Structural Behaviour of Concrete with Rice Husk Ash

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Abstract

Rice husk is an agro-waste material which is available in many parts of India and is produced about 100 million of tones. Rice husk ash (RHA) is obtained by the combustion of Rice husk. The most important property of RHA is that determines pozzolanic activity and is suitable for use in time pozzolana mix and for Portland cement replacement.

The paper presents the effect of Rice Husk Ash on the structural behavior (e.g. compressive strength, Flexure strength, Tensile strength) of concrete. For which Concrete mixes were prepared by taking as R.H.A. 5%, 10%, 15% of weight of cement.

KEY WORDS: - *Rice husk ash, compressive strength, flexural strength, Tensile strength.*

INTRODUCTION

India is a major rice producing country Rice milling generates a by product known as rice husk. This surrounds the paddy grain. During the milling of paddy about 78% of the weight is received as rice. Rest of 22% weight of paddy is received as husk. So, for every 1000 kgs of paddy milled, about 220 kgs (22%) of husk is produced and when this husk is burnt is the boilers, about 55kg RHA is generated. RHA is a good super-pozzolana. The product obtained from RHA is identified by trade name silpozz.

Properties (R.H.A.)

Rice Husk Ash is a Pozzolanic material. It is having different physical & chemical properties which are given in table 1 & 2, RHA is much finer than cement having very small particle of 25 microns and fills the voids between cement and aggregate which give the strength and density of the concrete. So, it can be reducing the amout of cement in the concrete mix.

The reactivity of ash is related to its surface area and that amount of amorphous silica. This ash is usually ground to finer powder it increases the compressive strength due to fineness also adding R.H.A. to the concrete even a small or low replacement will enhance the workability, strength of concrete.

Table-1 Physical Properties

Sl. No.	Particulars	Properties
1	Colour	Gary
2	Shape Texture	Irregular
3	Mineralogy	Non crystalline
4	Partical size	< 45 microns
5	Odour	Odorless
6	Sp. Gravity	2.3
7	Appearance	Very fine

Table-2 Chemical Properties

Sl. No.	Particulars	Properties
1	Silicon dioxide	86.94%
2	Aluminum oxide	0.2%
3	Iron oxide	0.1%
4	Calcium Oxide	0.3 – 2.2%
5	Magnesium Oxide	0.2 – 0.6%
6	Sodium oxide	0.1 – 0.8%
7	Potassium oxide	2.15 – 2.30%
8	Ignition loss	3.15 – 4.4%

EXPERIMENTAL DETAILS

Concrete mix (M20) was prepared with coarse aggregate (passing through 12.5 mm sieve), Fine aggregate (Passing through 4.75 mm sieve), cement (confirming to I.S. specifications) and water cement ratio of 0.491 and mix proportion 1:1.486:3.05 were adopted for the investigation with or without R.H.A.

Concrete beams, of size 100mm x 100mm x 500 mm concrete cubes 150mm x 150mm x 150 mm, concrete cylinders of diameter 150 mm and length 300mm. were cast with 3 different % of R.H.A (5%,10%,15%) of without R.H.A. After setting the specimens were emerged for curing for 28 days, after 28 days specimen was removed from water surface, dried before testing.

A) Compressive Strength

1) Rice husk ash (0%) (Control mix) Concrete mix proportion: -

Water	:	Cement	: Rice Husk	: Fine Aggregate	: Coarse Aggregate
0.49		1	0	1.486	3.05

Table-3 for R_0 (0%)

Sl. No.	Age in days	Crushing Strength (Mpa)	Avg. crushing Strength (Mpa)
1	3	7.77	8.14
2	3	8.44	
3	3	8.22	
4	7	13.78	14.45
5	7	14.89	
6	7	14.67	
7	28	20.44	22.22
8	28	22.67	
9	28	21.77	

Table-4 for R_1 (5%)

Sl. No.	Age in days	Crushing Strength (Mpa)	Avg. crushing Strength (Mpa)
1	3	8.93	9.57
2	3	9.79	
3	3	10.00	
4	7	16.88	16.34
5	7	16.00	
6	7	16.14	
7	28	26.22	26.47
8	28	26.22	
9	28	25.88	

Table-5 for R_2 (10%)

Sl. No.	Age in days	Crushing Strength (Mpa)	Avg. crushing Strength (Mpa)
1	3	10.22	10.58
2	3	10.66	
3	3	10.88	
4	7	18.66	19.10
5	7	19.11	
6	7	19.55	
7	28	29.77	30.15
8	28	30.08	
9	28	30.67	

Table-6 for R3 (15%)

Sl. No.	Age in days	Crushing Strength (Mpa)	Avg. crushing Strength (Mpa)
1	3	9.33	9.47
2	3	10.66	
3	3	8.44	
4	7	16.88	16.73
5	7	17.33	
6	7	16.00	
7	28	27.11	27.48
8	28	27.33	
9	28	28.00	

B) Flexural Strength of Concrete

Modulus of rupture is the extreme fibre stress calculated at the failure of specimen beams tested dry usually yield lower flexural strengths than those in weight conditions.

Table No 7 and 8: - for flexural strength of concrete added with rice husk ash: -

1) Rice husk ash (0%) (Control mix)

Table -7 for 7 days

Sl. No.	RHA Replacement (%)	Weight of Beam (Kg.)	Max^m load applied (Kg.)	Modulus of rupture (Mpa)	Average Modulus of rupture (Mpa)
01	0.00	13.21	1150	4.51	4.89
02	0.00	13.14	1280	5.06	
03	0.00	13.22	1300	5.10	
04	5.00	12.21	1325	5.15	5.10
05	5.00	13.14	1280	5.06	
06	5.00	12.84	1300	5.10	
07	10.00	13.18	1340	5.23	5.13
08	10.00	13.14	1280	5.06	
09	10.00	12.84	1300	5.10	
10	15.00	12.44	1080	4.15	4.26
11	15.00	12.81	1100	4.32	
12	15.00	12.81	1100	4.32	

Table -8 for 28 days

Sl. No.	RHA Replacement (%)	Weight of Beam (Kg.)	Max^{m} load applied (Kg.)	Modulus of rupture (Mpa)	Average Modulus of rupture (Mpa)
01	0.00	12.92	1150	4.51	5.25
02	0.00	12.910	1460	5.75	
03	0.00	12.960	1410	5.54	
04	5.00	12.760	1360	5.22	5.40
05	5.00	12.840	1390	5.45	
06	5.00	12.960	1410	5.54	
07	10.00	12.960	1500	5.85	5.75
08	10.00	13.100	1520	5.88	
09	10.00	12.960	1410	5.54	
10	15.00	12.650	1410	5.54	5.60
11	15.00	12.850	1460	5.72	
12	15.00	12.960	1410	5.54	

C) Split tensile strength of the concrete

Split tensile strength of the specimen is calculated by using below formula = 2P/ π DL
Were,

P = Compressive load applied on cylinder
L = Length of cylinder
D = Diameter of cylinder

Table -9 for 07 days

Sl. No.	RHA Replacement (%)	Weight of Beam (Kg.)	Max^{m} load applied (Kg.)	Modulus of rupture (Mpa)	Average Modulus of rupture (Mpa)
01	0.00	13.480	215	3.04	3.02
02	0.00	13.460	210	2.97	
03	0.00	13.220	215	3.04	
04	5.00	13.480	175	2.47	2.44
05	5.00	13.460	170	2.40	
06	5.00	13.420	175	2.47	
07	10.00	13.180	175	2.47	2.40
08	10.00	13.140	170	2.40	
09	10.00	13.240	165	2.33	
10	15.00	13.460	160	2.26	2.23
11	15.00	13.430	160	2.26	
12	15.00	13.240	165	2.19	

Table -10 for 28 days

Sl. No.	RHA Replacement (%)	Weight of Beam (Kg.)	Max^{m} load applied (Kg.)	Modulus of rupture (Mpa)	Average Modulus of rupture (Mpa)
01	0.00	13.240	240	3.40	3.44
02	0.00	13.480	240	3.40	
03	0.00	13.560	250	3.53	
04	5.00	13.560	240	3.40	3.42
05	5.00	13.460	245	3.46	
06	5.00	13.100	245	3.46	
07	10.00	13.260	230	3.25	3.29
08	10.00	13.460	235	3.32	
09	10.00	13.160	235	3.32	
10	15.00	13.420	220	3.11	3.04
11	15.00	13.440	210	2.97	
12	15.00	13.120	215	3.04	

CONCLUSION

From the Table it is clear that

1) By 10% replacement of RHA with cement compressive strength of concrete at 3-days increase by 23%, For 7 days increases by 24.34% and for 28- days increase by 26.30%
2) By 10% replacement of RHA with cement net amount of Rs. 50/- ca be saved for $1m^3$ of concrete.
3) In high rise structures we can improve pumpability by adding super plasticizers to increase workability.
4) RHA type admixtures can by used in low-cost structures, light structures as well as in thermal power plant also.
5) The introduction of RHA to HSC market has provided an alternative to use of silica fume. Equivalence in strength development and durability properties features of RHA has effectively expanded the design boundaries of concrete materials.

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