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Experimental Investigation on Partial Replacement of Coarse Aggregates by Flyash Aggregate in Concrete

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Abstract: Fly ash is one of the materials that are known as a waste material and which could have a bright future in construction industry as partial substitute of coarse aggregates. It is a finely divided residue resulting from the combustion powdered coal and transported by the flue gases and collected by electrostatic precipitators. At present, 120-150 million tons of coal fly ash is generated from 120 existing coal based thermal power plants in India. The aim of the present work is to examine or explore the potentiality of replacing the coarse aggregates by fly ash aggregate. An attempt is made to conform the effectiveness of fly ash aggregate as a partial replacement of coarse aggregates. Because of the storing issues, the fly ash negatively affects the environment. To solve this trouble, coarse aggregates was substituted up to 30% fly ash aggregate and determining its compressive strength of concrete and also the performance of fly ash aggregate on strength properties as a partial replacement of coarse aggregate in concrete mix design. The percentage replacement of coarse aggregate by fly ash aggregate were 10%, 20% and 30%. The compressive strength was observed to increase by about 30-35%.
Keywords: fly ash, Coarse Aggregates, Compressive Strength, Environment.

I. INTRODUCTION

Fly ash is finely divided residue resulting from the combustion of powdered coal and transported by flue gases and collected by electrostatic precipitators. At present India produces 120-150 million tons of fly ash annually. Dumping or disposal of such hazardous quantities of fly ash cause environmental and space troubles. During the past two decades, attempts have been made by many researchers and power thermal plants all over the globe to investigate the practical utilization of fly ash.

The chemical and physical properties of Demonstrate that it can be used to produce Products like fine aggregate, oarse aggregate. etc

The unsatisfactory performance of conventional concrete under aggressive environmental conditions has necessitated the researchers and engineers to look for new concrete composites.

The innovative use of concrete must examine explorations of areas, in use of new shapes, materials and technique of construction. Concrete is such a versatile material that such attempts of observation are quite possible. In modern age, without concrete construction is likely to be impossible. Plain concrete has two major deficiencies; a low tensile strength and allow strain at fracture. The tensile strength of concrete is very low because plain concrete normally contains numerous micro cracks.

Fly ash possesses mechanical and chemical characteristics that qualify the material to be used in concrete as a partial replacement for Portland cement or as a substitute for aggregates. For example, fly ash aggregate has a number of favorable mechanical properties for aggregate. The main aim of this study was to produce LWC(Light Weight Concrete) using 10%,20% and 30% replacement of coarse aggregate with fly ash aggregate and to determine the optimum replacement

A series of experimental was carried out using local materials.

II. PROPERTIES OF MATERIALS USED

A. Cement

In this experimental work, Ordinary Portland Cement (OPC) 53 grade conforming to IS: 12269 – 2013 was used.

B. Fine Aggregate.

Locally available river sand was used.

Table 2.1: Properties of Cement (OPC 53)

Sl. No.	Material Property	Results Obtained	Requirements as Per IS 12269 - 2013
1.	Specific Gravity	3.16	3.15
2.	Fineness	7.10%	Not more than 10%
3.	Normal Consistency	33%	Not more than 35%
4.	Initial Setting Time	55 minutes	Not less than 30 min
5.	Final Setting Time	355 minutes	Not more than 600 min
6.	Compressive Strength at: 3 – Days (MPa) 7 – Days (MPa) 28 – Days (MPa)	 32.50 39.50 56.20	 27 37 53

Table 2.2: Sieve Analysis and Physical Properties of Fine Aggregate

Sl. No.	Sieve No.	Mass Retained in grams	% Mass Retained	% Passing	Cumulative % Retained 'F'	Specifications For Zone I As Per IS:383-1970
1	4.75mm	0.0	0.0	0.0	100	90-100
2	2.36mm	50	5.0	5.0	95	60-95
3	1.18mm	540	54.0	59.0	41	30-70
4	0.60mm	240	24.0	83.0	17	15-34
5	0.30 mm	80	8.0	91.0	9	5-20
6	0.15mm	50	5.0	96.0	4	0-10
7	0.075 mm	30	3.0	99.0	1	-
8	Pan	10	1.0	100.0	0	-
9	Specific Gravity = 2.66					
10	Bulk Density = 1290 Kg/m^3					
11	Water absorption = 1.0%					
12	Fineness Modulus = 2.67					

C. Coarse Aggregate

Locally available Crushed aggregates confirming to IS 383-1970 are used in this dissertation.

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Table 2 .3: Sieve Analysis and Physical P roperties of Coarse Aggregate

Sl. No.	IS Si eve Size	Percentage Pass ing of Coarse A ggregates		Pe rcentage Passing of Different Fra ctions			Specifications A s Per IS:383-1970		
		I	II	I	II	Combined	Graded	Single Si zed	
		(20 mm)	(12.5 mm)	60%	40%	100%		I	II
1.	20 m m	100	10 0	60	40	100	95-100	85-100	--
2.	12.5 mm	0	98. 5	0	0	0	--	--	85-100
3.	10 m m	0	35. 2	0	29.5	29.5	25-55	0-20	0-45
4.	4.75 mm	0	8.4	0	4.1	4.1	0-10	0-5	0-10
5.	Sp ecific Grav ity = 2.64								
6.	Bulk Density = 1382 Kg/m^3								
7.	Wa ter absorpti on = 0.5%								

C. Fly Ash

Chemical compositio n of class F fly ash.

Table 2.4: Chemical Composition of fly ash

Sl. No	Ch emical Com pounds	% of Comp ounds
1	$Si0_2$	38.80
2	Fe_2O_3	19.48
3	CaO	18.10
4	Al_2O_3	14.70
5	MgO	3.30
6	SO_3	1.50

7	$K2O$	1.79
8	MnO	0.16
9	$TiO2$	1.02
10	BaO	0.27
11	SrO	0.11

Sl. No.	Sieve No.	Weight retained in kg	Corrected Mass in kg	% Retained	% Passing	Cumulative % Retained
1.		0.040	0.0412	0.824	99.176	0.824
2.		2.82	2.8212	56.424	43.576	57.248
3.		1.649	1.6502	33.04	66.996	90.252
4.		0.472	0.4732	9.464	90.536	99.176
5.		0.013	0.0142	0.284	99.716	100

Table 2.5: Sieve Analysis and Physical Properties of Fly ash Fineness modulus of coarse aggregate (Ec + 500)/100 = 8.48

III. EXPERIMENTAL DETAILS

A.compressive Strength

A total of 27 cubical specimens of standard dimensions 150 x 150 x 150 mm were tested in the present study. M25 grade of concrete was used for all. The percentage replacement of fine aggregate by copper slag was 0, 10, 20, 30 and 40. A constant water cement ratio of 0.45 was adopted for making concrete mixtures. The aggregate

used for this study was crushed stone from quarry with the nominal size of 20mm. The cube specimens were tested at 7, 14 and 28 days. Table 3.0 gives concrete mix designs details. Table 3.1, 3,2, 3.3 and 3.4 gives the 7 days, 14 days and 28 days cube compressive strength.

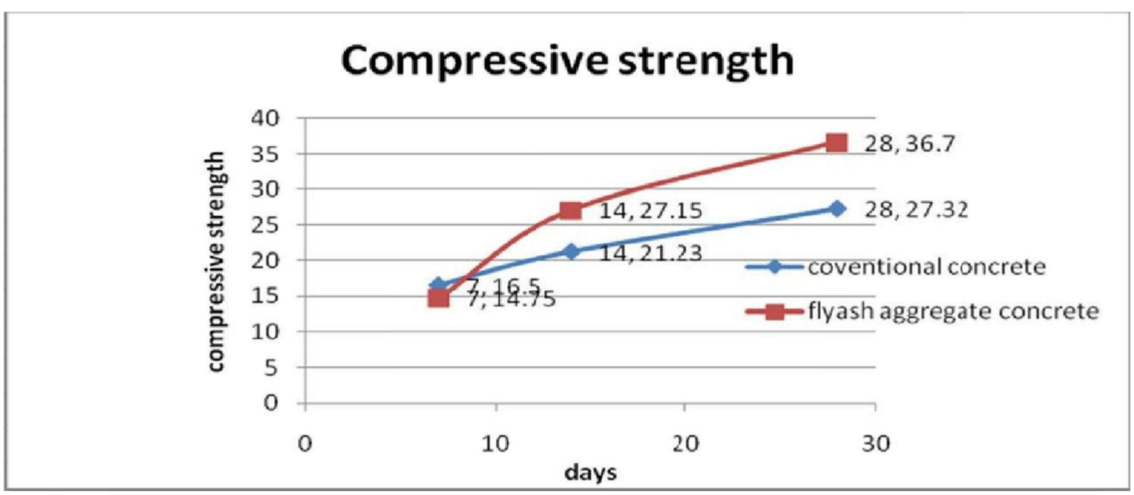
Table 3.0: Concrete Mix Design Details

Sl. No.	Replacement by %	Cement Kg/m^3	F.A kg/m^3	Fly Ash.A kg/m^3	C.A kg/m^3	Water kg/m^3
1.	10%	413.33	652.81	74.95	1046.38	186
2.	20%	413.33	652.81	149.9	930.12	186
3.	30%	413.33	652.81	224.86	821.08	186

Table 3.1: Cube Compressive Strength Showing compressi ve strength results for concrete specimen wit h fly ash ag gregate -10 % Repla cement

R atios (Fly ash: cement)	Compressiv e strength (Mpa)		
	7 days	14 days	24 days
5: 1, 10:2	14.75	27.15	36.17
Conv entional concrete	16.5	21.23	27.32
% Increase in Com pressive St rength	-1.75	5.93	8.82

Table 3.2: Cube Compressive Strength



Showing compressiv e strength results for concrete specimen with fly ash aggregate - 20 % Replac ement

R atios (Fly ash ; cement)	Compressive strength (MPa)		
	7 days	14 da ys	28 days
5: 1; 10:2	12.6	22.57	3 0
Conventional concre te	16.5	21.23	27.32
% In crease in Compressive Strength	- 3.9	1.34	2.6 8

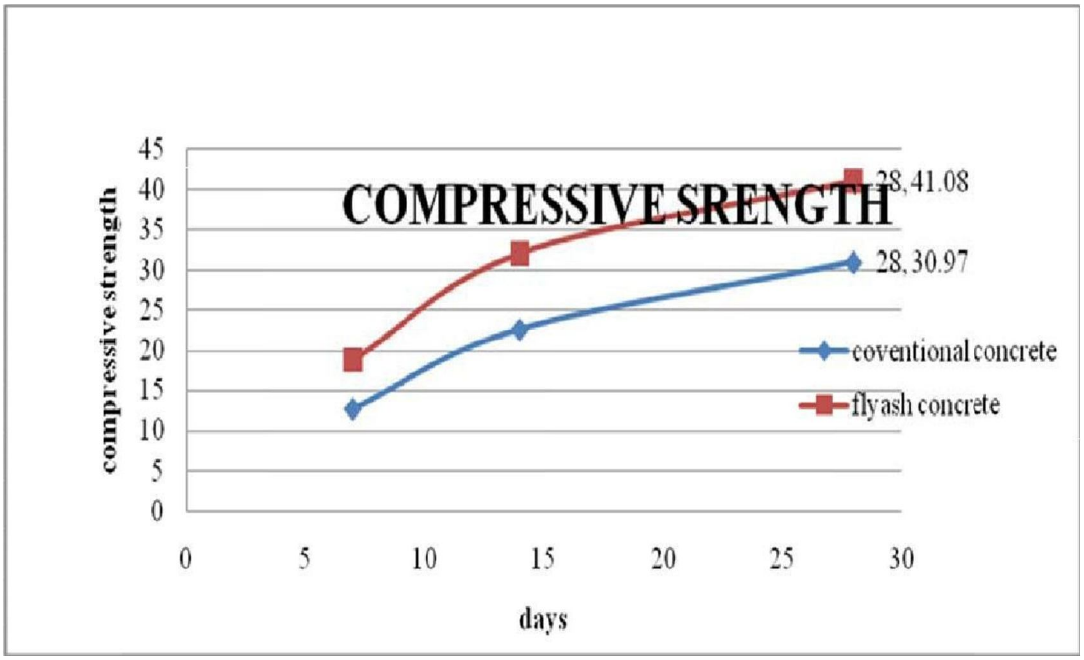
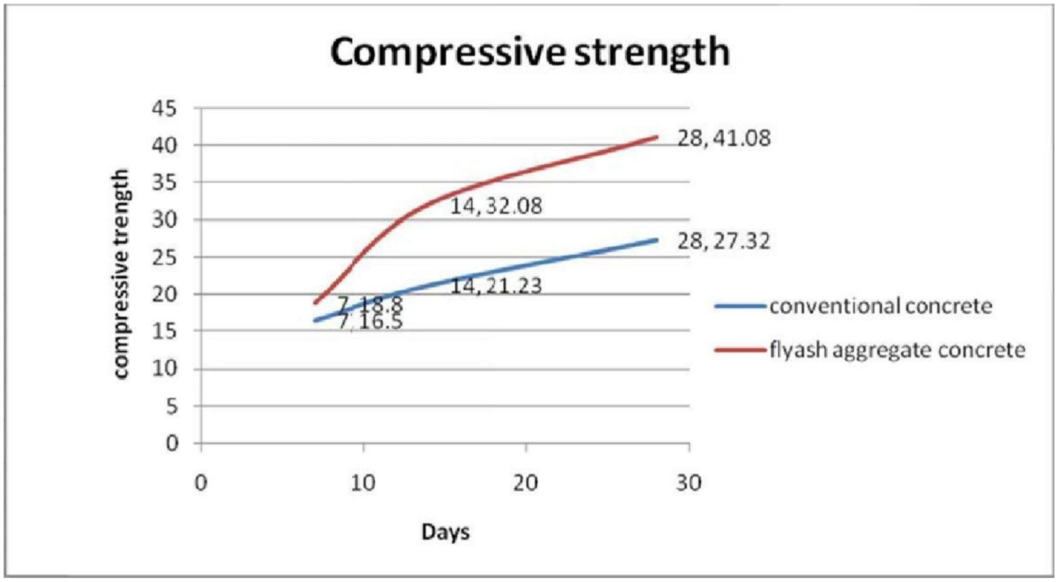


Table 3.3: Cube Compressive Strength Showing compressi ve strength results for concrete specimen wit h fly ash ag gregate - 30 % Repla cement

Ratios (Fly ash : ce ment)	Compressive strength (MPa)		
	7 da ys	14 days	28 days
5:1; 10 :2	18.8	32.08	41.20
Conventi onal concrete	16. 5	21.2 3	27.32
% Increa se in Compressive Strength	2.3	10.8 5	13.88



IV. CONCLUSION

The use of fly ash in concrete provides additional environmental as well as technical benefits for all related industries. As the fly ash is an Thermal power plant waste hence partial replacement of fly ash in coarse aggregate reduces the cost of making concrete.

The water absorption of fly ash was less compared to sand. Therefore, the workability of concrete increases with the increase of copper slag content in concrete mixes. hardened concrete fly ash significantly improves long term strength and durability. There is reduction in heat of hydration ,presence of fly ash in concrete decreases permeability. From the results of compressive test, we have got that the strength of concrete increases with respect to the percentage of fly ash added by the weight of coarse aggregate up to 30% as shown in the above tables.

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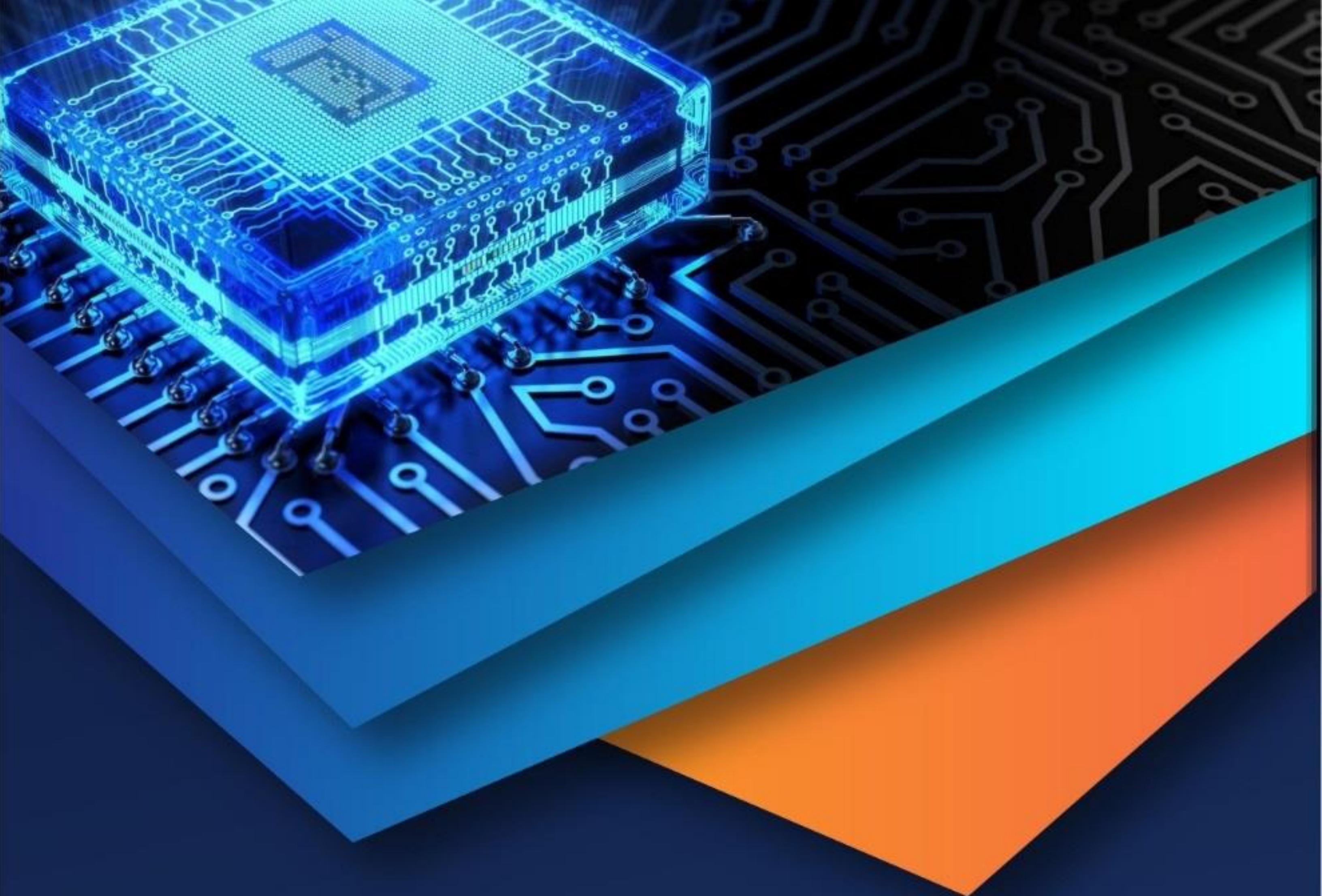

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