Partially Replacement of Portland Cement with Rice Husk Ash in Concrete

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***Abstract*—Concrete is a site made material unlike other materials of construction and as such can vary to a very great extent in its quality, properties and performance owing to the use of natural materials except cement. From materials of varying properties, to may concrete of stipulated qualities, an intimate knowledge of the inter-action of various ingredients that in to the making of concrete is required to be known both in the plastic condition and in the hardened condition. Rice husk is an agriculture by-product generated from peddy. Presently there are limited uses of rice husk and unused quantity is dumped unattended in the landfills, which create pollution in the environment. In this study, characterization of rice husk ash was carried out to evaluate its engineering properties. The cements were replaced partially by rice husk ash in two grades of concrete i.e. M20 by 0%,5% 10%,15% and 20%,rice husk ash, by weight. The slump, compressive strength and flexural strength tests were conducted and results were analyzed.**

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I. INTRODUCTION

Rice husk can be burnt into ash that fulfills the physical characteristics and chemical composition of mineral admixtures. Pozzolanic activity of rice husk ash (RHA) depends on (i) silica content, (ii) silica crystallization phase, and (iii) size and surface area of ash particles. In addition, ash must contain only a small amount of carbon.The optimized RHA, by controlled burn and/or grinding, has been used as a pozzolanic material in cement and concrete. Using it provides several advantages, such as improved strength and durability properties, and environmental benefits related to the disposal of waste materials and to reduced carbon dioxide emissions.

II. LITERATURE REVIEW

Prasad et. al. [1] Investigated on Cement concrete which continues to be the pre-eminent construction materials for use in any type of civil engineering structure He concluded in his investigation the blended cements, particularly are better in Sodium Sulphate environment. The blended cement mixes show more deterioration in Magnesium Sulphate exposure in compared to plain cement mixes. The Magnesium Sulphate environment is more severe than Sodium Sulphate environment. The performance of low water/binder ratio mixes is inferior in Sulphate resistance. The little initial air curing of mixes is beneficial for Sulphate resistance. He also stated that the deterioration of cement mixes increases with increase in the concentration of Sulphate. The presence of Chloride ions with Sulphate ions reduces the rate of Sulphate attack on cement mixes. The deterioration rate of mixes due to Sulphate attack is higher at high temperature with alternate wetting and drying cycles. Rao et. al [2] investigated on M20 grade of concrete. The title of "a study on use of rice husk ash in concrete". They have tested the following parameters in concrete- Compressive Strength Test, Flexural Strength Test for 3 days,7 days, 28 days and 56 days. They have prepared 5 mixes of concrete. In mixes they replaced cement by 5%, 7.5%, 10%, 12.5% and 15% of rice husk ash. The results of their research were-(i) Compressive strength is increased up to when amount of rice husk ash 12.5 %.(ii) Flexural strength is gradually decreased with increased amount of rice husk ash. Nair et.al [3] has investigated on M60 grade of concrete. The title of their experimental program is "Mechanical Properties of Rice Husk Ash (RHA) – High strength Concrete". They have tested the following mechanical properties of concrete- Workability Compressive Strength (cube), Flexural Strength, bond strength, modulus of elasticity, density and Split Tensile Strength and fresh concrete property workability. They have prepared mixes of concrete; In mixes they replaced cement by 0%, 5%, 15% and 25% rice husk ash in M60 grade concrete.

III. MATERIAL AND METHOD

A. Coarse Aggregate

20mm and 10mm (as shown in fig. 1 and 2) nominal size of coarse aggregate is used for experiment. For gradation of coarse aggregate IS 383:1970[4] used. For obtained the mechanical property of coarse aggregate (Table 1) IS: 2386-1963 Part- III [5] used.

Fig. 1. Coarse Aggregates (20 mm)

Fig. 2. Coarse Aggregates (10 mm)

Table 1. Properties of Coarse Aggregates

Property Test	Coarse Aggregates	
	20 mm	10 mm
Sp. Gravity (OD)	2.66	2.62
Sp. Gravity (SSD)	2.64	2.64
Sp. Gravity (Apparent)	2.68	2.68
Water Absorption	0.80%	0.80%

B. *Fine Aggregate*

The gradation of fine aggregates (Fig. 3) used in this study is presented in Table3.2. On the basis of gradation results, the fine aggregates (Table 2) used in this study were of Zone II as per Table 4 of IS: 383-1970.[4]

Fig. 3. Fine Aggregates

Table 2. Sieve Analysis of Fine Aggregates

Sr. No.	Sieve Size	% Passing	Limits for Grading Zone II as per IS: 383-1970
1	10 mm	100	100
2	4.75 mm	98.60	90-100
3	2.36 mm	96.00	75-100
4	1.18 mm	88.40	55-90
5	600 micron	38.70	35-59
6	300 micron	9.35	8.0-30
7	150 micron	1.00	0-10

C. *Cement*

Ordinary Portland cement (Table 3) of 43 grade was used in which the composition and properties is in compliance with the Indian standard organization.

Table 3. Properties of Cement

S.No.	Property Tested	Test Results	Standard Values as per IS: 4031-1988	Test Method
1	Specific gravity	3.15	-	IS 4031Part 4-1988
2	Initial setting time	115 Minutes	Minimum30 minutes	IS 4031 Part 5-1988
3	Final setting time	225 Minutes	Maximum 600 minutes	IS 4031 Part 5-1988
4	Compressive strength at 7 days	32.11 MPa	-	IS 4031 (Part 6-1988)

D. *Rice Husk Ash (RHA)*

Rice Husk Ash is a Pozzolanic material. It is having different physical & chemical properties. The product obtained from R.H.A. is identified by trade name Silpoz which is much finer than cement RHA is finer than cement having very small particle size of 25 microns, so much so that it fills the interstices in between the cement in the aggregate. That is where the strength and density comes from, therefore, it can reduce the amount of cement in the concrete mix can be used in a big way to make special concrete mixes. Fig. 4 shows the sample of RHA after 1 hour of grounding.

Figure 3.4 . Sample of RHA after 1 hour of Grounding

IV. EXPERIMENTAL PROGRAME

A. *Concrete Mix Design*

The For M20 grade of concrete, concrete mix design is prepared as per IS 10262:2009 [6]

i. Water content = 198 liter / m^3
ii. Cement content = 396 /m^3
iii. Water - cement ratio = 0.5
iv. Aggregates:
   - Coarse aggregate fraction = 0.62
   - Fine aggregate fraction = 0.38
v. Design Mix Calculation –
   a. Volume of concrete = 1m^3
   b. Volume of cement = (396/3.15) x (1/1000) = 0.126 m3
   c. Volume of water = (198/1) x (1/1000) = 0.198 m^3
   d. Volume of aggregates in all - = 1-0.126-0.198 = 0.68 m^3
   e. Coarse aggregate = d) x fraction of coarse aggregate x Specific gravity (G) of coarse aggregate x 1000 = 0.68 x 0.62 x 2.73 x 1000 = 1150.97 kg/m^3
   f. Fine aggregate = d) x fraction of fine aggregate x Specific gravity (G) of fine aggregate x 1000 = 0.68 x 0.38 x 2.63 x 1000 = 679.59 kg/m^3

Mix proportion of Cement, fine aggregate and coarse aggregate is – 1: 1.71: 2.91.

B. *Casting*

Cubes of size 150mm x 150mm x 150mm is casting for determination of compressive strength. Cement + partially rice husk ash+ sand +coarse aggregate are mixed properly with water – cement ratio as obtained in mix design and make a homogeneous mix. After 24 hr of moulding of concrete cubes are cured for 28 days.

C. Testing

Compressive strength of cubes is determined by compression test on compression testing machine of capacity 2000KN. For testing of compressive strength IS 516: 1959 [7] used. According to IS516:1959 [7] load of 140Kg/cm2/minute applied on the cubes until the cubes are cracks. Strength of concrete is fixed by using criteria of IS 456: 2000.

Figure.4.1 Compressive strength testing

V. RESULT

Table 5.1 shows the variation of Compacting factor values with different percentage of RHA in concrete. Table 5.2 shows the variation of compressive strength of cubes with different percentage of RHA in different days

Table5. 1: Compacting factor values of RHA concrete

Percentage replacement of RHA(%)	Compaction factor values
0	0.91
5	0.91
10	0.9
15	0.9
20	0.89
25	0.88

Table5.2. Compressive strength of cubes

Percentage replacement of RHA(%)	3days	7days	28days
0	14.51	20.58	30.3
5	12.96	19.3	31.5
10	13.32	19.7	31
15	10.7	18.58	30.14
20	8.88	16.22	21

VI. CONCLUSION

Based on the limited study carried out on the strength behavior of Rice Husk ash, the following conclusions are drawn-

- At all the cement replacement levels of Rice husk ash; there is gradual increase in compressive strength at certain limit.
- 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.
- Moreover with the use of rice husk ash, the weight of concrete reduces , thus making the concrete lighter which can be used as light weight construction material.
- The pozzolonic activity of rice husk ash is not only effective in enhance the concrete strength, but also in improving the impermeability characteristics of concrete as the rice husk ash is waste material, it reduces the cost of construction.

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