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Investigation of Strength of Concrete Containing Locally Available Industrial and Agriculture Waste

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Abstract: ***This paper presents the experimental study undertaken to investigate the influence of partial replacement of cement with Fly Ash (FA), Rice Husk Ash (RHA) and Sand with Stone Dust (SD). Fly ash is a by-product of burned coal from power station, stone dust is a by-product of crushed aggregate and rice husk ash is a by –product of burned rice husk at higher temperature from paper plant and other industries. Waste disposal is an important issue in the present time and utilization of Industrial waste Fly Ash, Stone Dust and Agricultural waste -Rice Husk Ash in concrete making is being researched. Considerable efforts are being taken worldwide to utilize natural waste and by –product as additional cementing materials to improve the properties of cement concrete. Stone Dust (SD), Rice Husk Ash (RHA) and Fly Ash (FA) are such materials. This study is carried out by keeping 20% replacement of cement by FA in all the mixes and then replacing cement and sand by RHA and SD respectively by different percentages. This study shows that 10% RHA+20% FA and 30% SD in concrete gives maximum strength.***

Keywords: Concrete, Compressive Strength, Fly Ash, Rice husk Ash and Stone dust.

1. Introduction

Concrete is well known as a heterogeneous mix of cement, water and aggregates. The characteristic of the concrete is determined by quality of the paste. Various materials are added such as fly ash, rice husk, stone dust to obtain concrete of desired property. The investigation is done to study the effect of partial replacement of cement with RHA, FA and sand with SD. The compressive test done for concrete cube size (150 x 150 x 150) mm.

(Kumar Sushil, 1992) represented that only small percentage that is 3% to 5% of fly ash is being used in India while in other countries the percentage of utilization is 30% to 80%, whatever be the type of fly ash, it causes types of pollution and air born diseases such as silicoses, fibrosis of lungs, bronchitis etc. As per the estimation of Government of India, power plants are going to use 1800 million tons of coal that may result 600 million tons of fly ash by 2031-2032 (Ujjwal Bhattachar, 2002). Author also enlightened the areas in which fly ash usage has potential in India. He pointed out that despite quite optimistic levels of utilization of fly ash in India; only less than 25% of the total fly ash produced is being utilized. (Chandrasekhar, 2006) rice husk is an agricultural residue which accounts for 20% of the 649.7 million tons of rice produced annually worldwide (World paddy production, 2008). The produced partially burnt husk from the milling plants when used as a fuel also contributes to pollution and efforts are being made to overcome this environmental issue by utilizing this material as a supplementary cementing material. (Dashan and Kamang, 1999) carried out an extensive work on some characteristics of Rice husk ash/ordinary Portland cement concrete. Test results indicate that the compressive strength for all the mixes containing RHA increases with age up to the 14-day hydration period but decreases to the 28-days hydration period while the conventional concrete increases steadily up to 28-day hydration period. (Nagabhusana and Bai, 2011) crushed stone powder can be effectively used to replace natural sand without reduction in the strength of concrete at replacement level up to 40%. (Pofale and Quadori, 2013) compressive strength of concrete (M25, M30) made using crusher dust increased at all the replacement level between 30-60% at an interval of 10%. However, maximum increased strength is observed at a replacement level of 40%**.** The work presented in this paper reports an investigation on the behavior of concrete produced from blending cement with FA and RHA.

2. Materials and Methods

The work presented in this paper reports an investigation on the behavior of concrete produced from blending cement with Rice Husk Ash (RHA), Fly Ash (FA), natural sand with Stone Dust (SD) and coarse aggregate. The physical and chemical properties of RHA, FA, SD and OPC were first investigated. Mixture proportioning was performed to produce high workability concrete for the control mixture. The effect of RHA, FA and SD on concrete properties was studied by means of the fresh properties of concrete and the mechanical properties. I.e. Compressive strength test was studied.

A. Cement

Table 1: Chemical properties of cement (OPC), Fly ash and Rice husk ash

Materials	SiO2	Al2O3	Fe2O3	CaO	MgO	LOI	SO3	K2O	Na2O3
Cement	19.71	5.20	3.73	62.91	2.54	0.96	2.72	0.90	0.25
Fly ash	60.20	18.45	16.20	2.00	1.02	--------	1.00	--------	---------
Rice husk	93.80	(SiO2+ Al2O3+ Fe2O3)		0.89	0.32	3.37	-----	0.12	---------
ash		=82.64							

The cement used was Ordinary Portland cement (43 Grade). OPC 43 grade cement is used for this whole experimental work. The physical test results on OPC are as follows.

1) Normal consistency = 28%
2) Initial Setting time = 47 min.
3) Final Setting Time = 405 min.
4) Specific Gravity = 3.22

B. Rice Husk Ash

Rice husk ash used was obtained from Nova. Industries, Malanpur, Gwalior .The Specific gravity of rice husk ash is 2.08 and produced after burning of Rice husk (RH) has high reactivity and pozzolonic 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. Chemical compositions of RHA are affected due to burning process and temperature. Silica content in the ash increases with higher the burning temperature.

C. Fly Ash

Fly ash used was obtained from Parichha thermal power plant, JHANSI (U.P.), INDIA. Fly ash is one of the residues generated in the combustion of coal.
Specific gravity of fly ash 1.95.

D. Aggregate

Good quality river sand was used as a fine aggregate. Coarse aggregate passing through 20mm and retained 10mm sieve.

a) Fine Aggregate
- Specific gravity = 2.57
- Fineness modulus = 3.58

b) Coarse Aggregate
- Specific gravity = 2.68
- Fineness modulus = 6.8

E. Stone Dust

Stone dust used was obtained from Stone Crusher plant located in Deen Dayal Nagar Gwalior (M.P.).The fineness modulus and specific gravity are 3.13 and 2.62 respectively.

3. Experimental Programme

Experimental programme comprises of tests on cement, RHA, FA and SD. Cement Concrete with partial replacement of cement with RHA, FA and natural sand by SD.

A. Mix Design

M20 mix is designed as per guidelines in IS 10262, 1982 based on the preliminary studies conducted in the constituent materials. Tests on fresh concrete are obtained as follows.

(1). Slump Test=55mm

Table 2: The quantities of ingredients per cubic meter

Water (liters)	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)
0.50	1	1.63	2.97
191.61	383	627.92	1138.06

B. Mixture Proportioning

The control design was done as per IS 10262-1982. The total mixing time was 5 minutes, the samples were then casted and left for 24 hrs before demoulding. They were then placed in the curing tank until the day of testing Cement, sand, Fly ash, Rice husk ash, Stone dust and fine and coarse aggregate were properly mixed together. Replacement levels of cement and sand by different waste materials are given in Table. Coarse aggregate were same in all concrete.

Table 3: Percentage of ingredients

S. No.	Designation	Mix Type	Binder			Water kg	Aggregate		
			Cement kg	FA kg	RHA kg		Coarse Agg. kg	Fine Agg. kg	
								Sand kg	SD kg
1.	C	Control	100%	-----	-----	0.64	100%	100%	-----
2.	M1	10%RHA+20% FA	70%	20%	10%	0.64	100%	60%	40%
3.	M2	10%RHA+20% FA	70%	20%	10%	0.64	100%	70%	30%
4.	M3	5%RHA+ 20% FA	75%	20%	5%	0.64	100%	60%	40%

4. Results and Discussion

The cube samples were tested are 2000 KN Compressive Testing machine at the curing ages of 3,7,14 and 28 days. The results are given in table-

S. No.	Mix Type	Compressive strength															
		3 Days strength of Cubes in KN			AVG. Str. N/mm^2	7 Days strength Of Cubes in KN			AVG. Str. N/mm^2	14Days strength of Cubes in KN			AVG. Str. N/mm^2	28Days strength of Cubes in KN			AVG. Str. N/mm^2
		1	2	3		1	2	3		1	2	3		1	2	3	
1.	C	150	180	150	7.11	250	240	200	10.22	300	420	310	15.25	600	650	590	27.25
2.	M1	150	170	180	7.40	360	310	350	15.11	380	350	360	16.14	450	400	400	18.22
3.	M2	210	160	280	9.63	360	400	350	16.44	400	390	450	18.37	500	530	490	22.51
4.	M3	210	150	170	7.85	200	250	230	10.07	280	280	320	13.03	450	460	400	19.40

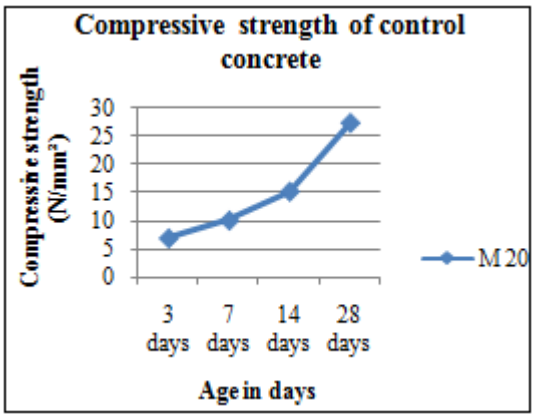

Figure: Compressive Strength of control concrete at different curing ages.

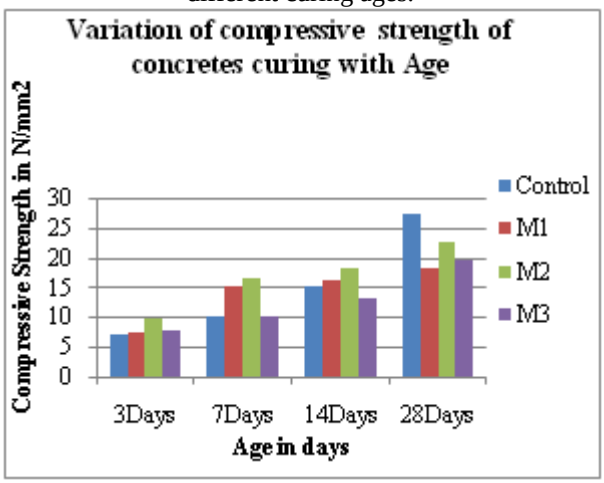

Figure: Variation of Compressive Strength of concrete at different curing ages.

5. Conclusions

Based on the results presented above, the following conclusions can be drawn:

1) Strength of M2 mix containing (70%C,10% RHA,20% FA and30% SD) was only 100% less than the control mix.

2) Strength of Mixes of M1 and M3 were (70%C, 10%RHA, 20%FA, 40%SD), (75%C, 5% RHA, 20% FA, 40% SD) and 100% less than the control mix respectively.
3) The durability properties are not checked.
4) Rice Husk Ash can be used as admixture as a partial replacement of cement.

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