Effect of Fly Ash as A Cement Replacement on The Strength of Concrete

Suman Anil Kumar, Saxena Anil Kumar, Arora T.R.

***Abstract:** This study is an attempt to find a suitable utilization for a particular fly ash depending upon its properties and thus reduce the need for vast areas for disposal of fly ash which in turn causes considerable damage to the environment .In India. around 110 million tones of fly ash get accumulated every year at the thermal power stations.. Internationally fly ash is considered as a byproduct which can be used for many applications. Fly Ash mission was initiated in 1994 to promote gainful and environment friendly utilization of the material. One of the areas identified for its bulk utilization was in construction of roads and embankments. Concrete is being widely used for the construction of most of the buildings , bridges, etc throughout the world. Hence it is the backbone to the infra structure development of a nation. India is taking major initiatives to improve and develop its infrastructure by constructing express highways, power projects and industrial structures. A huge quantity of concrete is required to meet out infrastructure development. Fly ash is a by-product of burned coal from power station. Considerable efforts are being taken worldwide to utilize natural waste.*

***Keyword:** Concrete, Being Widely Used For The Construction Of Most Of The Buildings , Bridges, Etc Throughout The World.*

I. INTRODUCTION

Fly Ash is a mineral portion of coal consumed in a coal fueled power plant. The particles of Fly Ash are spherical shaped, glassy and finer than cement particles. In recent years special attention has been devoted to industrial sectors. The industry produces large volume of solid wastes and therefore a huge problem of pollution is generated. The potential use of this waste as a cementing material for concrete is essential. Fly ash in concrete reacts with the hydraulic cement in the following ways: CH and alkali hydroxide, which are released into the pore structure of the paste, combined with the pozzolonic particles of fly ash forming a cementing medium. Heat generated by the hydration of hydraulic cement helps initiate the pozzolonic reaction and contributes to the rate of the reaction. Fly ash is one of the residues generated in coal combustion facilities, and comprises the fine particles that rise with the flue gases.
Fly ash is produced by coal-fired electric and steam generating plants. Typically, coal is pulverized and blown with air into the boiler's combustion chamber where it immediately gets ignites, generates heat and produces a molten mineral residue.

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Boiler tubes extract heat from the boiler, cool the flue gases and cause the molten mineral residue to harden and form ash. Coarse ash particles, called as bottom ash or slag, fall to the bottom of the combustion chamber, and the lighter fine ash particles, termed as fly ash, remain suspended in the flue gas. Fly ash is commonly used to supplement Portland cement in concrete production, where it can bring both technological and economic benefits, and is increasingly finding use in synthesis of geo polymers and zeolite .All Fly ash includes the substantial amounts of silica (silicon dioxide) and lime (calcium oxide).

II. Review of Literature

Hussein et al.(2013) in his study replaced OPC with 5 to 50% fly ash and observed that 10% fly ash showed the highest compressive strength at all ages, use of 15% to 30% fly ash significantly increased the compressive strength at 90 days and 180 days.
Mukherjee et al (2013) reported that that the zero slump concrete showed higher compressive compared to workable concrete with super plasticizer up to 60% replacement with fly ash .The strength gain with time is higher compared to the OPC concrete at all replacement level of cement by fly ash and the optimum strength gain was noted at 70% replacement at 28 days.
Bilodeau et al (1991) found that increasing the water cement ratio results in increased amount of scaling. They observed that a lot of variability in the results from scaling test of fly ash concrete. Also increased replacement levels of cement with fly ash resulted in the amount of scaling.
Hwang et al (1998) examined the effect of fine aggregate replacement on the rheology, compressive strength, and carbonation properties of fly ash and mortar. At 50% replacement of fine aggregate by fly ash, compressive strength of concrete increased by 51.5% , and 67.1% at 28 days and 365 days respectively.
Nasser and Lai(1993) shown that lower replacement levels of cement with fly ash in the range of 20% to 35 %,is optimum in order to have satisfactory durability to frost conditions.
Mehta and Monteria (1997) found that chemical attacks are improved with the use of fly ash and slags due to pore refinement of concrete made with such materials. Experiments have shown that cement pastes containing 10% to 30% low
calcium fly ash, causes pore refinement in the 28 days to 90 days curing period.

III. 1. Experimental works on Concrete

An M20 mix is designed as per guide lines in IS -10262, 2009 based on the preliminary studies conducted in the constituent material. Test on concrete is obtained as follows

1- Slump Test:

2- Compressive Strength Test:

3- Flexural Test:

2. Methods of Testing:

Testing is done as per following IS Code; the testing is done for Compressive strength of cubes as per IS 516-1959 .The testing done for Flexural strength of beam as per IS 516-1959.

A: Slump Test:

It is used to determine the workability of fresh concrete. The apparatus used for slump test are: slump cone and tamping rod.

3. Characteristics 0f Fly Ash:

Physical Properties:- (Source: from HEG LTD,Mandi deep, Bhopal)

- Specific Gravity - 2.52
- Bulk Density - 1.12 gm/cc
- Fineness - 351 m2/kg
- Color - Grey

Chemical Properties:-

- Silica - 56.64
- Alumina - 27.36
- Calcium Oxide - 2.20
- Loss on ignition - 3.09
- Sulpher - 3.95
- Iron - 4.80

B: Compressive Strength Test:

By this single test one judge that whether Concreting has been done properly or not. For most of the works cubical moulds of size 150 mm x 150 mm x 150 mm are commonly used..After 24 hours these moulds are removed and test specimens are put in water for curing.These specimens are tested by compression testing machine after 7 days curing or 28 days curing. Load was applied gradually at the rate of 140 kg/cm^2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

C: Flexural Strength Test:

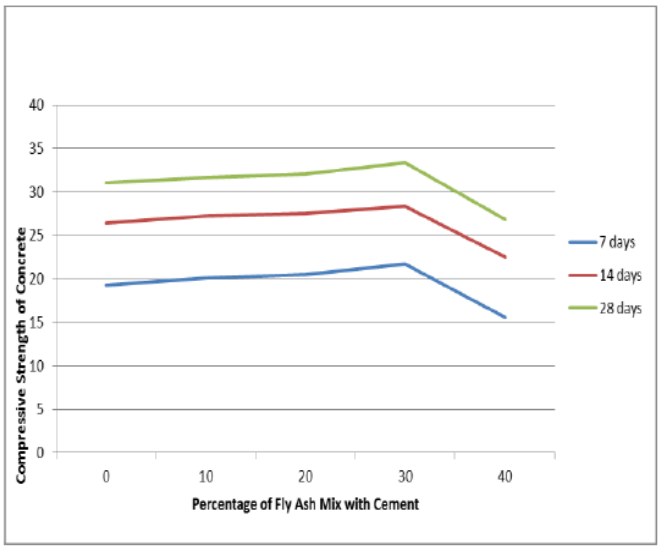
Test specimens were prepared by moulding concrete to a beam section, curing and storing in accordance with standard procedure. The section of the beam was square of 100 mm. The overall length of the specimen was 500 mm. Size (100x100x500) mm The specimen stored in water was tested immediately on removal from water. The test specimen was placed in the machine correctly centered with the longitudinal axis of the specimen at right angles to the rollers. For specimens, the mould filling direction shall be normal to the direction of loading. Calculations: The Flexural Strength is given by:

$F_b = pl / bd^2$ where b = width of specimen, d = failure point depth, l = supported length of Specimen, P = max. Load

IV. 1. Test Results

Cement (OPC)	% of Fly ash	Compressive Strength (in N/mm^2)			Flexural strength (28days) in (N/mm^2)
		7 days	14 days	28 days	
Normal concrete	0 %	19.28	26.43	31.10	4.11
90 %	10 %	20.09	27.26	31.69	3.52
80 %	20 %	20.51	27.56	32.05	2.75
70 %	30 %	21.70	28.39	33.40	2.21
60%	40%	15.55	22.52	26.82	2.05

Cement + Fly Ash



Graph-1: Compressive Strength of Concrete with Fly Ash

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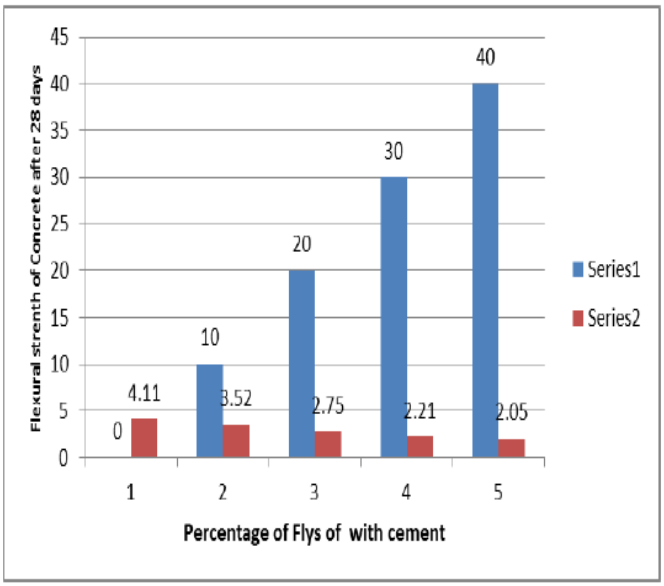

Graph-2: Flexural strength of concrete with fly ash

REFERENCES

1. Dire, R.K. (2005): International Conference on fly ash utilization, pp: O 1.1-1.10.
2. The investigation on the compressive strength of silica fumes concrete; Sen Gupta, s bhanja (2003)
3. Proc. of the international Coal Congress & Expo, 191-199.
4. Association, Research and Development Laboratories, Skokie, IL. Indian Standard code -10262-2009. IS 456 -2000,
5. Journal of Indian Institute of Science, Vol. (84), 189-216.
6. Testing and Evaluation, JTEVA, Vol.23, No.3, pp: 222-227.
7. Chemical Properties of Fly and Geo-environmental Engineering © ASCE, pp: 914-924.
8. Fly ash in concrete- Report of technical committee 67-FAB (RILEM)
9. V.M. Malhotra and A.A. Ramezanianpour- march 1994, Fly ash in concrete.