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Partial Replacement of Cement with Fly Ash In Concrete And Its Effect

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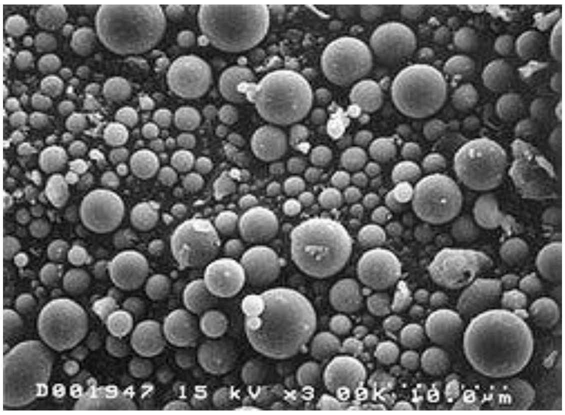
Abstract: Fly ash a waste generated by thermal power plants is as such a big environmental concern. In modern decades, the industrialization and urbanization are the two phenomena that are spreading all over the world. Apart from the requirement of these phenomena, there should also be investigation into their negative impacts on the worldwide environment and common life. Most important poor effect of these international processes has been the production of large quantities of industrial wastes. Therefore, the problems related with their safe management and dumping has turned into a major test to environmentalists and scientists. Another problem is the stress on land, materials and resources to sustain the developmental activities, including infrastructure. The thermal power plants produce considerably large quantities of solid byproduct namely fly ash.

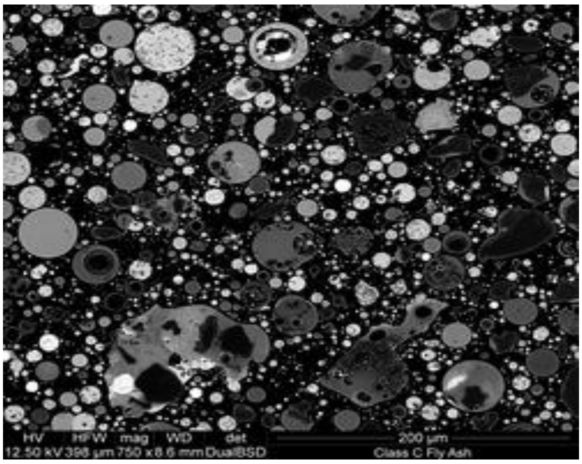
Keywords— *Fly ash, Cement, Compressive strength*

I. INTRODUCTION

Fly ash is a residual material of energy production using coal, which has been found to have numerous advantage for use in concrete.some of the advantage include improved workability, reduced permeability, increased ultimate strength, reduced bleeding, better surface and reduced heat of hydration. Several types of fly ash are produced depending on the coal and coal combustion process. It is a pozzolanic material and has been classified into two classes Fly ash is one of the residues generated in combustion, and comprises the fine particles that rise with the flue gases. Ash which does not rise is termed bottom ash. In an industrial context, fly ash usually refers to ash produced during combustion of coal. Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal-fired power plants, and together with bottom ash removed from the bottom of the furnace is in this case jointly known as **coal ash**. Depending upon the source and makeup of the coal being burned in the past, fly ash was generally released into the atmosphere, but pollution control equipment mandated in recent decades now require that it be captured prior to release. In the US, fly ash is generally stored at coal power plants or placed in landfills. About 43 percent is recycled, often used to supplement Portland cement in concrete production. In some cases, such as the burning of solid waste to create electricity the fly ash may contain higher levels of contaminants than the bottom ash and mixing the fly and bottom ash together brings the proportional levels of contaminants within the range to qualify as nonhazardous waste in a given state, whereas, unmixed, the fly ash would be within the range to qualify as hazardous waste.



Fly ash particles at 2,000x magnification



II. CHEMICAL COMPOSITION

Fly ash material solidifies while suspended in the exhaust gases and is collected by electrostatic precipitators or filter bags. Since the particles solidify while suspended in the exhaust gases, fly ash particles are generally spherical in shape and range in size from 0.5 µm to 100 µm. They consist mostly of silicon dioxide (SiO_2), which is present in two forms: amorphous, which is rounded and smooth, and crystalline, which is sharp, pointed and hazardous; aluminum oxide (Al_2O_3) and iron oxide Fly ashes are generally highly heterogeneous, consisting of a mixture of glassy particles with various identifiable crystalline phases such as quartz, mullite, and various iron oxides.

Component	**Bituminous**	**Sub Bituminous**	**Lignite**
Sio_2 (%)	20 – 60	40 – 60	15 – 45
Al_2O_3 (%)	5 – 35	20 – 30	20 – 25
Fe_2O_3 (%)	10 – 40	4 – 10	4 – 15
CaO (%)	1 – 12	5 – 30	15 – 40
LOI (%) **Loss on Ignetion**	0 – 15	0 – 3	0 -5

III. CLASSIFICATION OF FLY ASH

Two classes of fly ash are defined by ASTM C618: Class F fly ash and Class C fly ash. The chief difference between these classes is the amount of calcium, silica, alumina, and iron content in the ash. The chemical properties of the fly ash are largely influenced by the chemical content of the coal burned.

Class F fly ash:

The burning of harder, older anthracite and bituminous coal typically produces Class F fly ash. This fly ash is pozzolanic in nature, and contains less than 20% lime (CaO). Possessing pozzolanic properties, the glassy silica and alumina of Class F fly ash requires a cementing agent, such as Portland cement, quicklime, or hydrated lime, with the presence of water in order to react and produce cementitious compounds

Class C fly ash:

Fly ash produced from the burning of younger lignite or sub-bituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash will harden and gain strength over time. Class C fly ash generally contains more than 20% lime (CaO).

IV. PROBLEM DEFINATION

We performed work for nominal mix M25 grade concrete for 0.35 w/c ratio. With mineral admixture 10%, 20%, and 30% replacement by mass of cement. In this work we studied the effects of different w/c ratio, percentage of mineral admixture over the properties of concrete like workability & strength further more we studied the effect with age of concrete and slump loss. Quality is essence of good work. Good quality of concrete is a homogenous mixture of water, cement, aggregate and admixture. Only the mixing of these materials is not the matter but to obtain the concrete which governs all the properties of concrete mixes in fresh as well as hardened concrete. To produce good quality concrete the following steps are involved in concrete preparation.

1. Batching of materials. 2. Mixing 3. Compaction. 4. Finishing. 5. Curing and Demoulding. 6. Cube testing.

To produce good quality of concrete the selection of materials as well as selection of required grade of concrete is necessary

We have used M25 grade of concrete with the ratio 1:1:2 i.e. 1 part of cement, 1 part of fine aggregate and 2 part of coarse aggregate

A. Materials Specification Following are the materials used Cement: 53 grade of ordinary Portland cement

- Aggregate: 20mm retaining size
- Sand: Fine aggregate
- Water: Potable water
- Mineral admixtures: Fly ash

B. Characteristic of Material Cement: 53 grade of ordinary Portland cement

- Aggregate: 20 mm maximum nominal size of aggregate
- Sand: Fine aggregate
- Water Cement ratio 0.35

We casted three cubes for each w/c ratio and cured these for four days. And from this we get that M25 concrete delivers higher compressive strength with 0.35 w/c ratio. It shows in table I

We also study of variation in slump for different w/c ratio

Table ICOMPRESSIVE STRENGTH OF CONCRETE WITH DIFFERENT W/C RATIO

Sr.No.	W/C ratio	Compressive Strength N/Sq.mm	Avg. Comp. Strength N/Sq.mm
1	0.35	21.3	22.4
2		23.7	
3		22.2	
4	0.45	20.6	20.83
5		20.8	
6		21.1	
7	0.55	8.97	11.08
8		12.28	
9		12.0	

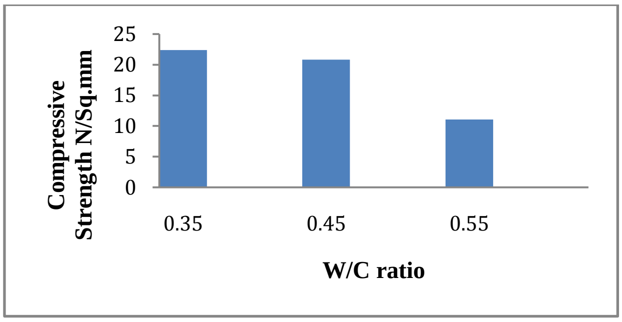


FIGURE I Variation in Compressive Strength for Different water cement ratio

Table II SLUMP OF CONCRETE WITH DIFFERENT W/C RATIO

W/C Ratio	0.35	0.45	0.55
Slump in MM	0	30	160

Table III Compressive strength for different proportion of fly ash after 7 days curing

S.N.	% Of Fly Ash	Compressive Strength N/Sq.mm	Avg. Compressive Strength N/Sq.mm
1	0 %	27.5	23.5
2		23.6	
3		19.4	
4	10 %	22.5	26.20
5		28.62	
6		27.5	
7	20 %	27.2	25.3
8		22.8	
9		25.9	
10	30 %	23.08	20.91
11		20.12	
12		19.54	

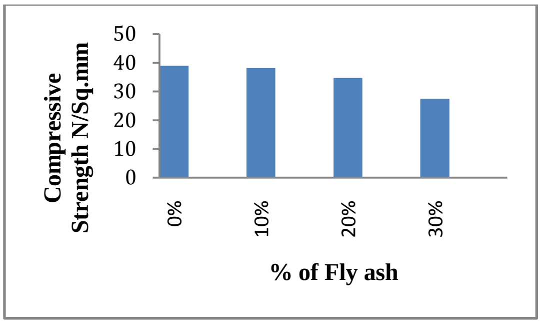


FIGURE III Compressive Strength For Different Proportion Of Fly Ash After 7 Days Curing\

Table IV Compressive strength for different proportion of fly ash after 14 days curing

S.N.	% Of Fly	Compressive	Avg.

	Ash	Strength N/Sq.mm	Compressive Strength N/Sq.mm
1	0 %	35.1	33.81
2		32.14	
3		34.2	
4	10 %	38.4	38.14
5		39.52	
6		36.5	
7	20 %	37.24	
8		31.45	
9		35.48	
10	30 %	26.5	
11		28.7	
12		27.29	

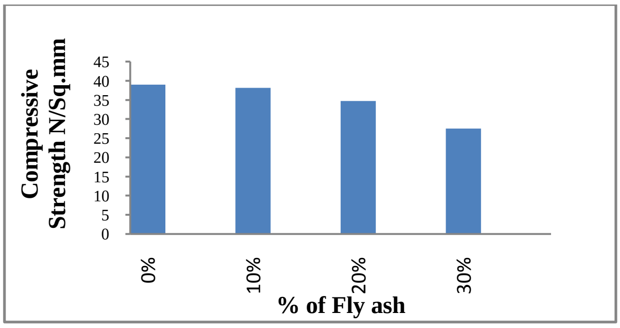


FIGURE II Compressive Strength For Different Proportion Of Fly Ash After 14 Days Curing

Table V Compressive strength for different proportion of fly ash after 28 days curing

S.N.	% Of Fly Ash	Compressive Strength N/Sq.mm	Avg. Compressive Strength N/Sq.mm
1	0 %	38.17	38.96
2		38.48	
3		40.25	
4	10 %	41.87	43.24
5		44.59	
6		43.28	
7	20 %	38.95	37.78
8		34.5	
9		39.89	
10	30 %	33.88	31.46
11		28.92	
12		31.58	

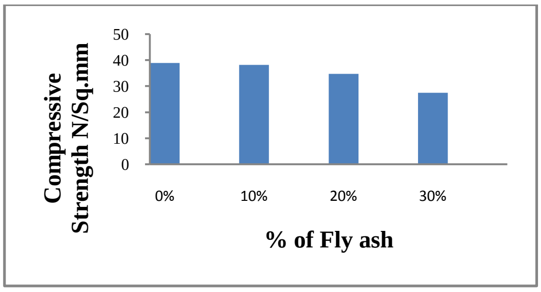
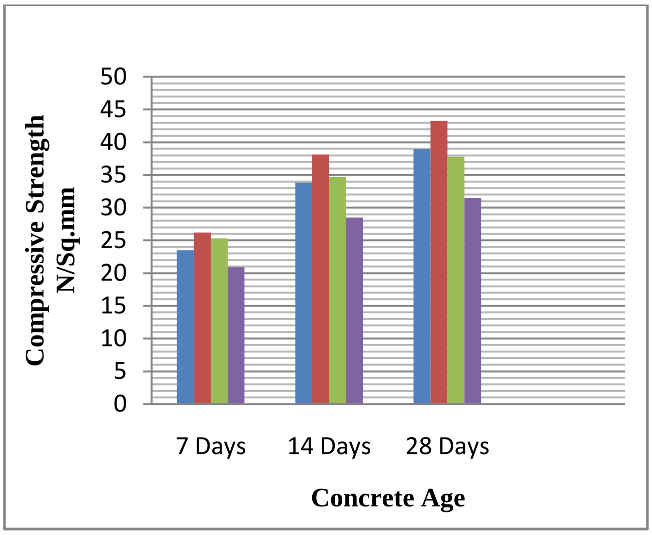


FIGURE IV Compressive Strength For Different Proportion Of Fly Ash After 28 Days Curing

In following figure we can compare variation of compressive strength of concrete for different proportion of fly ash and for different age of concrete. From the results obtained it can be clearly seen that for 10% to 20% replacement of fly ash with weight of cement compressive strength is increases and then if we further increases percentage of fly ash, compressive strength decreases.



COMPRESSIVE STRENGTH OF CONCRETE FOR DIFFERENT PERCENTAGE OF ASH AND FOR DIFFERENT AGE OF CONCRETE

V. CONCLUSIONS

This research concludes the study of the effect of fly ash on the properties of concrete‖ for nominal mix of M25 grade of concrete are as follows.

1. Slump loss of concrete increases with increase in w/c ratio of concrete.
2. For w/c ratio 0.35 without any admixtures, initial slump cannot be measured by slump cone test as it is very less.
3. Ultimate compressive strength of concrete decreasing with increase in w/c ratio of concrete.
4. Slump loss of concrete goes on increasing with increase of quantity of fly ash.
5. The 10% and 20% replacement of cement with fly ash shows good compressive strength for 28 days.
6. The 30% replacement of cement with fly ash ultimate compressive strength of concrete decreases.

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