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Experimental Study on Structural Properties of Concrete by Partial Replacement of Cement by Rice Husk ash

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Abstract: This work is carried out by using Rice Husk Ash (RHA) in concrete as a partial replacement of Ordinary Portland Cement (OPC).In the experimental investigation were taken to study the properties of concrete made with Rice husk ash . The replacement is done partially in the proportion of 0% ,10%,20% and 30% and its effect on workability of concrete, compressive strength, split tensile strength and flexural strength made with rice husk ash were investigated. when the replacement and the highest compressive strength at 30 % RHA replacement was achieved as compared to 0% RHA replacement at 7,14 and 28 days. By using rice husk ash in concrete, we can improve the properties of concrete because of their technical tendency regarding environmental pollution and reduction of cost as well. During the production of cement, a large amount of carbon dioxide (greenhouse gas) releases which effects the environment badly.
Keywords: rice husk ash, Eco-friend environment, compressive strength, split tensile strength, flexural strength test.

INTRODUCTION

While Concrete of the most widely used building material globally. Due to this led to a continuous and increasing demand of natural materials used for their production. Infrastructure development across the world created demands for construction material. Concrete manufacturing involve consumption of ingredients like cement, aggregates, water & admixtures. The Rice husk (RH) is the agricultural residue which is obtained from the covering of rice grains during the milling process. Manufacturing of rice in the world is more than 750 million tones. Rice husk comprises 75-90% organic matter such as lignin, cellulose, etc. and rest inorganic components like alkalis, silica and trace elements. Rice Hush Ash (RHA) a rural and local additive which has been investigated to be super

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pozzolanic in a good proportion to reduce the high cost of structural concrete. Rice Husk Ash (RHA) is an agricultural waste product, and how to dispose of it is a problem to waste manganate. The most expensive concrete material is the binder (cement) and such important expensive material is partially replaced with more natural, local and affordable material like RHA will not only take care of waste management but will also reduce the problem of high cost of concrete. This material is actually a super pozzolan since it is rich in Silica and has about 85% to 90% Silica content. A "pozzolan" is defined as "a siliceous or siliceous and aluminum material, which itself possess little or no cementing property, but will in a finely divided form and in the presence of moisture chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementations properties. The primary objective is to utilize rice husk ash as much as possible in civil construction works. This research has been conducted to identify the suitable composition of rice husk ash as cement replacement material in concrete and also

to study the mechanical properties of concrete. The scope of this research has many advantages over traditional concrete, such as Lower pollution and efficient disposal of rice husk ash is possible.

LITERATURE REVIEW

The effects of using Rice Husk Ash (RHA) as a partial cement replacement material in mortar mixes. This work is based on an experimental study of mortar made with Ordinary Portland Cement (OPC) and 10%, 15%, 20%, 25% and 30% of OPC replaced by RHA. The obtained results show that the strength and porosity of mortar incorporating RHA were better, up to 20% of cement replacement level[5]. The influence of particle size effect on the strength of rice husk ash mixed with gap-graded Portland cement concrete was discussed . They found that replacement of the cement partially up to 20% RHA by mass results in enhanced early-age compressive strength in the gap-graded binder mixtures[6]. The Study about strength characteristics of high strength rice husk ash concrete was discussed. They found that increase in the replacement of cement by RHA in concrete decreases the concrete workability by a slump of 27% and compaction factor of 9%. The optimum replacement level of Rice Husk Ash is found to be 10% for both M20 and M30 grades of concrete [7-8]. The investigation on the behaviour of concrete produced from ordinary Portland cement with RHA. The properties of fresh concrete and the effect of replacing 5%, 10%, 15%, and 20% of cement with RHA on the compressive strength were investigated. Incorporation of RHA in concrete resulted in increased water demand, for the hardened properties, RHA concrete gave excellent improvement in strength for 10% replacement, and up to 20% of cement could be valuably replaced with RHA without adversely affecting the strength[9]. The results of investigation on the use of rice husk ash as a partial substitute for cement in construction. The results shows that at 5% partial replacement of cement with rice husk ash can be used for structural concrete and at 15% replacement or more it can be used for non -structural construction works or light weight concrete construction. The cost analysis shows substantial amount of savings for the country[10]. The effect of pyroprocessing parameters on the pozzolanic reactivity of RHA has studied on his research[11] The design of fluidized-bed furnace for controlled burning of rice husks, by burning the rice husks under a controlled temperature and atmosphere, a highly reactive RHA was obtained[12]. The study of RHA in concrete acts accelerator because of having high silica content that shorten the setting time through absorption of surrounding water and provides several advantages which includes durability, improved strength, reduces the cost of cement and the most important in all of that is environmental benefits related to disposal and reduction in the emission of carbon dioxide[13].

MATERIALS USED

Cement

The cement used in this research should confirm IS specifications. There are several types of cements available commercially in the market of which Portland cement is very common and it is well known and available everywhere. PPC 43 grade was used for this study. The physical properties of the cement tested according to standard procedure confirm to the requirement of IS 12269:1989. The physical properties of the cement are listed in the Table 1.

Table 1 Physical properties of cement

Sl.No	Material	Cement
1	Fineness by Sieving (%) 90 micron mesh	6%
2	Normal Consistency	32%
3	Initial Setting Time (minutes)	45
4	Final Setting Time(minutes)	520
5	Specific Gravity	3.17

Fine Aggregate

Locally available river sand passing through 4.75mm sieve conforming to the recommendation of IS 383:1970 is used. Specific Gravity of fine aggregate of the sand is 2.54 shown in Table 2 .From the sieve analysis results fine aggregate is graded to Zone II and medium sand.

Table 2: physical properties of Fine aggregate

Physical Property	Values
Specific Gravity	2.54
Water Absorption (%)	17
Fineness modulus	3.7

Rice Husk Ash (RHA)

Rice Husk was burnt in an approximately 48hrs in an open air and uncontrolled burning process. The approximate temperature was in the range of 400-600°C**.** The collected ash was sieved as per IS standard sieve size 75µm and its colour was grey. Batching was done by volume at replacement percentages of 10, 20 and 30%. Table 3 shows the physical and chemical properties of rice husk ash. Table 4 shows the particle size distribution of rice husk ash .

Table 3: physical and chemical properties of rice husk ash

Physical Property	**Values**
Specific Gravity	1.75
Colour	Grey
Fineness modulus (%)	0
Appearance	Fine powder
Chemical property	**Percentage (By weight)**
Silica -SiO_2	67
K_2O	1.98
Iron Oxide-Fe_2O_3	0.55
Magenisa-MgO	1.77
Lime-CaO	1.30
Carbon	4.56
Al_2o_3	0.46

Table 4: Particle size distribution for rice husk ash

Sl.No	Sieve size	Weight of Aggregate retained	Weight retained (%)	Cumulative % weight retained	Percentage passing (%)
1	4.75	0	0	0	100
2	2.36	0	0	0	100
3	1.18	55	55	5.5	94.5
4	0.6	87	142	14.2	85.8
5	0.3	159	301	30.1	69.9
6	0.15	190	491	49.1	50.9
7	0.075	236	727	72.7	27.3
8	Pan	35	1000	100	0

Coarse Aggregate

Coarse aggregate to be used for production of concrete must be strong, impermeable, durable and capable of producing a sufficient workable mix with minimum water cement ratio to achieve proper strength. Locally available coarse aggregate retaining on 4.75 mm sieve is used. The physical properties of coarse aggregate is shown in Table 5 . From the sieve analysis results it was found that the combined aggregate of in the range of nominal size of coarse aggregate is 20mm.

Table 5: physical properties of Coarse aggregate

Physical Property	Values
Specific Gravity	2.77
Water Absorption (%)	1.5
Fineness modulus	3.5

Water

The water used in this research work ,has mostly it should be fit for drinking purpose. Its PH value is 6.5 to 8. Portable water available inside the laboratory it was used for mixing and curing of concrete.

Figure 1 a) Natural river sand **b) Rice husk ash**

PROPORTIONS EXPERIMENTAL INVESTIGATION

The concrete mix was designed as per IS: 10262-1982], IS: 456-2000 for the normal concrete. The grade of concrete, which adopted, is M20. The concrete mix proportion (cement: fine aggregate: coarse aggregate) is 1:1.5: 3 by volume and a water cement ratio of 0.45. Figure 5 shows the methodology of current research work.

The study is conducted to analyze the compressive strength, Split tensile strength and Flexural strength of concrete when the cement is partially replaced with waste rice husk ash . Compressive strength and split tensile strength tests were done on compression testing machine of 200 tonne capacity available in the laboratory using cube specimens. The flexural strength test was conducted in flexural testing machine of capacity of 40 tonne. Three samples per batch were tested with the average strength values reported in this article. The cement were replaced as 0%, 10%, 20% and 30% by weight of M-20 grade concrete. The size of cube of 150mm × 150mm × 150mm, cylinder of 150 mm dia and 300mm height and beam prism of 150mmx150mmx750mm of size were used to examine and results were analyzed after curing of 7days, 14days and 28 days. The workability of fresh concrete was measured in terms of slump values. The ingredients of concrete were thoroughly mixed till uniform consistency was achieved. The cubes, beams and cylinders were compacted on a vibrating table. Results obtained from the rice husk ash replacement by cement in concrete specimens were compared with data from a Conventional concrete.

RESULTS AND DISCUSSIONS

Workability: Slump Test

Slump test is the most commonly used method of measuring workability of concrete which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. Workability of concrete made by using glass waste powder was determined with different replacement level. The values of workability in terms of slump is given in Table.6. From the results it evident that workability of concrete made using rice husk ash as increased with increase of percentage of replacement of cement . All the measured slumps in this research were true slumps.

Table.6: Slump value of normal and rice husk ash concete

Sl. No	Designation of the Specimen	Replacement Level (%)	Slump (mm)
1	NMC	0	97
2	RHA10	10	82
3	RHA20	20	77
4	RHA30	30	65

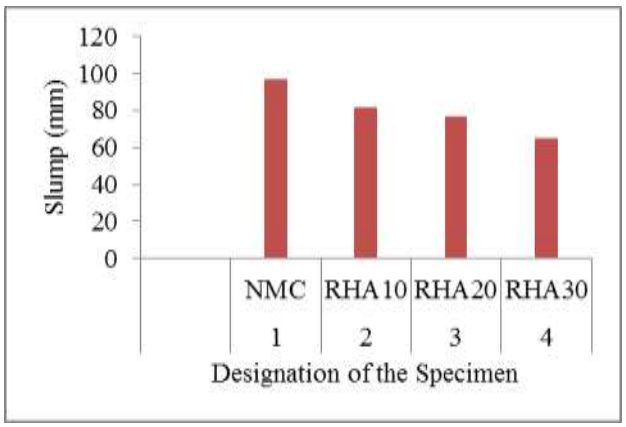

Figure.2: Slump value of normal aggregate and Rice husk ash concrete

The Compression Strength test

The compressive test was conducted in universal testing machine (UTM) in a capacity of 40 tonne was used. Three concrete cubes of 150mm size for M20 using the above mentioned mix ratio were prepared. For each mix ratio, three waste replacement cubes plus one with normal aggregates cubes were casted for testing. The compressive strength test values displayed in Figure 3 shows that rice husk ash has effect on the compressive strength of concrete. The compressive strength values were nominally increased when increases of rice husk ash replacement level of percentage in concrete. The maximum compressive strengths were recorded in Table 7, for concrete is 30% replacement of rice husk ash. The compressive strength development is due to the pozzolanic effect of RHA.

Table 7:Compressive strength values of rice husk ash concrete for 7,14 and 28days

Sl.No	Specimen	Compressive Strength (MPa)		
		7 days	14 days	28 days
1	NMC	19.34	23.23	29.45
2	RHA10	22.73	27.45	29.67
3	RHA20	25.22	29.34	32.50
4	RHA30	27.67	32.56	39.34

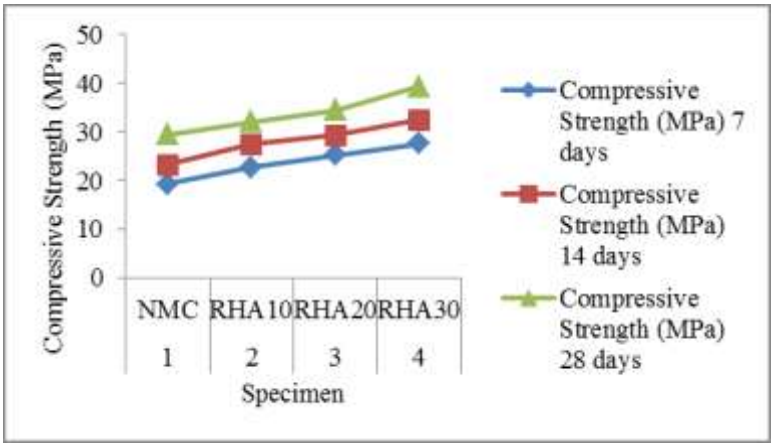

Figure 3 :Compressive strength values of rice husk ash concrete for 7,14 and 28days

CONCLUSIONS

Based on the experimental study for the use of rice husk ash in concrete as a replacement of fine aggregate, the following conclusions were observed.

The workability of concrete had been found to be decrease with increase RHA in concrete. Slump gradually decreased with increase in rice husk ash percentage. The compressive strength of the concrete is increased upto 30% when replacing rice husk ash as cement in nominal mix concrete. The research results indicate that there is a marginal improvement with 10 to 30% RHA replacement levels with Rice Husk Ash concrete. The utilization of rice husk ash in concrete provides additional environmental as well as technical benefits for all related industries.

REFERENCES

1. IS 383 -1970, Specifications for Coarse and Fine Aggregates from Natural Sources for Concrete, Bureau of Indian Standards, New Delhi.
2. IS 10262 -1981, IS Method of Mix Design, Bureau of Indian Standards, New Delhi.
3. IS 516 -1959, Methods of Tests for strength of concrete, Bureau of Indian Standards, New Delhi.
4. IS 456 -2000, Code of Practice for Plain and Reinforced Concrete ,Bureau of Indian Standards, New Delhi.
5. Alireza Naji Givi , Contribution of Rice Husk Ash to the Properties of Mortar and Concrete - A Review, Journal of American Science, 6(3),157-165,2010.
6. Bui D D, Hu J and Stroeven P,Particle size effect on the strength of rice husk ash blended gap-graded portland cement concrete Cement & Concrete Composites, 27,357– 366, 2005.
7. Gemma Rodriguez de Sensale, Strength development of concrete with rice husk ash , Cement & Concrete Composites,28,158-160, 2006.
8. Hwang Chao-Lung, Bui Le Anh-Tuan and Chen Chun-Tsun, Effect of rice husk ash on the strength and durability characteristics of concrete, Construction and Building Materials,25, 3768–72, 2011.
9. Habeeb, G.A., Rice Hush Ash Concrete: The effect of RHA average particle size on mechanical properties and Drying Shrinkage, Australian Journal of Basic and Applied Sciences,3(3),1616-1622, 2009.
10. Maurice E. Ephrain, Compressive Strength of Concrete with Rice Husk Ash as Partial Replacement of Ordinary Portland Cement, Scholarly Journal of Engineering Research,1(2),32-36, 2012.
11. Mehta, P. K, Siliceous Ashes and Hydraulic Cements Prepared There from, Belgium Patent 802909, July 1973, U.S. Patent 4105459,Aug. 1978.
12. Pitt, N, Process for Preparation of Siliceous Ashes, U.S. Patent 3959007, May 1976.
13. Siddique R, and Iqbal Khan M, Supplementary Cementing Materials, 232,2011.

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