ASSESSMENT OF USE OF RICE HUSK ASH IN SELF CONSOLIDATING CONCRETE

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ABSTRACT

The main objective of this study is to investigate the utilization potential of Rice Husk Ash(RHA) in self-consolidating concrete (SCC). The effect of Ordinary Portland Cement (OPC) partial substitution with RHA on the mechanical properties such as workability, compressive strength, and flexural strength of the SCC were investigated. RHA which is an Agricultural Waste and is used because of its super pozzolanic properties is used for production of SCC. The tests were conducted to find the optimal mix design for best compressive strength. Further investigations were carried out to determine the flexural properties of SCC to obtain the moduli of rupture and tensile strength. The values obtained from the investigations are 7.56 MPa, 9.82 MPa and 6.57 MPa for tensile strength for 5 %, 10 %and 15 % respectively.The tests are conducted to determine the strength characteristics of the SCC, when cement partially substituted in different proportions of RHA. The preliminary results of research based on partial replacement of cement with RHA in SCC and its effectiveness in analysedand computed.

Keywords: Ordinary Portland Cement (OPC), Selfconsolidating Concrete(SCC), Rice husk ash(RHA)

I. INTRODUCTION

India being an Agriculture based economy, produces a considerable amount of by-products such as rice husk. In this world fighting with the enemies like global warming and shortage of natural construction materials, we are entitled to find alternatives which minimise the environment degradation as well as provide comparable output to the traditional materials. We performed experimentations to determine and evaluate the effectiveness ofusingRHA in production of (SCC). As RHA is produced in huge quantities at power plants across the country, it is readily available and lowers down the pressure on cement industry because it can be used as apartial replacement to cement.Moreover it reduces the greenhouse gases produced during the production of Cement and as well reduces the need to dump the Rice husk Ash generated.

Self-consolidating concrete (SCC) is concrete that is characterised by low yield stress, high deformity and moderate viscosity that is just sufficient to ensure the suspension of the solid particles during transportation, placement and until the concrete hardens. Because of its flow ability it shows remarkable results in heavily reinforced structural members.

RHA is obtained on burning an Agro-waste, Rice Husk under controlled temperature condition with temperature below 800 ºC, the process reduces the Rice Husk into ash which is nearly 25% by weight. It is a super pozzolanic material because of the presence of silica (85% to 90%) and alumina (5%). pozzolanic material can be defined as siliceous or siliceous &alumina substance, having very less or absolutely nocementious property but possessing cementite properties, when present in fine particle form in presence ofmoisture react with calcium hydroxide at room temperature.

We have focussed our experimentation on mechanical properties like workability, compressive and flexural strengths of SCCto determine viability of RHAsubstitution.

II. MATERIAL

2.1 Rice Husk Ash (RHA)

Rice Husk which is burnt for 36hrs(approx) under uncontrolled burning in the an open area. The temperature being in the range of 450- 550degree Celsius. The ash sogenerated was sieved by a sieve of size 75µm(BS standard sieve) and the RHA hence collected was of grey colour. Batching for the same is done by volume method.

2.2 Cement

Ordinary Portland cement (OPC) grade 43 is being used.(accordance IS 8112:2013

2.3 Aggregates

The aggregate used is such that it passes through 16mm sieve and is retained on10mm sieve. The Percentage water absorbed when dipped in water for 24hours was 0.75 % by weight which is in compliance with IS 2386 – Part 3: 1963. Proper Inspection was carried to ensure absence of deleterious materials in aggregate used.

2.4 Water

The water used was tap water and was free from any kind of contaminants such as oils, acids, salts, sugars or organic materials. The water had a pH of 8.

2.5 Super Plasticizer

The super plasticizer used is SS-PLAST-PC-100.SS-PLAST -PC-100 is new generation super plasticizer for long retention. It is formulated with synthetic polymers with High Molecular weight poly carboxylate and organic polymers. SS-PLAST-PC-100 conforms to IS: 9103-1999, IS: 2645-1975 and ASTM C-494 type F & G

Table 1: Technical Properties of Super Plasticizer

Colour	**Light Yellowish**
Form	Viscous Liquid
Specific Gravity/ Density	1.10±0.02
Chloride	Nil
pH	6 to 7
Air Entertainment	Max. 1.5% of control as per IS 9103: 1999
Water Reduction	More than 35%

Table 2: Chemical and Physical Properties of RHA (Wt %)

Chemical properties of RHA

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O_3	K_2O	LOI	Reference
92.5a	1.2	2.1	0.9	0.4	0.1	2.0	0	0.9	
88.5b	1.1	2	0.9	0.4	0.1	2.6	0	0.9	[1]
87.32	0.22	0.28	0.48	0.28	-	1.02	3.14	2.1	[2]
87.6	0.68	0.93	1.3	0.35	-	0.12	2.37	-	[3]
93.2	0.4	0.1	1.1	0.1	0.9	0.1	1.3	3.7	[4]
80	3.93	0.41	3.82	0.25	0.78	0.67	1.45	8.65	[5]
87.2	0.15	0.16	0.55	0.35	0.32	1.12	3.6	6.55	[6]

Chemical Properties of OPC

20.25	5.04	3.16	63.61	4.56	-	0.08	0.51	3.12	[2]
21.89	5.3	3.34	53.27	6.45	3.67	0.18	0.98	3.21	[3]
20.9	4.8	3.4	65.4	1.3	2.7	0.2	0.4	0.9	[4]

Physical properties of RHA

Material specific gravity(gm/cm^3)	Mean particle size (Um)	Blaine's Fineness	References
2.3a, 2.27b	-	4750(cm^2/gm), 5750(cm^2/gm)	[1]
2.06	2.5	36.47(m^2/kg)	[2]
2.23	10.00	11200(cm^2/gm)	[4]
2.11	-	-	[5]
2.06	8	28800(m^2/kg) nitrogen absorption	[6]
3.11	-	3250(cm^2/gm)	[1]
3.14	14.6	-	[7]
3.14	15	3600(cm^2/gm)	[8]
3.1	22.5	326(m^2/kg)	[2]

a,b – RHA obtained from electric power station and rice mill respectively

III. METHODOLOGY

SCC is a concrete consisting of cement, aggregate, water and chemical admixtures. It is essential that the material remains in suspension and uniformly distributed throughout the process of handling, placing and until setting.

The following tests were carried to determine the workability:

3.1 Slump Flow and T500 Test

Slump flow test and T500 time as the test performed to determine the flow ability and the flow rate of SCC, when it is allowed to flow freely without any obstructions. The tests performed were in compliance with the procedure described in EN 12350-2[9]. The slump flow results depict the filling ability of SCC, T500 is the speed of flow and hence help to determine the viscosity of SCC.

3.2 V- Funnel Test

The V- Funnel testis used to determine the filling ability and viscosity of SCC. The test is performed in accordance to EN 12350-1[9].

3.3 L-Box Test

The L-Box test is being used to determine the passing ability of SCC, the passing ability plays a major role in movement of concrete through narrow opening including the space between reinforcement bars, without blocking and requiring vibrations. The test was performed on three bar apparatus. The three bar apparatus is used when the structure is heavily reinforced. The test was performed in accordance with EN 12350-1[9].

IV. RESULTS AND DISCUSSION

The experimental results for RHA, cement, and cement SCC is determined and listed below:

4.1 Rice Husk Ash

The following values were obtained after performing experiments as per Indian Standard codes

- Normal Consistency = 19%
- Initial Setting time = 200 minutes
- Final setting time = 290 minutes
- Compressive strength = 11N/mm^2
- Specific gravity = 2.09

4.2 Ordinary Portland Cement

- Normal Consistency = 24 %
- Initial setting time = 30 minutes
- Final setting time = 10 hours
- Specific Gravity = 3.1

4.3 Fresh Self-Consolidating Concrete

The following tests were performed to determine the workability of fresh concrete and hence average value are listed below:

Slump Flow test -693mm

V Funnel Test -2.8s

L box Test-0.8

V. MIX PROPORTIONING

The mix proportioning is done in compliance to EFNARC and Indian standard recommendations in IS 10262-1982. The mean target strength was 31.6 N/mm^2 for the Mix proportion. The total binder material was 316.36 kg/m^3, fine aggregate was taken to be 903kg/m^3 and coarse aggregate was taken 739 kg/m^3, the water binder ratio was kept 0.45. The super plasticiser content was kept 1.5% of the total cementing material. The mixing was carried out in a pan mixer for 5 minutes, then the moulds were filled and kept for 24 hours before de-moulding. The moulds were kept in curing tank until the day of testing. The moisture content and water absorption of the aggregate and Rice husk ash were taken into consideration and hence the accordingly. The cubes were kept in curing tank for 7, 28 and 48 days. The cement was replaced in percentages of 0,5,10,15,20,25 and 30 with RHA and 150x150x150mm cubes were used for casting. The compaction was provided in three layers with 25 number of blows water content corrections were applied.

VI. TEST METHODS

The compressive strength testing of cubes is done according to the IS 516– 1959.

Table 3: Workability test Values

Mix			Workability		
S no.	Cement (%)	Rice Husk Ash (%)	Slump Test	L- Box Test P_L	V- Funnel Test
1	100	0	695	0.61	2.2
2	95	5	663	0.66	2.8
3	90	10	694	0.64	2.2
4	85	15	657	0.666	2.8
5	80	20	673	0.67	2.7
6	75	25	701	0.65	2.1
7	70	30	695	0.71	2.8

Table 4: Compressive strength results

Mix			Strength after curing in Days in N/mm²			
S no.	Cement (%)	Rice Husk Ash (%)	7 Days	28 Days	48 Days	Tensile Strength
1	100	0	18.11	24.65	30.96	7.56
2	95	5	16.67	30.82	30.821	9.82
3	90	10	18.26	19.78	24.04	6.57
4	85	15	19.47	23.43	27.09	4.43
5	80	20	17.43	21	23.13	3.75
6	75	25	16.13	17.35	21.06	3.75
7	70	30	12.55	14	17.65	2.46

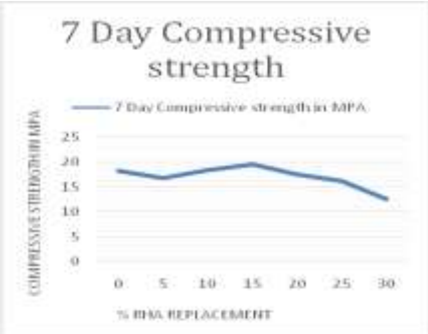

Figure 1: Compressive Strength 7 Day

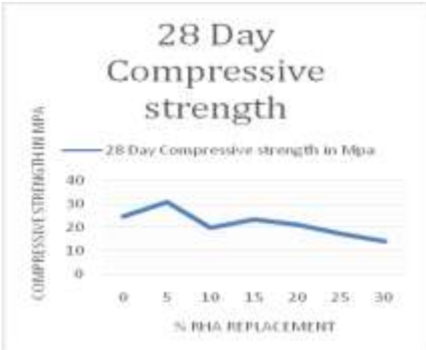

Figure 2: Compressive Strength 28 Day

Figure 3: Compressive Strength 48 Day

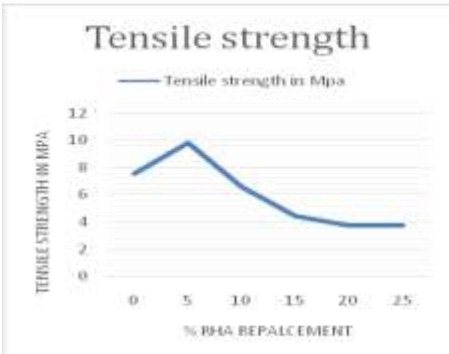

Figure 4: Tensile Strength with different mix Proportion

VII. CONCLUSIONS

Based upon the experimentation results above, the following conclusions are made:-

1) Water cement ratio is increased with addition of RHA as RHA is a highly porous material.
2) With increase in replacement of RHA, the workability of SCC decreases.
3) RHA being rich in silica is preferred over silica fumes to increase the strength.
4) RHA particles being very fine, it is harmful for human being, but the cost of RHA is zero. Thus we prefer RHA over silica fumes.
5) The compressive strength increases with an increase in percentage of RHA up to 5% of cement in SCC.
6) RHA SCC workability can be increased with use of chemical admixtures such as plasticiser, super plasticiser.
7) Due to high specific surface area of the RHA, the content of super-plasticiser was increased in Design mix [1].
8) RHA addition in the concrete evidently reduces the weight of SCC after 90 Days of moist curing.

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