

Effect of Partial Replacement of Cement by Rice Husk Ash in Concrete

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Abstract: Due to pozzolanic reactivity, Rice Husk Ash is used as a supplementary cementing material in concrete. It has economical and technical advantages to be used in concrete. I am going to partially replace cement by the use of RHA by 5%, 10% & 15% & 20% by weight of cement in four different experiment to find out the maximum strength and compare it with the strength of normal concrete by using the grade of M30 at the days of 7days,14days&28 days. This research therefore is an investigation of the performance of the concrete made of partially replacing OPC with RHA on the structural integrity and properties of RHA concrete.

Keywords: Rice Husk Ash, Concrete, OPC, Compressive Strength, Admixture

1. Introduction

Rice husk is an agricultural residue widely available in major rice producing countries. The husk surrounds the paddy grain. During milling process of paddy grains about 78 % of weight is obtained as rice, broken rice and bran. Remaining 22 % of the weight of paddy is obtained as husk. This husk is used as fuel in the various mills to generate steam for the parboiling process. This husk contains about 75 % organic volatile matter and the rest 25 % of the weight of this husk is converted into ash during the firing process, this Ash is known as rice husk ash. This RHA contains around 85 % - 90% amorphous silica.

Rice husk is generated from the rice processing industries as a major agricultural by product in many parts of the world especially in developing countries. About 500 million tons of paddies are produced in the world annually after incineration only about 20% of rice husk is transformed to RHA. Still now there is no useful application of RHA and is usually dumped into water streams or as landfills causing environmental pollution of air, water and soil. RHA consists of non-crystalline silicon dioxide with high specific Surface area and high pozzolanic reactivity, thus due to growing environmental concern and the need to conserve energy and resources, utilization of industrial and biogenic waste as supplementary cementing material has become an integral part of concrete construction. Pozzolonas improve strength because they are smaller than the cement particles, and can pack in between the cement particles and provide a finer pore structure. RHA has two roles in concrete manufacture, as a substitute for Portland cement, reducing the cost of concrete in the production of low cost building blocks, and as an admixture in the production of high strength concrete.

Rice Husk Ash (RHA):

Rice Husk used in this experiment was obtained from J.P. Enterprises, Kushinagar, U.P.

Table 1: Physical Properties of Rice Husk Ash

Physical state	Solid-non hazardous
Appearance	Very fine powder
Color	Grey
Odor	Odorless
Specific gravity	1.7

Cement:

Table 2: Physical properties of Cement

S. No	Characteristics	Test Result	Standard Result(As Per Is Code)
1	Consistency	32%	30%
2	Initial Setting Time	90 min	Not less than 30 min
3	Final Setting time	310 min	Not more than 600 min
4	Specific Gravity	3.157	3.15
5	Fineness Modulus	7%	Not more than 10%
6	Compressive Strength	44N/mm ²	Not less than 43 N/mm ²

Fine Aggregates:

Fine aggregate was purchased which satisfied the required properties of fine aggregate required for experimental work and the sand conforms to zone II as per the specifications of IS 383:1970.

- a) Specific gravity = 2.62
- b) Fineness modulus = 2.81

Coarse Aggregates:

Crushed granite of 20 mm maximum size has been used as coarse aggregate. The sieve analysis of combined aggregates confirms to the specifications of IS 383: 1970 for graded aggregates.

- a) Specific gravity = 2.70
- b) Fineness Modulus = 6.816

Water:

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. Mixing water should not contain undesirable organic substances or inorganic constituents in excessive proportions. In this project clean potable water is used.

Admixture:

Super plasticizers (CICO Plast super HS) are usually distinctive in their nature, and they make possible the production of concrete which, in its fresh and hardened state, is substantially different form of concrete made using the water reducing admixture.

Mix design for M-30 Grade Concrete

Design Stipulations:

Characteristic Compressive Strength required at the end of 28 days: 30 N/mm²
 Maximum size of Aggregate: 20mm
 Type of Exposure: Severe
 Degree of Quality Control: Good

Test Data for Materials:

Specific Gravity of Cement: 3.157
 Specific Gravity of Coarse Aggregate: 2.70
 Specific Gravity of Fine Aggregate: 2.62

Target Mean Strength of Concrete:

For a tolerance factor of 1.65, the obtained target mean strength for the given grade of concrete
 = 30 + 5 x 1.65 = 38.25 N/mm²

Selection of Water Cement Ratio:

The free water cement ratio for the obtained target mean strength is 0.45. This is equal to the value prescribed for Moderate conditions in IS 456-2000.

Table 3: The mix proportion then becomes

Water	Cement	Fine aggregate	Coarse aggregate	Admixture
179.41	398.68	669.847	1175.24	3.98

Mixing Proportion:

The mixture proportioning was done according the Indian Standard Recommended Method IS 10262:2009. The target mean strength was 38.25MPa for OPC control mixture, the total binder content 398.68kg/m³, fine aggregate is taken 669.847kg/m³ coarse aggregate is taken 1175.24kg/m³ the water to cement ratio was kept constant 0.45, the Super-plasticizer content 1% by weight of cementitious material was kept maintain a slump of (75-100mm) for all mixture.

Hence cement was replaced by rice husk ash at various percentage of replacement 0%, 5%, 10%, 15% and 20% by weight of cement and 150x150x150mm cube casting.

Table 4: The results of the compressive strength of RHA Concrete

	Age (days)	Control concrete	Percentage Replacement with RHA			
			5%	10%	15%	20%
Average Compressive Strength N/mm ²	7	28	28.20	29.90	26.75	25.00
	14	31	31.50	32.90	29.00	27.00
	28	39	39.20	40.50	35.20	32.50

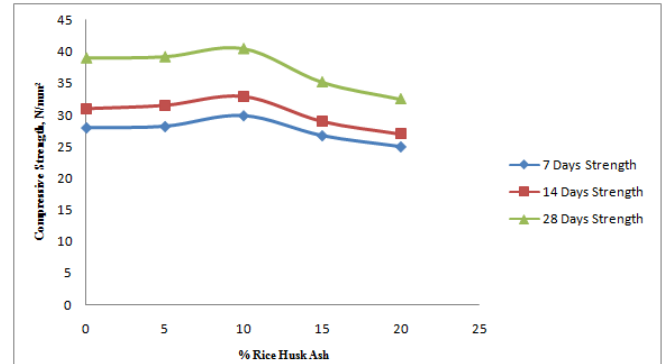


Figure 1: Percentage of Rice Husk Ash v/s Compressive strength

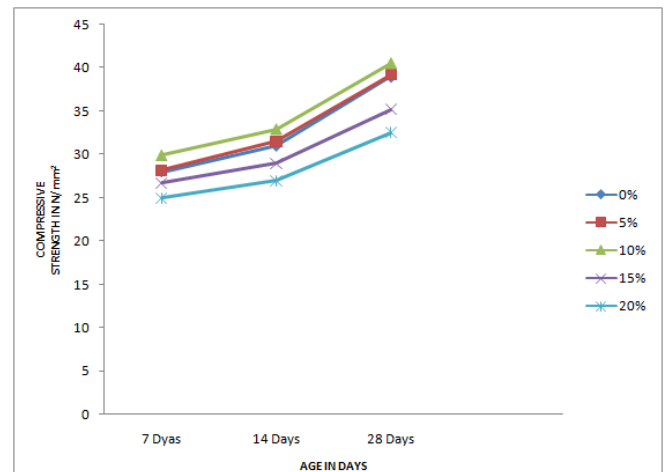


Figure 2: Variation of Compressive strength with age and percentage of Rice Husk Ash

2. Conclusions

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

- At the initial ages, as replacement level of RHA increases the compressive strength also increases.
- The optimum strength is obtained at the level of 10 % of OPC replaced by RHA.
- Using RHA as replacement of OPC in concrete, the emission of greenhouse gases can be reduced up to a greater extent.
- OPC replacement by RHA results in reduction of cost of production of concrete in the range of 7 to 10%.
- OPC replacement by RHA is environmental friendly due to utilization of waste (RHA is basically a waste obtained from Rice Mill) and replacement of cement (Production of 1 MT cement emerges 1 MT Carbon-di-Oxide).

References

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