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Study on Effects of Partial Replacement of Cement by Rice Husk ash in Preparation of Mortar

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Abstract—*This research paper analyzes the physical and chemical properties of the RICE HUSK ASH (RHA) and compares the same with the properties of ordinary Portland cement in order to partially replace it with the RHA in mortar. Ordinary Portland cement was replaced by RHA at 6 different levels (0, 5, 10, 20, 30 and 40%) in preparing the mortar cubes at a constant water cement ratio (0.405) found out at 0% replacement by normal consistency test as per Indian Standard Code. Compressive strength of the different mortar cubes were found by UTM after the curing ages of 3, 7 and 28 days. Effects of partial replacement of OPC by RHA on initial settling time and final settling time is also studied and advantages of using RHA have been discussed.*

Keywords*: Rice Husk Ash, compressive strength, mortar, cementitious material, settling time.*

1. INTRODUCTION

The construction industry is of paramount importance for any developing country such as India and cement, mortar and concrete are indispensable part of the contemporary construction industry. Mortar, in its simplest form comprises of portland cement, water and fine aggregates. The mortar derives its strength in fresh and hardened state mainly from cement. Nowadays various admixtures such as silica fume, fiber, super plasticizer are also added in the concrete and mortar to impart desirable characteristics.

But due to the high cost and environmental impacts of ordinary portland cement, need for its replacement is realized. Various research works have been carried out to find a suitable pozzolon for partially replacing cement in preparation of mortar, concrete (Adewuyi and Ola, 2005; De Sansale, 2006).
Rice husk ash (RHA) has been reported as a successful partial replacement of cement in mortar and concrete by many researchers [1-3].Rice husk is rice milling industry's waste generated during milling of paddy. This rice husk is burned at controlled temperature to be used as a fuel for power generation leaving behind Rice husk ash.

India produces about 122 tons of paddies every year and each ton of paddy produces 40kg of RHA.

With such huge quantity of RHA being generated in India, its disposal and dumping is a major area of concern. Hence there is a need as well as good potential to use RHA as a substitute of cement in making mortar and concrete.

This paper studies the physical and chemical properties of RHA and compares the same with the properties of cement to use it as a partial replacement of cement in mortar and effects on the compressive strength of the mortar.

2. LITERATURE REVIEW

Obilade and IO (2014) investigated the properties of RHA when used as a partial replacement of OPC in concrete and concluded that the compacting factor decreased as the percentage replacement of OPC with RHA is increased they also got result showing that bulk density reduces as percentages RHA increases due to increase in voids in the concrete cubes.

Makarand et al (2014) investigated the suitability of RHA as a pozzolanic material and concluded that (M0 + 20% RHA) is the best combination among the all mixes giving nearly equal compressive strength as compared to normal concrete. They also revealed that due to addition of RHA workability of concrete also increases.

Jayanti et al (2013) carried out experimental studies on characteristics of strength mortar in which RHA partially replaces OPC and observed that replacement of cement to the extent of approximately 10% by weight of cement gave the optimum result for 28 days strength.

3. EXPERIMENTAL WORK

3.1 Properties of RHA

The RHA obtained from Ganga dairy pvt. Ltd., Bihar (rice husk burned at 400^0C for 3 hours) has been used in the analysis of the physical and chemical properties of RHA .Physical and chemical properties of the RHA have been compared with the properties of cement and reported in Table: 1 and Table: 2 respectively.

The OPC used is “Jaypee” 43 grade.

3.2 Mix Design of mortar

Normal consistency was found out by vicat test performed according to IS 4031 part 4 (1988) in order to determine water cement ratio for different mixes of mortar and are reported in Table: 3, However water cement ratio of mix (100% cement + 0% RHA) is taken constant in preparing different mixes of mortar in order to determine the effects of RHA.

3.3 Initial and Final settling time

To obtain the time dependent workability of cementitious material, initial settling time and final settling time test was performed as per IS code 4031 part 5(1988) and the results are reported in Table: 4.

3.4 Mix Proportions

The test specimen were prepared as per IS 4031 part 4 (1988). Cement taken is 43 grade OPC and sand taken is conforming to IS 650 (1966) and IS 10080 (1982). Proportions for different mixes have been reported in Table: 5.

Table 1: Physical properties of RHA

S. No.	Particulars	Properties	Method of Test
1	Particle retained on 45 micron IS sieve in%	25%	IS:1727:1967
2	Bulk density	0.0965g/cc	IS:2720(part 8):1982
3	Water content	5.26%	IS:2720(part 2):1982

Table 2: Chemical properties of RHA

S. No.	Particulars	RHA	Cement	Method of Test
1	SiO2(Impure) Pure	82% 78%	21%	IS:1727:1967
2	Al2O3	1.02%	6%	IS:1727:1967
3	Fe2O3	0.15%	3.5%	IS:1727:1967
4	CaO	1.0%	65%	IS:1727:1967
5	Loss on Ignition	0.3%	4%	IS:1727:1967

Table 3: Water cement ratio of different mixes

RHA(%)	%Water	Water(ml)	Cement(g),RHA(g)	Water Cement Ratio
0	28.5	114	400,0	0.405
5	35	140	380,20	0.47
10	40	160	360,40	0.52
20	63.5	254	320,80	0.755
30	85	340	280,120	0.97
40	-	-	240,160	-

Table 4: Initial and Final Settling Time

S. No.	RHA (0%)	Initial Settling Time (min)	Final Settling Time (min)
1	0	95	160
2	5	110	180
3	10	130	205
4	20	155	240
5	30	180	280
6	40	200	330

Table 5: Mix Proportions

RHA (%)	RHA (gm)	Cement (gm)	Sand (gm)	Quantity of water (ml)
0	0	200	600	81
5	20	180	600	81
10	40	160	600	81
20	80	120	600	81
30	120	80	600	81
40	160	40	600	81

4. RESULTS AND DISCUSSION

The result of the compressive strength of the mortar cubes show that the compressive strengths reduced over all as the percentage RHA is increased. It can be seen from Table: 6 that the compressive strength of cubes reduced linearly up to 20% RHA and falls sharply at 30% and 40% RHA. Hence the mix with 20% RHA is the best mix combination amongst all the mixes investigated.

Table 6: Test result of compressive strength on mortar cubes for different mixes

S. No.	RHA (%)	3 Days(N/mm2)	7 Days(N/mm2)	28 Days(N/mm2)
1	0	23.5	25	41.6
2	10	21.2	23.6	39.4
3	20	19.3	20.8	37.2
4	30	12.4	14.5	26.2
5	40	6.2	7.8	13.4

5. CONCLUSIONS

From the investigations carried out, following conclusions can be made:

1) RHA can be used as a partial replacement of cement successfully in mortar/concrete in the range of 0–20% by which the cost of mortar/concrete can be reduced considerably as RHA is an agro waste.
2) Bulk density of the mortar/concrete also reduces as a result of partially replacing cement by RHA, eventually reducing the dead load on the structure and saving the cost of construction material.

3) Addition of Rice husk ash increases the plasticity and workability of the mortar/concrete.
4) Addition of rice husk ash increases the impermeability characteristics of the mortar/concrete and can be used in flooring, outside surfaces of the non- load bearing wall (Further tests are recommended).

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