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Effect on Compressive Strength with Partial Replacement of Fly Ash

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ABSTRACT: The cement is main ingredient used for concrete. The search of any other such material which can be alternative for cement should lead to lowest possible environment impact. The huge quantity of ash being accumulated over the years is likely to pose a massive problem for its disposal and cause environmental pollution leading to health hazards. To minimize all these effects a best option is to promote large scale utilization of coal ash which has potential for use in the country. About 5% of the annual production of 38.4 million tones of fly ash from different thermal power stations in the country is being utilized. By utilizing fly ash and by putting the waste material into constructive use, not only a 'waste material' is not wasted, but a new, versatile and potential construction material is born. It is a case of churn waste into wealth and turning ash into case. In the present study, replacement is of fly ash with cement having been studied for partial replacement of fly ash with cement at 10%, 20%, 30%. It was observed that 10% replacement of fly ash was 20% and 50% decrease the compressive strength at the age of 7 and 28 days respectively In 20% replacement 7% and 11% increase in compressive strength was observed at the age of 7 and 28 days respectively. In 30% replacement 23% and 19% increase the compressive strength was observed at the age of 7and 28daysrespectively.

Keywords: Fly ash percentage, Curing period, Compressive strength

I. INTRODUCTION

Energy is the main backbone and blood stream of modern civilization of the world over, and the electrical power from thermal stations is a major source of energy on which hinges the functioning and growth of manhood. Energy in the form of electricity is a basic necessity for economic development and social progress. Power development is thus a major requirement of overall economic development. Thermal power electricity is generated from the coal fired thermal stations. Coal based thermal power stations generate electricity on one hand which is essential for our development and growth, on the other hand, these power stations also produce massive quantities of coal ash which could pose serious environment and other related problems. In thermal power stations, mainly two types of ashes are produced from burning of coal. The lighter one goes up the chimney and collected either by mechanical or by electrostatic precipitator is known as fly ash. Portion of fly ash escapes along with hot gases through chimneys. The other fraction containing coarser materials are collected at the bottom of the furnace, is called bottom ash. Fly ash is fine and carried away with flue gases. It is separated from hot gases in Electrostatic precipitator. Fly ash is in two type class f and c, in class f fly ash normally produces by burring anthracite or bituminous coal, usually has less than 5% CaO. Class f fly ash has pozzolanic only and in class c fly ash normally produced by burning lignite or sub bituminous coal. Some class c fly ash may have CaO content in excess of 10%. In addition to pozzolanic properties, class c fly ash also possesses cementations properties.

II. MATERIALS

In the experimental program fine aggregate zone II ordinary portland cement (43 grade), and coarse aggregates of used 20mm (70%) and 10mm (30%) as per Indian standard used. The physical properties of material are given in Table 1 to 6.

III. LITERATURE REVIEW

According to Mohammed *et al.,* Strength development of concrete containing coal fly ash under different curing temperature condition' published in 2009 world coal ash (W.O.C.A) conference May 2009 in Lenington, U.S.A conclude that Fly ash concrete was experimental to be like to that of an equivalent Portland cement concrete at normal curing temperature(20^0 for 32 days) Their work indicates that fly ash concrete could be used in concrete when untimely strength required. according to Amit Mittal Experimental Study on the use of fly ash in mix concrete "result that, as fly ash content increase there is reduce the strength of concrete**.** "High early strength containing large quantities of fly ash" concluded that Fly ash improves the workability of concrete [3]. As the amount of fly ash is inversely proportional to workability of concrete. According to Manmohan and Mehta,1981study on experiment have shows that cement paste containing 10-35% low calcium fly ash cause significant pore refinement in the 28 to 90 days curing period**.**

IV. EXPERIMENTAL PROGRAM

To find out the experimental investigation 12 cubes, M-20 were casted in total, out of which 3 cubes were used for normal cube testing. Then 3 cubes were taken for 10% replacement with fly ash replacement. Similarly 3 cubes were taken for 20% replacement with fly ash and as another were cubes taken for 30% replacement of fly ash. The concrete mix was prepared as per Indian standard having mix design are (1:1.32:2.85) with water cement ratio 0.45.

Table 1: Material Quantity.

Sr. No.	Fly Ash & replacement	Cement kg/m^3	Sand kg/m^3	Aggregate kg/m^3
1	0%	425.77	562	1211
2	10%	383.20	562	1211
3	20%	340.60	562	1211
4	30%	298.40	562	1211

Table 2: Physical Properties of Ordinary Portland Cement.

Sr. No.	Characteristics	Values	Value specified by IS:1489 (Part 1)-1991
1	Specific Gravity	3.13	-----
2	Standard Consistency, percent	32	-----
3	Initial Setting Time, minutes	105	Minimum30
4	Final Setting Time, minutes	260	Maximum 600

Table 3: Physical Properties of Coarse Aggregates.

Sr. No.	Characteristics	Value	
		CA-I	CA-II
1	Type	Crushed	Crushed
2	Maximum Nominal Size (mm)	20	10
3	Specific gravity	2.63	2.66
4	Total Water absorption	1.70	1.75
5	Fineness modulus	7.01	6.66

Table 5: Physical Properties of Fine Aggregate.

Sr. No.	Characteristics	Test Values
1	Specific gravity (oven dry basis)	2.63
2	Fineness modulus	2.51
3	Water absorption	2.30

Table 6: Physical Properties of fly ash.

Properties	Description	Requirement as IS: 3812-2003
Physical properties	Fineness – sp. Surface (m^2/kg)	> 320
	Comp. strength at 28 days as % of cement mortar cube	> 80
	Lime reactivity (MPa)	> 4.0
	Drying shrinkage	> 0.15
	Soundness by autoclaving Expansion Method	> 0.8
	Retention	> 34

V. RESULT AND DISCUSSION

First of all and foremost three cubes of M-20 grade of size 150 $mm^3$where tested on compression testing machine and compressive strength of these cube were noted at the age of 7days and 28 days. The average compressive strength of these cubes was found in16.8 MPa and 24.44 MPa at the age of 7 days and 28 days respectively. Then 10% of cement was replaced with fly ash by weight and other material content was same in the cubes, and cured for 28 days. It was observed that average compressive strength of these cubes was having 13.90 MPa and 16.10MPa at the age of 7 days and 28 days respectively. It was observed that 20% and 50% decrease the compressive strength value for 7 and 28 days respectively. Similarly in the 20% of cement was replaced with fly ash, It was observed that average compressive strength of these cubes were having 7% and 11% increase compressive strength value for 7 and 28 days respectively. In 30% of cement was replaced by fly ash. It was observed that average compressive strength of this cube was 23% and 20%increasecompressive strength value 7 and 28 days respectively. The results are shown in Table 7 to 10.

Table 7: Compressive Strength at 10% Replacement of concrete.

STRENGTH → / DAYS ↓	M-20 concrete	10% Fly Ash Replacement
	Compressive Strength (MPa)	Compressive Strength (MPa)
7 Days	16.8	13.90
28 Days	24.44	16.10

Table 8: Compressive Strength at 20% Replacement of concrete.

STRENGTH → / DAYS ↓	M-20 concrete	20% Fly Ash Replacement
	Compressive Strength (MPa)	Compressive Strength (MPa)
7 Days	16.80	17.90
28 Days	24.44	26.70

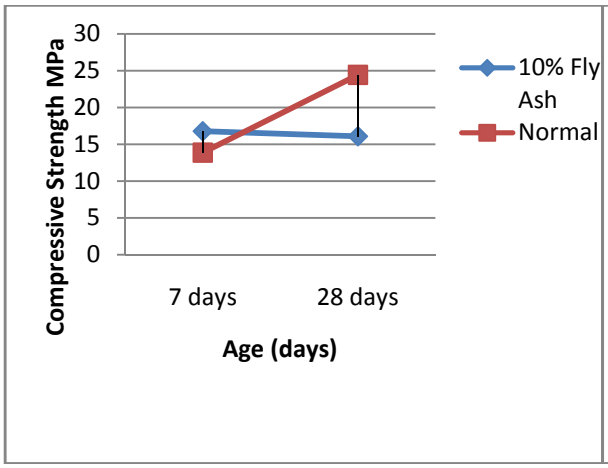

Fig. 1. Compressive strength at 10 % replacement.

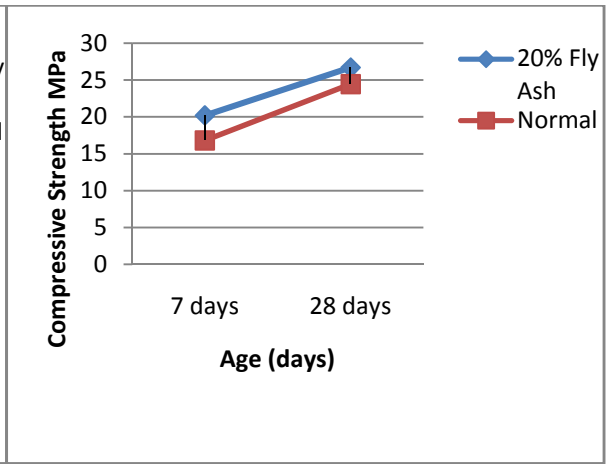

Fig. 2. Compressive Strength at 20% replacement.

Table 9: Compressive Strength at 30% replacement of Concrete.

STRENGTH → / DAYS ↓	M-20 concrete	30% Fly Ash Replacement
	Compressive Strength (MPa)	Compressive Strength (MPa)
7 Days	16.8	20.22
28 Days	24.44	30.55

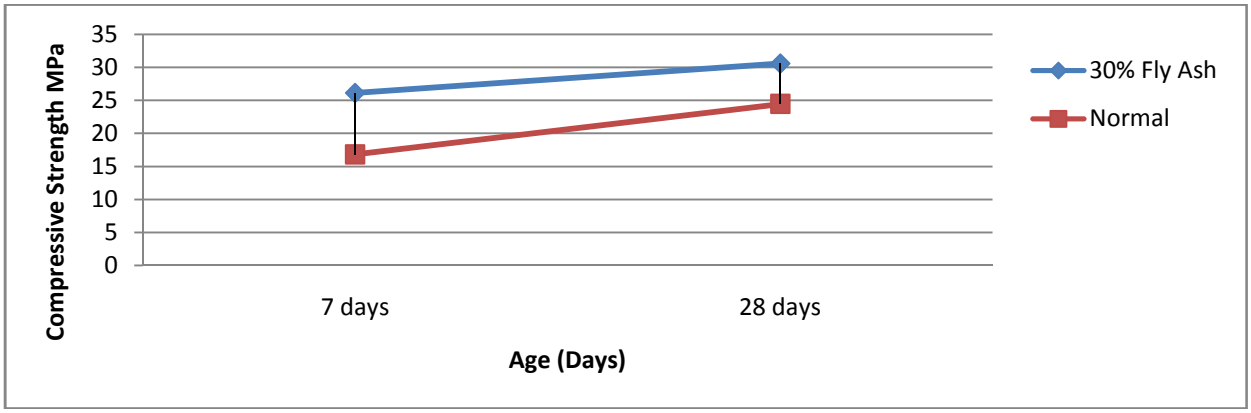

Fig. 3. Compressive strength at 30% replacement of concrete.

Table 10: Compressive strength of all Replacement.

Curing Age in Days	Normal concrete M-20	10% Fly Ash	20% Fly Ash	30% Fly Ash
	Compressive Strength in MPa			
7 Days	16.80	13.90	17.90	20.22
28 Days	24.44	16.10	26.70	30.55

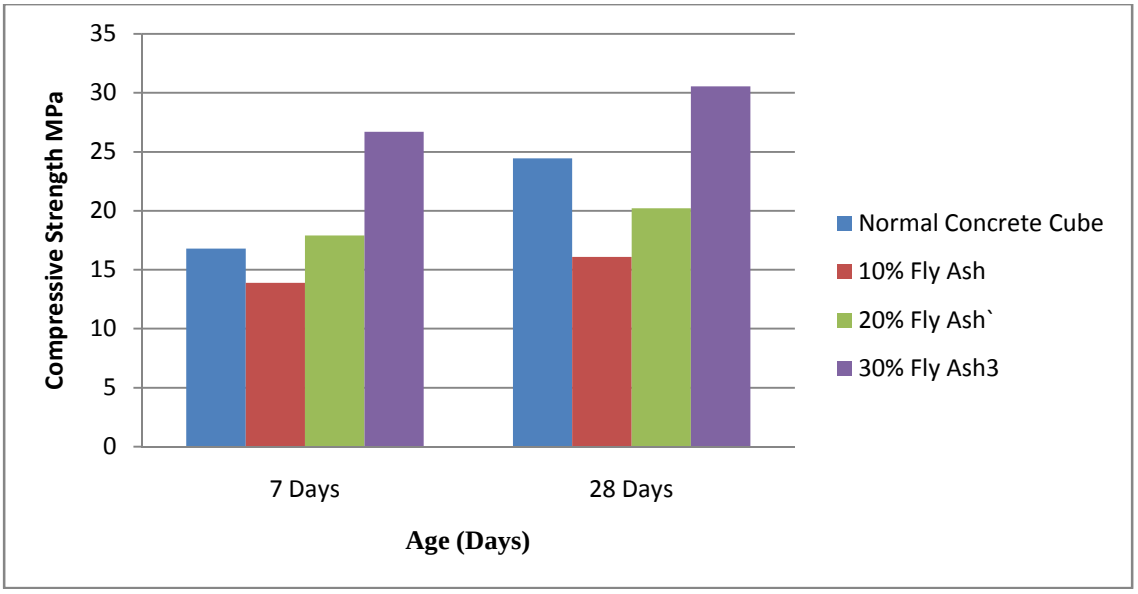

Fig. 4. Compressive Strength of Concrete in all replacement.

Fig. 5. Preparing mix of M-20 concrete.

Fig. 6. Tamping in Concrete.

Fig. 7. Compaction of Concrete.

Fig. 8. Casted Cubes.

VI. CONCLUSION

The result obtained from compressive strength test conducted on concrete containing various percentage of fly ash from different places was as follows;

(i) As the fly ash content increases there was increase as well as decrease in the strength of concrete.

(ii) The 10% replacement of fly ash gives 20% and 50% decrease the compressive strength at the age of 7 and28 days respectively.

(iii) It was observed with replacement of 20% fly ash concrete compressive strength was increased by 7% and 11% as compared to normal concrete cubes.

(iv) It was seen that with 30% of fly ash 23% and 25% increase compressive strength at 7 and 28 days period of curing.

(v) It was observed that with increase in age the compressive strength also increased for fly ash replaced concrete.

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