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Effect of Partial Replacement of Cement by Rice Husk Ash and Fine Aggregate by Waste Glass

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Abstract :- This paper summarizes the experimental studies on strength characteristics of concrete in which Rice Husk Ash (RHA) is used as partial replacement of ordinary Portland cement (OPC) and fine aggregate by waste glass. Concrete pastes were proportioned with varying dosages of RHA as partial replacement of OPC at 0%, 2.5%, 5%, 7.5%, 10% and 12.5% by weight of cement. The compressive strength test was carried out on hardened 150 mm concrete cubes after 7, 14 and 28 days curing in water. The results revealed that the compressive strength of the hardened concrete decreased with increasing OPC replacement with RHA. A further study was carried out by replacing fine aggregate by waste glass at 10%, 20%, 30%, 40% and 50% with 10% RHA as partial replacement of OPC. It was observed that the compressive strength of the hardened concrete is increased up to 30% and beyond that it is decreasing.

Keywords :- Rice Husk Ash, waste glass, partial replacement, compressive strength

I. INTRODUCTION

Rice milling industry generates a lot of rice husk during milling of paddy which comes from the fields. This rice husk is mostly used as a fuel in the boilers for processing of paddy. Rice husk is also used as a fuel for power generation. Rice husk ash (RHA) is about 25% by weight of rice husk when burnt in boilers. It is estimated that about 70 million tons of RHA is produced annually worldwide. This RHA is a great environment threat causing damage to the land and the surrounding area in which it is dumped. India is a major rice producing country, and the husk generated during milling is mostly used as a fuel in the boilers for processing paddy, producing energy through direct combustion and / or by gasification. About 20 million tones of RHA are produced annually. Lots of ways are being thought of for disposing them by making commercial use of this RHA. Rice husk ash produced after burning of Rice husks (RH) has high reactivity and pozzolanic property. Indian Standard code of practice for plain and reinforced concrete, IS 456- 2000, recommends use of RHA in concrete but does not specify quantities.

The most widely used fine aggregate for the making of concrete is the natural sand mined from the riverbeds. However the availability of river sand for the preparation of concrete is becoming scarce due to the excessive nonscientific methods of mining from the riverbeds, lowering of water table, sinking of the bridge piers, etc. are becoming common treats. The present scenario demands identification of substitute materials for the river sand for making concrete. The amount of waste glass produced has gradually increased over the recent years due to an ever growing use of glass products. Most waste glass has and is being dumped into landfill sites. The land filling of waste glass is undesirable because waste glass is non biodegradable which makes them environmentally less friendly. If fine aggregate is replaced by waste glass by specific percentage and in specific size range, it will decrease fine aggregate content and thereby reducing the ill effects of river dredging and thus making concrete manufacturing industry sustainable.

II. LITERATURE REVIEW

The RHA used by Ghassan Abood Habeeb [1] for their study is efficient as a pozzolanic material; it is rich in amorphous silica (88.32%). The loss on ignition was relatively high (5.81%). Increasing RHA fineness increases its reactivity. The compressive strength of the blended concrete with 10% RHA has been increased

significantly, and for up to 20% replacement could be valuably replaced by cement without adversely affecting the strength. Increasing RHA fineness enhances the strength of blended concrete.

Sathawane [2] reported that compressive strength increases by 30.15% in compared with targeted strength and reduces by 8.73% compared with control concrete at 28 days, flexural strength increases by 4.57% compared with control concrete at 28 days, split tensile strength decreases by 9.58% compared with control concrete at 28 days, were obtained at combination of 22.5% FA and 7.5% RHA. Partial replacement of FA and RHA reduces the environmental effects, produces economical and eco-friendly concrete.

Kartini, K., Nurul Nazierah [3] reported that 10% replacement of cement with RHA was found to be the optimum replacement in achieving the targeted strength, however, for durability index performance, higher replacement level (up to 50%) can be achieved, resulted in decreased in charge passed and decreased in water absorption, therefore, improved the durability performance of the concrete. These shows that high amount of silica in RHA gave some effects on the strength and durability of the HSC.

Maurice E. Ephraim [4] found the specific gravity of RHA to be 1.55, the density of RHA concrete was found to be 2.043, 1.912 and 1.932kg/m^3 at 10%, 20% and 25% replacement percentages respectively. RHA concrete was found to be very workable with a slump value of over 100mm. The incorporation of RHA in concrete resulted in increase water demand and enhanced strength. The compressive strength values at 28days were found to be 38.4, 36.5 and 33N/mm^2 at the same replacement percentages above. These compressive strength values compared favorably with the controlled concrete strength of 37N/mm^2 at a mix ratio of 1:1.5:3.

S. I. Khassaf [5] obtained results indicated that it was a significant reduction of workability in fresh concrete with the increase amount of RHA content in concrete, and it was an increase in the compressive strength and splitting tensile strength by increased of RHA% until 20% , The maximum increment is around 10.5%and 11% for the compressive strength and splitting tensile strength respectively then it were decrease with the increase of RHA to 30%, the decrease was around 17 % and 10.5% for compressive strength and tensile splitting strength respectively. The test of drying shrinkage indicated that it was decreased with increased of RHA%, the maximum decreased given by 30% RHA it was about 28% of normal concrete shrinkage after 90 days age.

S.P. Gautam [6] observed that on replacing fine aggregate by 20% glass waste on average there is an increase in compressive strength at 7 d by 13.64% however, at 28 d; increase in compressive strength is 2.18%. It is seen that there is an increase in compressive strength at 7 d by about 11.32% whereas at 28 d compressive strength is decreased marginally at 30 and 40% replacement level.

T. Phani Madhavi [7] proposed the use fly ash as cement replacement material and glass aggregate as fine aggregate material partially in concrete. Natural sand was partially replaced (10% 20% 30%) with sheet glass aggregate and cement was partially replaced (10% 20% 30%) with fly ash. The maximum compressive strength obtained for 28 days is 43.73 N/mm^2 with the replacement of 10% of Cement by fly ash and 20% of fine aggregate by glass aggregate which was the economical and an ideal mix.

Sadoon Abdallah, Mizi Fan found that compressive strength of the concrete with partial replacement of sand by finely crushed waste glass increased with the increment ratio of waste glass, especially at the later ages, with compressive strength at 28 days being 5.28% higher compressive strength for 20% replacement compared to controlled concrete, which also indicated the contribution of pozzolanic reaction.

III. MATERIALS AND EXPERIMENTAL METHODOLOGY

In the present work, various materials like Rice husk ash, Cement, Coarse aggregate, Fine aggregate, Water were used. It was found that specific gravity, initial setting time , final setting time for RHA was 2.22 , 195 mins. and 265 min respectively. From the experimental results it was found that the specific gravity, Initial setting time, Final setting time of cement was 3.145, 175 min and 270 min., respectively

In this study the concrete cubes are prepared with w/c ratio as 0.5 and grade of concrete M20. In order to study the effect of RHA as partial cement replacement on the strength of concrete 54 cubes of size 150 mm were cast with 0%, 2.5%, 5%, 7.5%, 10% and 12.5% RHA as cement replacement. Further the 45 cubes were cast with 10% RHA and different partial fine aggregate replacement with waste glass 10%, 20%, 30%, 40% and 50% The samples were demoulded after 24 hours and kept in a curing tank for 7, 14 and 28 days as required.

Table 1:- Mix proportion for partial replacement cement with RHA

Mix Proportion	RHA (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Cement (kg)
0	0	20.50	40.50	13.5
2.5	0.342	20.50	40.50	13.158
5	0.675	20.50	40.50	12.825
7.5	1.017	20.50	40.50	12.483
10	1.350	20.50	40.50	12.150
12.5	1.692	20.50	40.50	11.808

Table 2:- Mix proportion for partial replacement cement with 10% RHA and fine aggregate with waste glass

Mix proportion	RHA (kg)	Coarse Aggregate (kg)	Fine Aggregate (kg)	Glass (kg)	Cement (kg)
10%	1.350	40.50	18.225	2.025	12.150
20%	1.350	40.50	16.200	4.050	12.150
30%	1.350	40.50	14.175	6.075	12.150
40%	1.350	40.50	12.150	8.100	12.150
50%	1.350	40.50	10.125	10.125	12.150

Compressive Strength Test:

The steel mould of size 150x150x150 mm is well tightened and oiled thoroughly. The fresh mixed concrete is placed and well compacted through mechanical vibrators and after 24 hours they were allowed for curing in a period of 3, 7, 28 days and they were tested. After the curing period the specimen is taken out from the curing tank and wipes it clean. The dimensions of the specimens and the weight of the specimens were noted down with accuracy. Then the specimen is placed between the loading the surface of the CTM and the load is applied till the specimen fails. The ultimate load at the time of failure is noted down. The load was applied at the rate of 140 kg/cm2/min till the cube breaks.

IV. RESULTS AND DISCUSSIONS

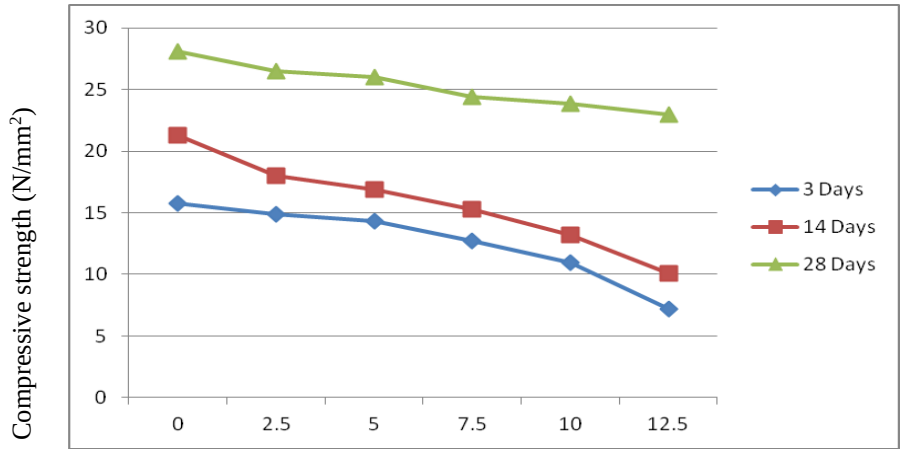
The compression test was performed as per Indian Standard specifications. From the test the average stresses values taken accordingly. The test results are shown in table 3 and table 4. Based on the test results obtained from the compressive strength test on 3days, 7days, and 28days, the graph between percentage replacement Vs Compressive strength was shown in Fig.1, and Fig. 2 respectively.

Table 3: Compressive strength test

S.No.	Partial replacement of cement with RHA (%)	Compressive Strength (N/mm^2)		
		3 Days	7 Days	28 Days
1	0	15.79	21.32	28.12
2	2.5	14.88	18.04	26.48
3	5	14.32	16.90	26.02
4	7.5	12.73	15.27	24.4
5	10	10.98	13.20	23.87
6	12.5	7.17	10.04	22.98

Table 4: Compressive strength test

S.No.	Partial replacement of cement with RHA (%)	Partial replacement of fine aggregate with waste glass (%)	Compressive Strength (N/mm^2)		
			3 Days	7 Days	28 Days
1	10	10	10.81	13.26	22.73
2	10	20	11.02	13.84	23.06
3	10	30	13.87	19.84	25.71
4	10	40	10.43	16.54	22.31
5	10	50	8.90	12.22	19.69



Partial replacement of cement with RHA

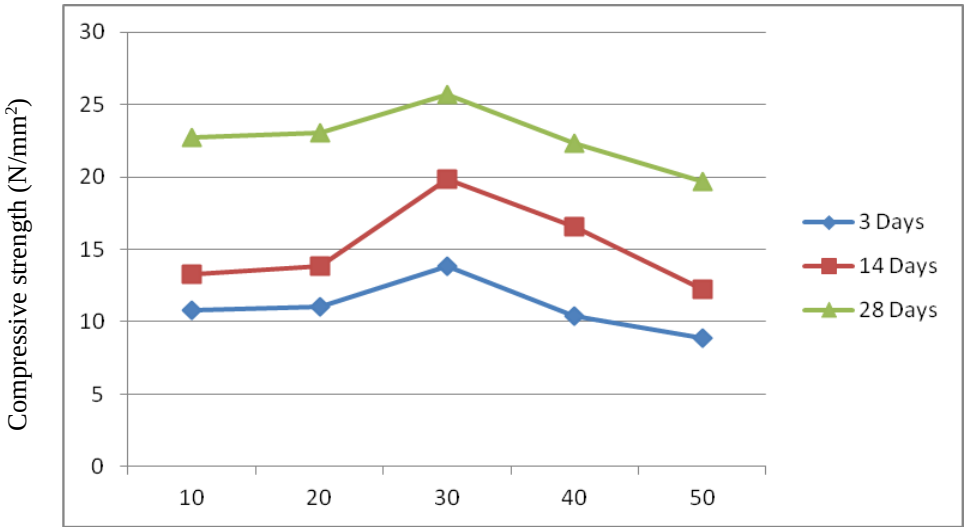


Fig.2 : Effect of partial replacement of cement with RHA and fine aggregate with waste glass on compressive strength of concrete

It is observed that on partial replacement cement with RHA there is a decrease in the compressive strength of concrete. If the cement is replaced with 10% RHA and fine aggregate with varying percentage of waste glass the compressive strength of concrete is increased up to 30% and beyond that it is decreasing.

V. CONCLUSIONS

- Compressive strength of concrete is gradually decreased when the cement is partially replaced with RHA.With a percent increase in cement by RHA there is decrease in gain of early strength with time in concrete.
- For the partial replacement of fine aggregate by waste glass and cement by 10% RHA the value of compressive strength is increased up to 30% and beyond that it is decreased.
- The optimum value of compressive strength of concrete is achieved at 30% replacement of fine aggregate by glass with 10% partial replacement of cement by RHA.
- With a percent increase in fine aggregate with waste glass with 10% RHA there was increase in gain in early strength of concrete up to 30% and then it was decreased.
- It was found that even by replacing cement with RHA up to 12.5 % and sand with glass up to 40 %, the strength is more than conventional concrete.

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