Experimental Investigation on Flexural Behavior of Concrete Beam by Using Agricultural and Industrial Waste Materials

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Abstract: ***Due to the rapid industrialization taking place globally, the problems generated are acute shortage of construction material and increasing in productivity of wastes. The production and consumption of Fly Ash, Rice Husk Ash and Stone Dust are created have increased considerably. By the usage of Industrial and Agriculture waste at suitable scale as concrete for constructional works, the present research aims at waste management, by use of Fly Ash, Rice Husk Ash and Stone Dust waste in improvement of concrete. Fly ash, Rice Husk Ash is obtained as waste product from the thermal and paper industries. Investigations were carried out to explore the possibility of using Fly Ash, Rice Husk Ash, Stone Dust as a replacement of cement and sand in concrete mixtures. This paper deals with an experimental study on the properties of concrete containing Fly ash, RHA and Stone dust. The flexural behavior of plain concrete beam is investigated in this study. Replacement of cement by RHA and FA taken together is 25% and 30%. All beams had the same dimension tested under two point load.***

Keywords: Concrete, Fly Ash, Rice Husk Ash, Stone Dust, Flexural Strength, Compressive Strength

1. Introduction

Many research organizations are doing extensive work on waste materials concerning the viability and environmental suitability. (Crouch et al, 2007) studied on high volume fly ash concrete, from this study they concluded that HVFA mixtures would be ideal for warm weather placements when compared with ordinary concrete. Also HVFA exhibits comparable costs, increased compressive strength and enhanced durability properties. (Bressan et al, 2004) present work investigates the replacement of 10% in mass of cement with fly ash in the concrete mixture. The mechanical properties as compressive strength, flexural strength are experimentally determined for this concrete composition. From the experimental results shown in the present work it is possible to add class F fly ash to concrete. Fracture in concrete is due to rupture of the interface paste and aggregate, and the presence of pores. (Ajay Kumar et al, 2012) studied the use of RHA directly or in the form of ash either as a value added material for manufacturing and synthesizing new materials or as a low cost substitute material for modifying the properties of existing products. Presence of silica is an additional advantage in comparison to other by product materials which makes RHA an important material for a wide range of manufacturing and application oriented processes. Easy availability and low price of rice husk in rice producing countries was an extra benefit towards the use of this material. (Nair et al. 2006) sought to identify the most feasible method for field production of reactive pozzolanas from rice husk in the southern state, Kerala in India. The ash produced was lime or Portland cement to create concrete that would be appropriate for low-strength rural construction application. The goal was to suggest an affordable building option for rural housing. (Dr. D.S.P. Rao and V. Giridhar Kumar, 2004) studied the strength characteristics of concrete with stone dust as fine aggregate, draws the following conclusions –the concrete beams with crusher dust developed about 20% flexural strength. (Kumar et al. 2006) investigated the flexural behavior of high-performance reinforced concrete beams using sandstone aggregates.

2. Materials and Methods

A. Cement

The cement used was Ordinary Portland cement (43 Grade). 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.

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 is 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.

F. Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quality and quantity of water is required to be looked into very carefully.

3. Experimental Programme

A. Mix Design

A 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: 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 mix proportion of 1:1.63:2.97 (cement: fine aggregate: coarse aggregate) by weight was arrived for M20 concrete with conventional aggregates. The mixture proportioning was done according the Indian Standard Recommended Method IS 10262-1982.The target mean strength was 27.59 N/mm^2 for the OPC control mixture. Coarse aggregate is taken the water to binder ratio was kept constant as 0.50. The total mixing time was 5 minutes; the samples were then casted and left for 24 hrs before demolding. They were then placed in the curing tank until the day of testing Cement, sand, Fly ash, Rice husk ash, Stone dust, fine aggregate and coarse aggregate were properly mixed together in accordance with British Standard Code of Practice. Cement was replaced in percentages of 10% and 20% with rice husk ash, fly ash and Sand was replaced in percentages of 30% with Stone dust and 100 × 100 ×500mm^3, Beam mouldes was used for casting. The concrete beams were cured in the tank for 28 day.

Table: 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%	70%	30%
3.	M2	5%RHA+ 20% FA	75%	20%	5%	0.64	100%	60%	40%

4. Compressive Strength

Compressive strength of concrete mixes made with and without fly ash, rice husk ash, and stone dust were determined at 3, 7, 14 and 28 days of curing. Compressive strength increases with the increase in the percentage of Fly ash and Rice Husk Ash up to replacement (20%FA and 10% RHA) of Cement and stone dust up to replacement (30% Stone dust) of sand in Concrete for different mix proportions.

S. No.	Mix Type	3 Days strength of Cubes in N/mm^2	7 Days strength Of Cubes in N/mm^2	14Days strength of Cubes In N/mm^2	28Days strength of Cubes in N/mm^2
1	Control	7.11	10.22	15.25	27.25
2	M1	8.45	17.18	19.70	27.56
3	M2	8.29	16.44	18.37	24.88

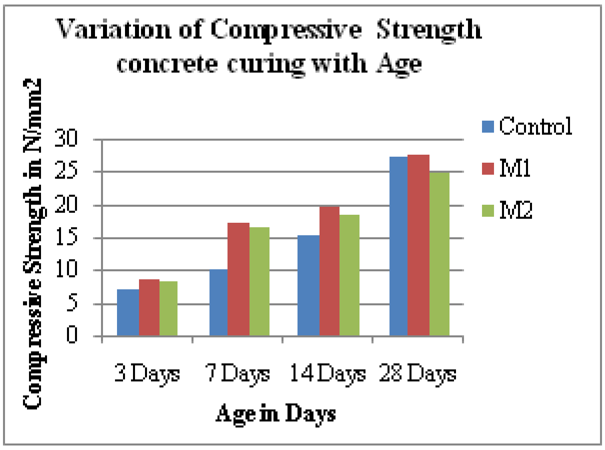

Figure: Variation of Compressive Strength concrete curing with Age.

5. Flexural Strength

Concrete specimen of size 100mm*100mm*500mm is cast in metal mould. Test specimens are stored in water before testing. The bearing surface of support and rollers are wiped, cleared and any loose sand or other material is removed. The specimen is placed in machine for testing.

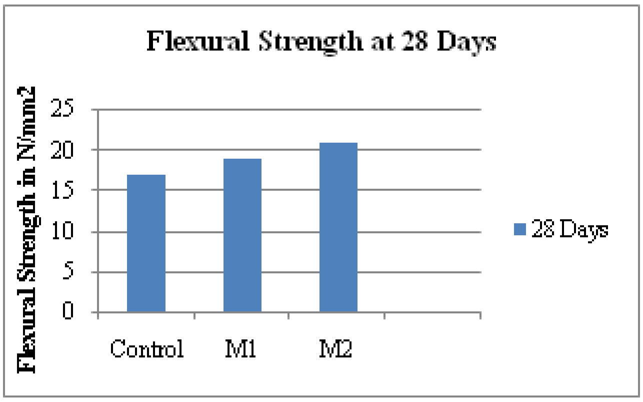

Figure: Flexural strength at 28 Days for M20 Concrete

6. Result and Discussion

S. No.	Designation	Curing Age in days	Compressive strength in N/mm^2	%variation in compressive str. from control	Flexural Strength in N/mm^2	% variation in flexural str. from control
1.	Control	28	27.25	0	16.88	0
2.	M1	28	27.56	+1.13%	18.89	+11.90%
3.	M2	28	24.88	-8.69%	20.93	+23.99%

7. Conclusions

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

1) Flexural strength of the concrete increases 11.90% when 30% cement is replaced by Fly Ash and Rice Husk Ash and 23.99% increases when 25% cement is replaced by Fly Ash and Rice Husk Ash.
2) Environmental effects from wastes and residual amount of cement manufacturing can be reduced through this project.

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