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INVESTIGATION OF FLY ASH BASED CONCRETE WOTH DIFFERENT COMBINATIONS

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Abstract : The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. Presently large amounts of fly ash are generated in thermal industries with an important impact on environment and humans. In recent years, many researchers have established that the use of supplementary cementitious materials (SCMs) like fly ash (FA), blast furnace slag, silica fume, metakaolin (MK), and rice husk ash (RHA), hypo sludge etc. can, not only improve the various properties of concrete - both in its fresh and hardened states, but also can contribute to economy in construction costs. This experimental work describes the feasibility of using the thermal industry waste in concrete production as partial replacement of cement. The use of fly ash in concrete formulations as a supplementary cementatious material was tested as an alternative to traditional concrete. The cement has been replaced by fly ash accordingly in the range of 0% (without fly ash), 20%, 30% & 40% by weight of cement for M-20 mix. Concrete mixtures were produced, tested and compared in terms of compressive and split strength with the conventional concrete. These tests were carried out to evaluate the mechanical properties for the test results for compressive strength and split strength for 28 days are taken. This paper presents an Effect of Fly Ash on Properties of Concrete. The use of fly ash in concrete imparts several environmental benefits and thus it is eco-friendly. It saves the cement requirement for the same strength thus saving of raw materials such as limestone, coal etc required for manufacture of cement. Fly ash is pozzolanic material & it improving the properties of concrete like compressive strength & Durability. The results obtained are discussed and compared with the available literature.

Keywords *- fly ash (FA), supplementary cementitious materials (SCMs), blast furnace slag, silica fume, metakaolin (MK), and rice husk ash (RHA), hypo sludge, M-20 mix, pozzolanic material, compressive strength & Durability.*

1.INTRODUCTION

Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits. These industrial wastes are dumped in the nearby land and the natural fertility of the soil is spoiled. Fly ash is the finely divided mineral residue resulting from the combustion of ground or powdered coal in electric power generating thermal plant. Fly ash is a beneficial mineral admixture for concrete. It influences many properties of concrete in both fresh and hardened state.

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Moreover, utilization of waste materials in cement and concrete industry reduces the environmental problems of power plants and decreases electricity generation costs. Cement with fly ash reduces the permeability of concrete and dense calcium silicate hydrate (C–S–H). Research shows that adding fly ash to concrete, as a partial replacement of cement (less than 35 percent), will benefit both the fresh and hardened states.

While in the fresh state, the fly ash improves workability. This is due to the smooth, spherical shape of the fly ash particle. The tiny spheres act as a form of ball bearing that aids the flow of the concrete (Morotta, 2005). This improved workability allows for lower water-to-cement ratios, which later leads to higher compressive strengths (Mindess, et al., 2003).

In the hardened state, fly ash contributes in a number of ways, including strength and durability. While fly ash tends to increase the setting time of the concrete. The pozzolanic reaction removing the excess calcium hydroxide, produced by the cement reaction, and forming a harder CSH The present day world is witnessing the construction of very challenging and aesthetic structures. Concrete being the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Efforts are being made in the field of concrete technology to develop such concretes with special characteristics. In the present experimental investigation the fly ash has been used to study the effect on compressive and split strength on M20 grade of concrete.

2. AIM OF THE STUDY

Properties of concrete depend upon properties of ingredients and their relative proportion. Addition of mineral in concrete mixes, while designing of mixes has become increasingly complex. This is due to the chemical composition and pozzolonic properties of admixtures. The study will investigate the effect over the various properties of concrete with use of mineral admixtures. Based on above mechanism & combination the main objectives of this study are

a. To increase strength & durability of concrete by reducing water content & cement content. .
b. Reduce disposal problem by using industrial waste as a concrete ingredient.

3. MATERIALS USED

Cement:

Cement used in the investigation was found to be Ordinary Portland Cement(53 grade) confirming to IS : 12269 – 1987.

Fine Aggregate:

The fine aggregate used was obtained from a near by river course. The fine aggregate confirming to zone – II according to Is 383-1970 was used..

Coarse aggregate:

The coarse aggregate used is from a local crushing unit having 20mm nominal size. The coarse aggregate confirming to 20mm well-graded according to IS:383-1970 is used in this investigation.

Fly ash:

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Fly ash is composed of the non-combustible mineral portion of coal. Particles are glassy, spherical 'ball bearings' finer than cement particles. Sizes of particle are less than 90 microns. it is a pozzolonic material which reacts with free lime in the presence of water, converted into calcium silicate hydrate (C-S-H) which is the strongest and durable portion of the paste in concrete. The fly ash used in this project is obtained from Dr.N.T.T.P'S power plant.

Fig.1 Flyash

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 quantity and quality of water is required to be looked into very carefully. Water cement ratio used is 0.42 for M20 concretes.

Super plasticizer:

High-range water reducers, ASTM C 494 (AASHTO M 194) Types F (water reducing) and G (water reducing and retarding), can be used to impart properties induced by regular water reducers, only much more efficiently. They can greatly reduce water demand and cement contents and make low water-cement ratio, high-strength concrete with normal or enhanced workability. A water reduction of 12% to 30% can be obtained through the use of these admixtures. The reduced water content and water-cement ratio can produce concretes with

a. Ultimate compressive strengths in excess of 70 MPA,
b. Increased early strength gain,
c. Reduced chloride-ion penetration, and
d. Other beneficial properties associated with low water-cement ratio concrete.

Fig.2 Super plasticizer [NAPTHA]

4. EXPERIMENTAL WORK

Adopted Mix design - M20

Mix proportions:

Mass of cement = 300 kg/m3

Mass of water = 165 kg/m3

Mass of fine aggregate= 775.668 kg/m3

Mass of coarse aggregate =1163.5 kg/m3

Water cement ratio = 0.42

If admixtures are to be used add 1% of admixtures to the binding material.

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The following table shows the quantities of materials are to be required for 30% of fly ash for m_{20} mix design:

Material	For cubic mete in Kg's	For one cube in Kg's	For one cylinder in Kg's
OPC(53 G)	210	0.7 0875	1.113
Fly Ash	90	0.30 375	0.477
Fine Aggregate(RS)	775.668	2.61 7	4.114
Coarse Aggregate(20 mm)	1163.5	3.92 68	6.171
Water	165	0.55 6	0.875

Table.1: Designed Values of Materials

A. Methodology

A Partial replacement of cement with admixtures is done by mix proportions of mixed design procedure which is M20 grade. Before going to adding the admixtures into the cement a normal proportion is to be done. The **0%** of replacement of cement is considered, the mixing of all the materials are undertaken from M20 mixed design. The quantity of required materials are given in table 1. Through those proportions with water - cement ratio, the mixing of all aggregates is taken. The step by step process is explained below. The step by step process is same as for **20%, 30%,** and **40%** of all admixtures.

A standard 150×150×150mm cube specimens 300 mm height X 150mm diameter cylinder specimen were casted.

The samples were then stripped after 24hours of casting and are then be ponded in a water curing.

The method of curing adopted was the ponding method of curing and produced samples were cured for 7days, 14days, and 28 days.

B. Test For Fresh Properties of Concrete (Workability Test)

Slump Test:

which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing to workability, nor is it always representative of the placability of the concrete. It is not a suitable method for very wet or very dry concrete. It does not measure all factor contributing to workability. The slump test was carried in accordance with B.S:1882 PART2:1970.

Fig.3 Slump Cone test

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C. Test For Harden Properties of Concrete

a. Compressive Strength of Concrete

The compression test was conducted according to IS 516-1959. This test helps us in determining the compressive strength of the concrete cubes. The obtained value of compressive strength can then be used to assess whether the given batch of that concrete cube will meet the required compressive strength requirements or not. For the compression test, the specimen's cubes of 15 cm x 15 cm x 15 cm were prepared by using hwa concrete as explained earlier. These specimens were tested under universal testing machine after 7 days, 14 days and 28 days of curing. Load was applied gradually at the rate of 140kg/cm^2 per minute till the specimens failed. Load at the failure was divided by area of specimen and this gave us the compressive strength of concrete for the given sample.

Fig.4 Compressive strength testing machine

b.Split-Tensile Test

It is the standard test, to determine the tensile strength of concrete in an indirect way. This test could be performed in accordance with IS : 5816-1970.

A standard test cylinder of concrete specimen (300 mm X 150mm diameter) is placed horizontally between the loading surfaces of Compression Testing Machine. The compression load is applied diametrically and uniformly along the length of cylinder until the failure of the cylinder along the vertical diameter. To allow the uniform distribution of this applied load and to reduce the magnitude of the high compressive stresses near the points of application of this load, strips of plywood are placed between the specimen and loading platens of the testing machine. Concrete cylinders split into two halves along this vertical plane due to indirect tensile stress generated by poison's effect.


Fig.5: Split tensile sample testing

5. RESULTS

A. FLY ASH CUBES

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Days	0 %	20 %	30 %	40 %
7 D	29.11	26.88	30.22	22.88
14 D	35.11	31.11	32.22	27.11
28 D	38.88	34.44	35.33	30.00

Table.2 Flyash cubes compressive strength values

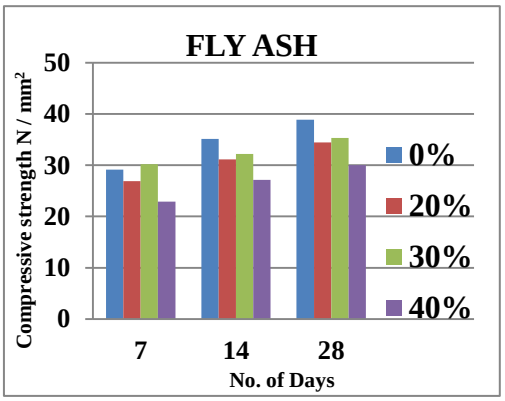

Fig.6: Flyash cubes compressive strength graph

B. ADMIXTURE CUBES:

Days	**0 %**	**20 %**	**30 %**	**40 %**
7 D	29.11	24.66	25.77	21.55
14 D	35.11	29.77	34.66	28.88
28 D	38.88	36.88	38.22	31.33

Table.3 admixtures cubes compressive strength values

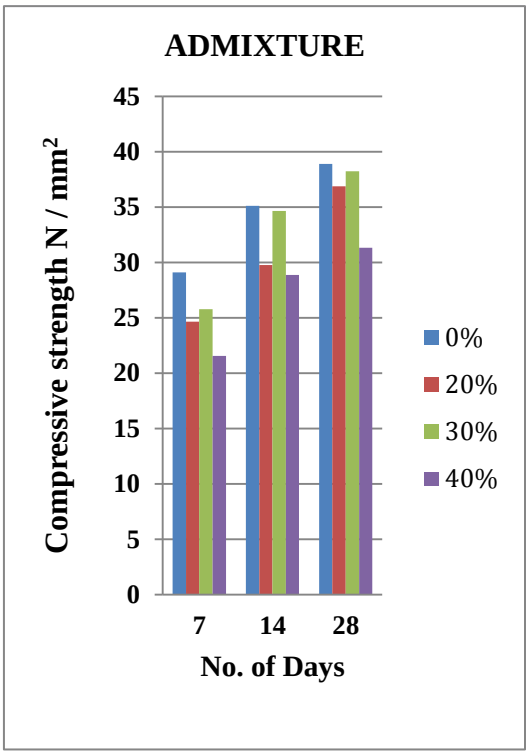

Fig.7: admixtures cubes compressive strength graph

C. FLY ASH CYLINDERS:

Days	0%	20%	30%	40%
7 D	2.76	2.05	2.47	2.12
14 D	2.78	2.08	2.26	2.26
28 D	2.97	3.11	2.76	2.4

Table.4 Flyash cylinders tensile strength values

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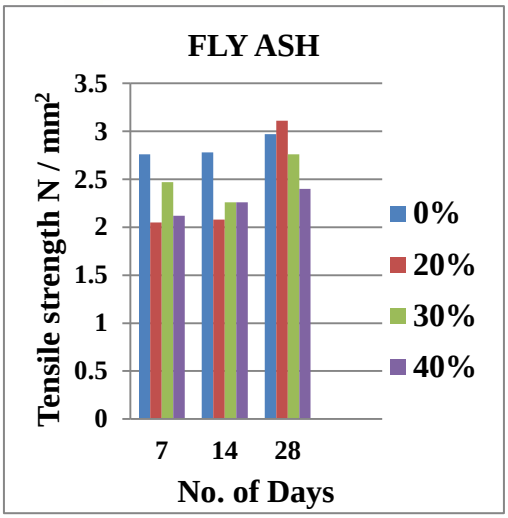

FIG.8: Flyash cylinders tensile strength graph

D. ADMIXTURE CYLINDERS:

Days	0 %	20 %	30 %	40 %
7 D	2.76	1.84	1.41	1.55
14 D	2.78	2.76	1.84	1.34
28 D	2.97	2.76	1.84	2.54

Table.5 admixtures cylinders tensile strength values

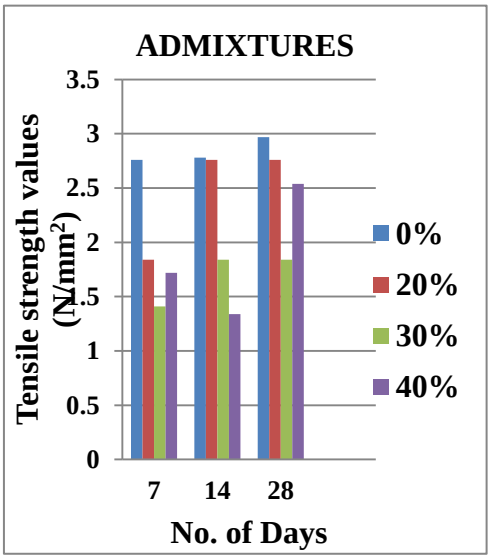

Fig.9: admixtures cylinders tensile strength graph

E. SLUMP CONE TEST:

Fly Ash Percentage (%)	Fly Ash Cone Height in mm	Admixture Percentage (%)	Admixture Cone Height in mm
0	280	0	0
20	275	1	155
30	270	1	160
40	260	1	170

Table.6 slump cone test values

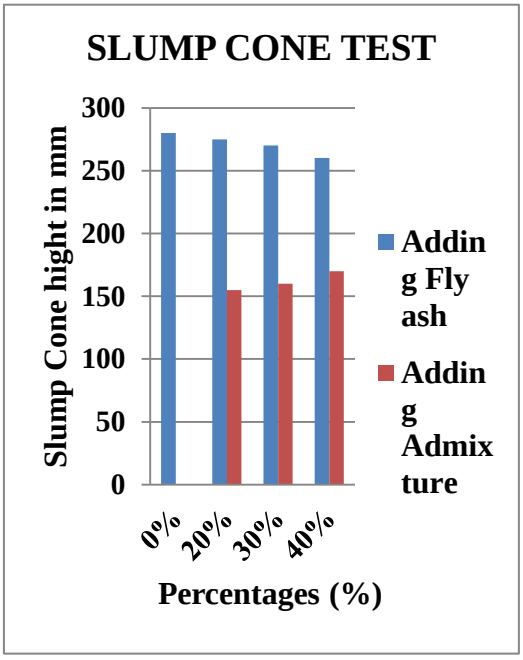

Fig.10:slump cone test

6. CONCLUSION

Based on limited experimental investigation concerning the compressive & split strength of concrete, for nominal mix of M25 grade of concrete the following conclusions are drawn:

a. Compressive strength reduces when cement replaced fly ash. As fly ash percentage increases compressive strength and split strength decreases.
b. Use of fly ash in concrete can save the coal & thermal industry disposal costs and produce a 'greener' concrete for construction.
c. Slump loss of concrete goes on increasing with increase of quantity of fly ash.
d. Concrete with 20% and 30% replacement of cement with fly ash shows good compressive strength for 28 days than normal concrete for 0.42 w/c ratio.
e. But in the case of 40% replacement of cement with fly ash ultimate compressive strength of concrete decreases.
f. The cost analysis indicates that percent cement reduction decreases cost of concrete, but at the same time strength also decreases.
g. This research concludes that fly ash can be innovative supplementary cementitious Construction Material but judicious decisions are to be taken by engineers.

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