscopic nature.
2. It was also observed that there is an increase in water absorption with increase in RHA content at the age of 28 days but after 90 days of curing the water absorption percentage reduced significantly and RHA blended concrete becomes less permeable.
3. Compressive strength of RHA blended concrete shows an increment up to 20% of RHA content. At the level 25% RHA replacement the compressive strength is almost equal to strength of concrete with 0% RHA content. Therefore 25% of RHA replacement can be considered as optimum limit.

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