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Effects of Rice Husk Ash on the Strength and Durability of Concrete

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Introduction

Concrete is a traditional material used in the construction industry for the past one century and it has become indispensable despite its inherent deficiencies. The concrete for future has to satisfy the conditions of strength and durability, to meet the requirements of huge construction works with least maintenance costs. Efforts are made all -round the globe for developing concrete of enhanced life. The durability can be determined based upon its resistance to penetration by external agents, resistance to internal deterioration due to the chemical composition of its ingredients and structural requirements. The production of concrete involves selection of suitable ingredients, their careful proportions and quality control. One of the salient features of concrete with good performance is its strength apart from other things. However it is generally agreed that high performance concrete need not always be of high strength alone. Mehta P. K. et al[1,2,3] have discussed in detail the principles of production of High Performance Concrete. The strength requirements are not the only necessity, but it could be more resistant to unacceptable rate of deterioration. As already mentioned, the main ingredients of performance concrete are cement, aggregates, water, mineral admixtures which include micro fillers, chemical admixtures such as superplasticizers, retarders, air entraining agents etc. A number of investigations have been reported using mineral admixtures such as silica fume, flyash etc which act as microfillers and thereby the microstructure of the hardened cement material becomes denser and stronger which improves its strength durability characteristics. Mehta P.K. and V.M. Malhotra[1] have reported investigations using Rice Husk Ash (RHA) as a mineral admixture in place of silica fume, and reported it an excellent replacement of silica fume. However little work is reported in India about the usage of Rice Husk as an admixture of Indian conditions. The present paper highlights some of the investigations carried out with rice husk ash as a mineral admixture for producing concretes with strength and improved durability.

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Experimental Investigations

The experimental program consisted of casting and testing of 60 standard cubes and equal number of cylinders of different concrete mixes. The parameters investigated include strength, permeability and acid resistance for ordinary concrete with the replacement of cement with Rick Husk Ash.

Materials

Cement

Ordinary Portland Cement (OPC) 43 grade confirming to IS-8112 was used through out the work. The specific gravity was 3.01 and the fineness was 2400cm^2 /gm.

Coarse Aggregate

Crushed granite obtained from a local source was used as coarse aggregate. The specific gravity was 2.84.

Fine Aggregate

River sand was used as fine aggregate. The specific gravity was 2.68.

Rice Husk Ash

Rice husk used was obtained from a local rice mill. The rice husk was burnt in open fields and ground to fineness of 16000 cm^2/gm (Blaine's).

Discussion of Test Results

The results obtained from the experimental investigations are tabulated. From the results obtained the effect of Rice Husk Ash (RHA) on the strength and durability were analyzed.

Effect of rice husk ash on normal strength concrete

The strength of concrete mixes of normal strengths with and without RHA replacement are reported in table 1. It can be seen from table 1 that upto a maximum of 40% of RHA as a partial replacement for cement the strength of concrete of 1:2:4 mix has improved i.e. for mixes designated A1 to A4, beyond which there is reduction in strength. However, in case of mixes from A6 to A9 and A10 to A12, the improvement in strength with addition of RHA was observed up to 30% ash content, beyond which there was decrease. It can also be noted from the table that the workability of concrete has reduced with the addition of RHA.

Table 1 - Concrete Compressive Strength (using RHA as replacement)

Specimen	Mix	w/c	Workability (CF)	Rice husk ash %	Compressive strength (MPa)
A1	1 : 2 : 4	0.65	0.940	0	19.0
A2	1 : 2 : 4	0.65	0.935	20	22.2
A3	1 : 2 : 4	0.65	0.916	30	23.0
A4	1 : 2 : 4	0.65	0.897	40	23.8
A5	1 : 2 : 4	0.65	0.875	50	17.8
A6	1 : 1.5 : 3.0	0.55	0.943	0	28.9
A7	1 : 1.5 : 3.0	0.55	0.865	20	28.2
A8	1 : 1.5 : 3.0	0.55	0.840	30	29.0
A9	1 : 1.5 : 3.0	0.55	0.810	40	16.3
A10	1 : 1.5 : 3.0	0.50	0.920	0	29.8
A11	1 : 1.5 : 3.0	0.50	0.855	20	31.5
A12	1 : 1.5 : 3.0	0.50	0.835	30	30.2
A13	1 : 1.5 : 3.0	0.50	0.800	40	17.5

Effects of Chemicals on Rice Husk Ash Concrete

Table 2, gives the chemical resistance results of normal strength concretes subjected to 5% H_2SO_4. It can be seen that the RHA concrete are more resistant to all types of acids. It was observed from the experimentation that RHA has significant resistance to H_2SO_4, where a significant improvement in resistance can be noted. The reduction in the weight loss reported in table indicates improved dimensional stability and better integrity of concrete with the addition of RHA.

Table 2 - Chemical resistance (1:2:4 / 0.65)

S. No.	Chemical	% RHA Replacement	% reduction in weight
1	5% H_2SO_4	0	14.840
2	5% H_2SO_4	20	9.058
3	5% H_2SO_4	30	6.000
4	5% H_2SO_4	40	3.650
5	5% H_2SO_4	50	2.300

Permeability Studies on RHA Concrete

Table 3 gives the permeability test result of the effect of addition of RHA in normal strength concretes. It can be clearly seen that the addition of RHA has reduced the permeability ranging from 40% to 60%. The significantly reduced ingression of aggressive agents into concrete means less damage which in turn is an improvement in the durability of concrete.

Table 3 - Co-efficient of permeability (1:2:4/0.65)

S.No.	% RHA	% reduction in permeability
1	0	—
2	10	25
3	20	40
4	30	55
5	40	59

Conclusions

There is an improvement in the strength of concrete with the addition of RHA as a replacement. The optimum dosage is around 30-40%.

The performance of concrete in terms of acid attack and permeability of concrete has been improved with the addition of RHA.

References

1. **V.M. MALHOTRA and P.K. MEHTA,** "Pozzolanic and cementitious materials" - Garden and Branch Publishers.
2. **V.M. MALHOTRA,** "Silica fume, flyash and other mineral by-products in concrete", SP-79.
3. **MEHTA P.K. and AITCIN P.C.,** "Principles Underlying Production of High Performance Concrete", Cement Concrete and Aggregates ASTM Vol. 12, No. 2, pp. 70-78.