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Utilization of Fly-Ash and Pond-Ash as A Partial Replacement of Cement In Concrete Mix Design

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ABSTRACT

Now-a-days energy planners are aiming to increase the use of renewable energy sources and nuclear to meet the electricity generation. But till now coal-based power plants are the major source of electricity generation. Disadvantages of coal-based thermal power plants is disposal problem of fly ash and pond ash. It was earlier considered as a total waste and environmental hazard thus its use was limited, but now its useful properties have been known as raw material for various application in construction field. In this present study of concrete produced using fly ash, pond ash and OPC 53 grade will be carried. An attempt will be made to investigate characteristics of OPC concrete with combined fly ash and pond ash mixed concrete for Compressive Strength test, Split Tensile Strength test, Flexural Strength test and Durability tests.

Keywords : Fly Ash, Pond Ash, Concrete, Compression, Flexural, Split tensile strength, Durability.

I. INTRODUCTION

Now-a-days energy planners are planning to increase the use of renewable energy sources and nuclear to meet the electricity demand in world but thermal power plants are the major sources of electricity production. The major disadvantages of thermal power plants are the disposal problem of different ashes. Ashes from these thermal power plants are available in large quantities type like fly ash and pond ash. Fine ash is used in construction industry in some amount and course ash is disposed over land in slurry forms. Only around 45% of fly ash is used in different sectors. Remaining fly ash is being disposed over land and around one acre of land is used for fly ash disposal to produce 1MW electricity from coal. Ashes utilization helps to reduce the consumption of natural resources.

To produce electricity approximately 180 MT Ash (fly ash and pond ash) is generated as a by-product material. The problem is the disposal of the ashes and its dumping. The problem after the production of electricity is it ash generated which produces air pollution, land pollution and availability of land for dumping which is very costlier. The research has to be carried out to find specific experimental data on the characteristic strength of concrete used fly ash and pond ash as cement replacement partially in concrete. If the experimental result is positive then the fly ash and pond ash can be used for partial replacement of cement in concrete which will reduce the cost of the concrete. Alternative materials will be generated and also the dumping problem and other environmental problem will be resolved.

II. METHODS AND MATERIAL

Cement:

Ordinary Portland cement of 53 grade confirming to specifications as per IS 12269–2013 is used and Specific Gravity is 3.15.

Fine aggregates:

The sand used for the experimental study is locally available and was confirming to zone-II. The specific gravity of fine aggregate is found to be 2.63. (Having characteristics according to IS 383-1963).

Coarse aggregate:

By conducting the physical test on coarse aggregate the obtained value of specific gravity is 2.9. (Having characteristics according to IS 383-1963).

Water:

Clean potable water available in the laboratory satisfying the requirements of IS 456:2000 is used for concrete mix.

Pond Ash:

Pond Ash from Gandhinagar Thermal Power Station is used for replacement of cement. Which contributes to the concrete mix and its specific gravity is 2.17.

Fly ash:

Fly Ash from Gandhinagar Thermal Power Station is used as a replacement of Cement. The specific Gravity of fly Ash is 2.3.

Experimental Investigation:

The experimental investigation is carried out by replacing cement partially with fly ash and pond ash in varying percentages to improve the strength of concrete. The required materials were weighed and mixed manually. The cube specimens of size 150 mm x 150 mm x 150 mm, beam specimens of size 700 mm x 150 mm x 150 mm and cylinder specimens of size 300 mm x 150 mm was casted. The specimens have been de moulded after 24 hours from the casting and the specimens were cured at a room temperature in water tank.

In this present study partial replacement of cement has done by using fly ash and pond ash. The grade of concrete is M_{25}.

TEST PROCEDURE:

Compressive Strength Test:

For the compressive strength test, cube (150mm x 150mm x 150mm) are tested in compression as given in IS: 516-1959. The compressive strength test was carried out at 7, 28 and 56 days of curing. The test was carried out on a set of triplicate specimens and the average compressive strength values was taken.

Compressive strength (N/mm^2) = Ultimate compressive load (N) / Area of cross section of specimen (mm^2)

Flexural Strength Test:

For flexural strength test. Beam (150mm x 150mm x 700mm) was tested in accordance with the test. The flexural strength test was carried out at 7 and 28 days of curing. The flexure strength of beam was calculated using the following equation:

Flexural Strength of Beam (N/mm^2) = PL/BD^2

P = Failure Load (N)

L = Length of beam (mm)

D = Diameter of beam (mm)

B = Width of beam (mm)

Split Tensile Strength Test:

For split tensile strength test. Cylinder (150mm x 300mm) was tested in accordance with the test. The split tensile strength test was carried out at 7 and 28 days of curing. The split tensile strength of cylinder was calculated using the following equation:

Split tensile strength= $2P/(\Pi DL)$

P = Ultimate Load (N)

L = Span of the Specimen (mm)

D = Width of the Specimen (mm)

Water Absorption Test:

The water absorption values for different mixtures of concrete was determined on 150mm x 150mm x 150mm cubes as per American society for testing and materials. The specimens was taken out of curing tank after 28 days to record the water saturated weight (Ws). The drying was carried out in an oven at a temperature of 105°c. The drying process was continued until the difference between two successive measurements agree close. Oven-dried specimens was weighted after they cooled to room temperature (Wd). Using these weights, saturated water absorption (SWS) was calculated. The formula used to find water absorption value of concrete specimens is given in equation:

SWA = [(Ws-Wd)/Wd] x 100

Where,

SWA - Saturated water absorption.

Ws - Weight of the specimen at fully saturated condition.

Wd - Weight of oven dried specimens.

Acid Attack Test [H_2SO_4]:

Acid attack on concrete often leads to deterioration and results in the failure of the structure. Hence it is necessary to test the durability of the concrete against acid reactions. Three cubes were cast for each specimen of concrete. The casted cubes were cured in clean water for 7 days. After curing, the cubes was dried for 24 hours. The dried weights of the cubes were noted down. Then the cubes were cured in the respective acid for 28 days. The concentrations of acid was maintained at 5% at its respective pH level. The weight of the cubes after 28 days of curing in acid was note down. The percentage loss in weight of the cubes was determined. That was loss in weight of the concrete cubes due to acid attack.

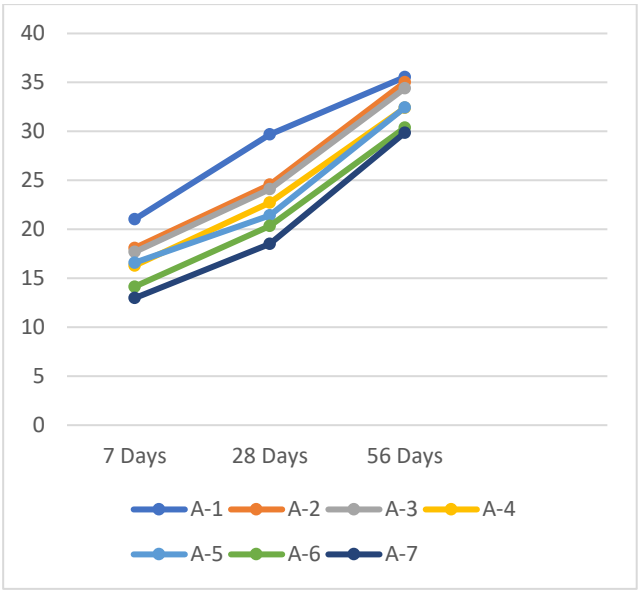
TABLE I

CONTENT OF VARIOUS MIX PROPORTION FOR M-25 GRADE CONCRETE

A-1	Control Mix M-25 Grade Concrete
A-2	M-25 Grade Concrete Contains 10% Fly Ash and 10% Pond Ash
A-3	M-25 Grade Concrete Contains 10% Fly Ash and 15% Pond Ash
A-4	M-25 Grade Concrete Contains 10% Fly Ash and 20% Pond Ash
A-5	M-25 Grade Concrete Contains 15% Fly Ash and 10% Pond Ash
A-6	M-25 Grade Concrete Contains 15% Fly Ash and 15% Pond Ash
A-7	M-25 Grade Concrete Contains 15% Fly Ash and 20% Pond Ash

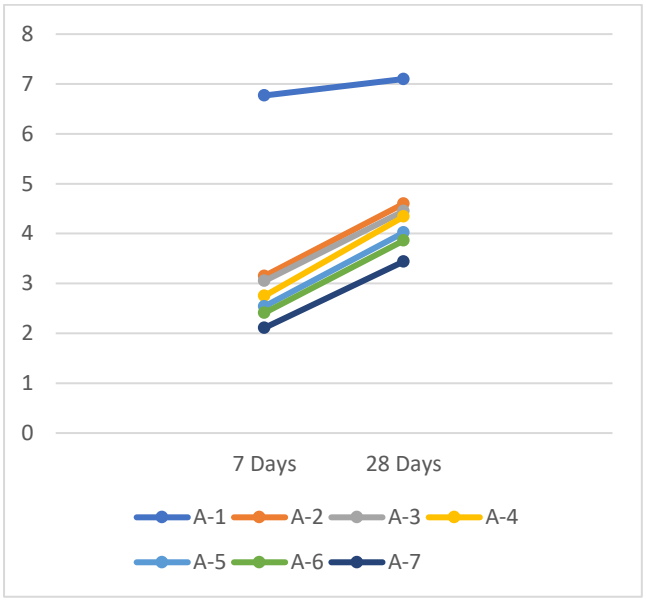
III. RESULTS AND DISCUSSION

Compressive Strength Results:



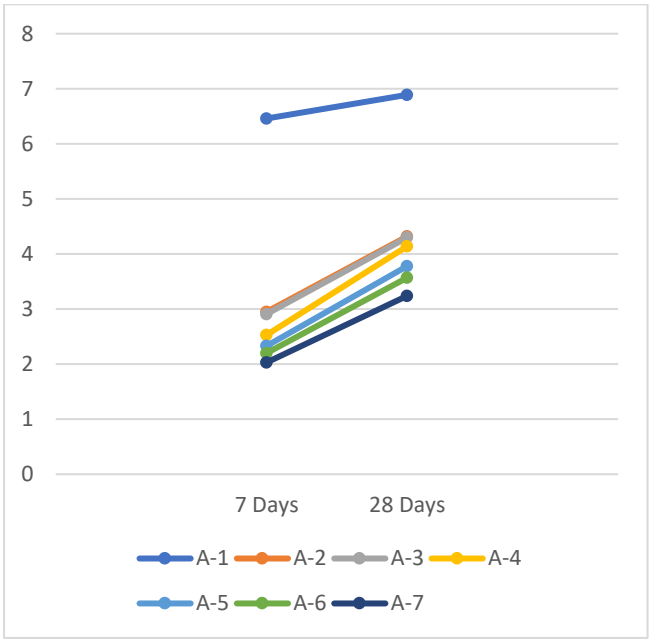
Graph: 1 Concrete Mix V/S Compressive Strength (N/mm^2) At 7, 28 & 56 Days

Flexural Strength Results:



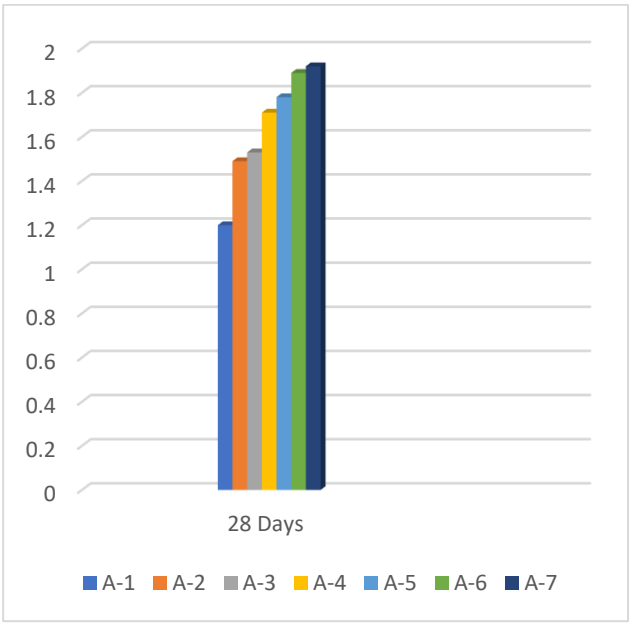
Graph: 2 Concrete Mix V/S Flexural Strength (N/mm²) At 7 & 28 Days

Split Tensile Strength Results:



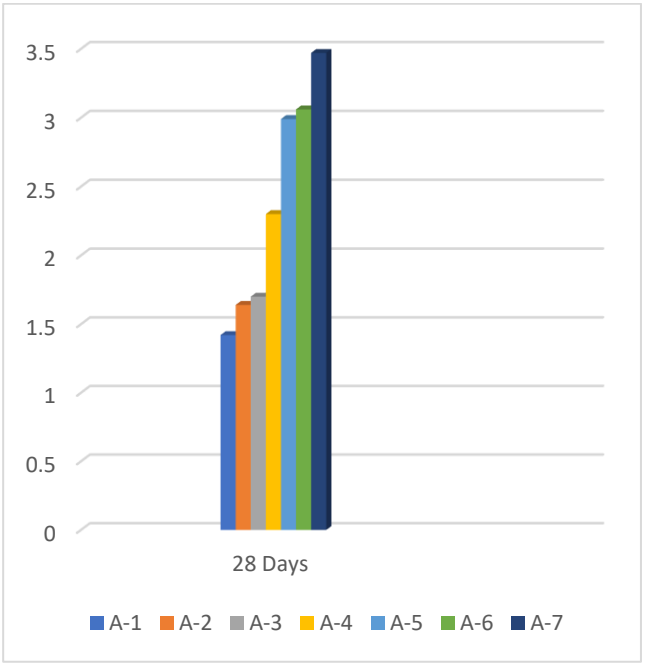
Graph: 3 Concrete Mix V/S Split Tensile Strength (N/mm²) At 7 & 28 Days

Water Absorption Test Results:



Graph: 4 Concrete Mix V/S Water Absorption Test (%) At 28 Days

Acid Attack Test Results:



Graph: 5 Concrete Mix V/S Acid Attack Test (%) At 28 Days

IV.CONCLUSION

- The experimental results of this research work indicate that the concrete has less compressive strength compared to conventional concrete. The compressive strength of concrete on 7th day for A-2 mix is 18.09 N/mm² compared to 21.02 N/mm² for conventional A-1 mix. The compressive strength of concrete on 28th day for A-2 mix is 24.56 N/mm² compared to 29.70 N/mm² for conventional A-1 mix. The compressive strength of concrete on 56th day for A-2 mix is 35.01 N/mm² compared to 35.54 N/mm² for conventional A-1 mix.
- The Flexural strength of concrete on 7th day for A-2 mix is 3.15 N/mm² compared to 6.77 N/mm² for conventional A-1 mix. The Flexural strength of concrete on 28th day for A-1 is 6.79 N/mm² compared to 7.10 N/mm² for conventional mix.
- The Split tensile strength of concrete on 7th day for A-2 mix is 2.95 N/mm² compared to 6.46 N/mm² for conventional A-1 mix. The Split tensile strength of concrete on 28th day for A-2 mix is 4.32 N/mm² compared to 6.89 N/mm² for conventional A-1 mix.
- The water absorption value of concrete for mix A-1 is higher than control A-2 mix at 28 days.
- The Acid attack test value of concrete for mix A-1 is lesser (loss in weight) than other control mix specimens at 28 days.

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