# Experimental Study on High Performance Economical Concrete

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**Abstract**

Our project presents the experimental investigation carried out to study use of pond ash in concrete. Now a day it is important to think about effective utilization of pond ash to preserve natural resources and to have sustainable development. The concrete was prepared with different percentage of pond ash (15, 25, 35, 45 and 55 %) and it was tested at different ages (7 and 28 days). Results of pond ash concrete were compared with control concrete. For all proportions slump in a range of 100-120 mm was maintained. A property of pond ash concrete in fresh state and hardened state was tested. IST and FST of pond ash concrete goes on increasing as replacement level of pond ash with cement increases this is because of less content of cement. It is found that rate of increase of compressive strength at early ages mainly 3,7 and 28 days was low and during later age this rate was faster. This shows that later age strength of pond ash concrete is very good and has a scope to use in concrete which are of great importance in the construction field

**Keywords:** pond ash , cement , aggregate , replacement of sand.

## 1. Introduction

Lot of research has been carried out to use alternative material in concrete so as to satisfy various properties of concrete. Pond ash is one such alternative material which can be effectively used to replace the natural material. When coal is burned mainly flyash and bottom ash is produced. The fly ash is collected by Electrostatic precipitator process. The ash which is fall at the bottom of boiler is mixed with water, and then it is carried away from plant through pipes and finally dumped on open land. After evaporation whatever ash remains is called pond ash. The use of pond ash limited by technical and other concern, in structural concrete but it can be conveniently used in geotechnical and highway constructions, mass concrete construction, earth fill, encouraging the use of huge amount of pond ash generated from thermal power station. The power generation in India is likely to go up from 1,12,090 MW to2,12,000 MW in the year 2012. Every year about 65 to 75 million tonnes of ash continue to remain unutilized and dumped in ash ponds and the quantity of ash in ash ponds has increased from about 450 million tonnes in 1999-2000 to more than 900 million tonnes in 2005-2006. For disposal of this ash requires huge valuable land which may be agricultural or forest.

The disposal of Pond ash is a big challenge to all as concerning to their quantity which is increasing day by day. Hence worldwide investigation was performed to find alternative use of this waste material and its use in concrete as a partial replacement of cement is one of the effective methods of utilization. The possibility of utilization of thermal power plant byproduct i.e. pond ash as replacement to cement in concrete is taken into consideration.

**1.1 Supplementary cementious materials**

More recently, strict environmental – pollution controls and regulations have produced an increase in the industrial wastes and sub graded byproducts which can be of SCMs in concrete constructions not only prevent these materials to check the pollution but also to enhance the properties of concrete in fresh and hydrated states. The SCMs can be divided in two categories based on their type of reaction: hydraulic and pozzolanic. Hydraulic materials react directly with water to form cementitious compound like GGBS. Pozzolanic materials do not have any cementitious property but when used with cement or lime react with calcium hydroxide to form products possessing cementitious properities.

**1.1.1 Ground granulated blast furnes :**

It is hydraulic type of SCM. Ground granulated blast furnace slag (GGBS or GGBFS) is obtained by quenching molten iron slag ,a by-product of iron and steel making from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. Ground granulated blast furnace slag (GGBFS) has been utilized for many years as an additional cementitious material in Portland cement concretes, either as a mineral admixture or as a component of blended cement. Granulated blast furnace slag typically replaces 35–65% Portland cement in concrete. The use of GGBFS as a partial replacement of ordinary Portland cement improves strength and durability of concrete by creating a denser matrix and thereby increasing the service life of concrete structures. It has a higher proportion of the strength-enhancing calcium silicate hydrates (CSH) than concrete made with Portland cement only, and a reduced content of free lime, which does not contribute to concrete strength.

**1.1.2 Fly ash:**

It is pozzalanic SC material. Fly ash is one of the residues generated in the combustion of coal. Fly ash is generally captured from the chimneys of coal fired power plants, and is one of two types of ash that jointly are known as coal ash. the other, bottom ash, is removed from the bottom of coal furnaces. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide ($SiO2$) (both amorphous and crystalline) and calcium oxide ($CaO$). Fly ash is classified as Class F and Class C types.

It has been used successfully to replace Portland cement up to 30% by mass, without adversely affecting the strength and durability of concrete. Several laboratory and field investigations involving concrete containing fly ash had reported to exhibit excellent mechanical and durability properties. However, the pozzolanic reaction of fly ash being a slow process, its contribution towards the strength development occures only at later ages . Due to the spherical shape of fly ash particles, it can also increase workability of cement while reducing water demand.

**1.1.3 Silica Fume:**

It is also a type of pozzolanic material. Silica fume is a byproduct in the reduction of high-purity quartz with coke in electric arc furnaces in the production of silicon and ferrosilicon alloys. Silica fume consists of fine particles with a surface area on the order of 215,280 $ft^2/lb$ (20,000 $m^2/kg$). When measured by nitrogen adsorption techniques, with particles approximately one hundredth the size of the average cement Because of its extreme fineness and high silica content, silica fume is a very effective pozzolanic material particle.

Silica fume is added to Portland cement concrete to improve its properties, in particular its compressive strength, bond strength, and abrasion resistance. These improvements stems from both the mechanical improvements resulting from addition of a very fine powder to the cement paste mix as well as from the pozzolanic reactions between the silica fume and free calcium hydroxide in the paste. Addition of silica fume also reduces the permeability of concrete to chloride ions, which protects the reinforcing steel of concrete from corrosion, especially in chloride-rich environments such as coastal region. It has been reported that the pozzolanic reaction of silica fume is very significant and the non evaporable water content decreases between 90 and 550 days at low water /binder ratios with the addition of silica fume

**1.1.4 Pond Ash:**

When coal is burned mainly fly ash and bottom ash is produced. The fly ash is collected by Electrostatic precipitator process. The ash which is fall at the bottom of boiler is mixed with water, and then it is carried away from plant through pipes and finally dumped on open land. After evaporation whatever ash remains is called pond ash. The use of pond ash limited by technical and other concern, in structural concrete but it can be conveniently used in geotechnical and highway constructions, mass concrete construction, earth fill, encouraging the use of huge amount of pond ash generated from thermal power station. The disposal of coal ash would require 1000 square km. area or one meter square of land per person in India.

**1.2 Objectives**

The main objectives of the present study are as mentioned below:

- To explore the use of Pond ash as a partial replacement of cement in concrete.
- To study the effect of pond ash on the compressive strength of concrete.
- To compare the strength of conventional concrete and proposed pond ash concrete at different mix proportion.

## 2. Materials and Methodology

**2.1 Cement**

Cement must develop the appropriate strength. Generally same types of cements have quite different rheological and strength characteristics, particularly when used in combination with admixtures and supplementary cementing materials.

It is a mixture of calcareous, siliceous, aluminous substances and crushing the clinkers to a fine powder. Cement is the most expensive materials in concrete and it is available in different forms. When cement is mixed with water, a chemical reaction takes place as a result of which the cement paste sets and hardens to a stone mass. The cement used in this experimental investigation is ordinary Portland cement 53 grade ultra tech brand (IS 12269:2013). Storage of cement requires extra special care to preserve its quality and fitness for use. To prevent its deterioration it is necessary to protect it from rain, winds and moisture.

**2.1.1 Tests on cements**

The important physical properties of Portland cement are:

1. Fineness test
2. Standard consistency test
3. Initial and final setting time test

**2.2 Coarse aggregates**

As coarse aggregates in concrete occupy 35 to 70% of the volume of the concrete. It may be proper to categories the properties into two groups: exterior features (maximum size, particle shape, textures) and interior quality (strength, density, porosity, hardness, elastic modulus, chemical mineral composition etc.). Smaller sized aggregates produce higher concrete strength.

Particle shape and texture affect the workability of fresh concrete. The transition zone between cement paste and coarse aggregates, rather than the properties of the coarse aggregates itself. The maximum size of aggregate in between 20mm to 4.75mm. The physical properties of both coarse aggregate are evaluated as per IS: 2386 (Part III)-1963. In present investigation, we used coarse aggregates about size 10mm and 20mm.

**2.2.1 Sieve analysis of coarse aggregates**

Sieve analysis helps to determine the partial size of coarse aggregate. This is done by sieving the aggregates as per IS:2386 (part I) - 1963. In this investigation, we use different sized particles left over different sieves. Table 4.3.2(a) : Sieve analysis of 10mm coarse aggregate IS Sieve Designation

Table 2.2.1(a) : Sieve analysis of 10mm coarse aggregate

| IS Sieve Designation(mm) | Weight retained in gm | Percentage of Weight retained | Cumulative percentage of weight retained | Percentage of passing | Requirements as per IS 383 | remarks |
|---|---|---|---|---|---|---|
| 12.5 | 0 | 0.00 | 0.00 | 100.00 | 100 | |
| 10 | 276 | 13.80 | 13.80 | 86.2 | 85-100 | |
| 4.75 | 1642 | 82.10 | 95.90 | 4.10 | 0-20 | |
| 2.36 | 79 | 3.95 | 99.85 | 0.15 | 0-5 | |
| Pan | 3 | 0.15 | 100.00 | 0.00 | 0.0 | |

Fineness modulus = sum of cumulative percentage of aggregates retained on each sieve /100

$$= \frac{(0 + 13.80 + 82.10 + 3.95)}{100}$$

= 2.09

Table 2.2.1(b) : Sieve analysis of 20mm coarse aggregate

| IS Sieve Designation(mm) | Weight retained in gm | Percentageof Weight retained | Cumulative percentage of weight retained | Percentage of passing | Requirements as per IS 383 | remarks |
|---|---|---|---|---|---|---|
| 40 | 0 | 0.00 | 0.00 | 100.00 | 100 | |
| 20 | 254 | 12.70 | 12.70 | 87.30 | 85-100 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | 1648 | 82.40 | 95.10 | 4.90 | 0-20 | |
| 4.75 | 98 | 4.90 | 100.00 | 0.00 | 0-5 | |
| Pan | 0 | 0.00 | 100.00 | 0.00 | 0.0 | |

Fineness modulus = sum of cumulative percentage of aggregates retained on each sieve / 100

$$= \frac{(0 + 12.70 + 95.10 + 100.00)}{100}$$

$$= 2.08$$

### 2.2.2 Flakiness & Elongation index of coarse aggregates

The particle shape of aggregates is determined by the percentage of flaky and elongated particles contained in it. According to IS code 2386 (part-1) 1963 an aggregate having the least dimensions less than three fifth of its mean dimension is termed as flaky and particles having largest dimension (length) greater than 9/5 times the mean size are termed elongated. The presence of excess flaky and elongated particles in concrete aggregates decreases the workability appreciably for a given W/C ratio, therefore they require larger amount of sand, cement and water.

Table 2.2.2(a): flakiness & Elongation index of 10mm coarse aggregate

| Sieve Size (mm) | | Mass of test sample (consisting of at least 200 pieces)(gm) | Mass of flaky aggregates passing the Flakiness slot (gm) | Mass of non flaky aggregate retained on the flakiness slot(gm) | Mass of sample retained on elongation gauge (gm) for aggregates which are not flaky | Mass of sample retained on elongation gauge (gm) for aggregates which are flaky |
|---|---|---|---|---|---|---|
| Passing | Retained | | | | | |
| 63 | 50 | 0 | 0 | 0 | 0 | 0 |
| 50 | 40 | 0 | 0 | 0 | 0 | 0 |
| 40 | 25 | 0 | 0 | 0 | 0 | 0 |
| 31.5 | 25 | 0 | 0 | 0 | 0 | 0 |
| 25 | 20 | 0 | 0 | 0 | 0 | 0 |
| 20 | 16 | 0 | 0 | 0 | 0 | 0 |
| 16 | 12.5 | 0 | 0 | 0 | 0 | 0 |
| 12.5 | 10 | 1045 | 185 | 860 | 196 | 664 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | 6.3 | 852 | 150 | 702 | 150 | 552 |
| Total | | 1897 | 335 | 1562 | 346 | 1216 |

- Flakiness Index $= \frac{\text{weight of sample passing} \times 100}{\text{total weight of sample}}$

  $= \frac{335 \times 100}{1897}$

  = **17.66%**

- Elongation Index $= \frac{\text{weight of sample retained} \times 100}{\text{total weight of sample}}$

  $= \frac{346 \times 100}{1897}$

  = **18.24%**

Table 2.2.2(b) : flakiness & Elongation index of 20mm coarse aggregate

| Sieve Size (mm) | | Mass of test sample (consisting of at least 200 pieces)(gm) | Mass of flaky aggregates passing the Flakiness slot (gm) | Mass of non flaky aggregate retained on the flakiness slot(gm) | Mass of sample retained on elongation gauge (gm) for aggregates which are not flaky | Mass of sample retained on elongation gauge (gm) for aggregates which are flaky |
|---|---|---|---|---|---|---|
| Passing | Reatined | | | | | |
| 63 | 50 | 0 | 0 | 0 | 0 | 0 |
| 50 | 40 | 0 | 0 | 0 | 0 | 0 |
| 40 | 25 | 0 | 0 | 0 | 0 | 0 |
| 31.5 | 25 | 0 | 0 | 0 | 0 | 0 |
| 25 | 20 | 562 | 52 | 510 | 120 | 390 |
| 20 | 16 | 2560 | 420 | 2140 | 256 | 1884 |
| 16 | 12.5 | 1042 | 350 | 692 | 236 | 456 |
| 12.5 | 10 | 1210 | 246 | 964 | 320 | 644 |
| 10 | 6.3 | 10 | 0 | 10 | 0 | 10 |
| Total | | 5384 | 1068 | 4316 | 932 | 3384 |

- Flakiness Index = $\frac{\text{weight of sample passing} \times 100}{\text{total weight of sample}}$

  = $\frac{1068 \times 100}{5384}$

  = **19.84%**

- Elongation Index = $\frac{\text{weight of sample retained} \times 100}{\text{total weight of sample}}$

  = $\frac{932 \times 100}{5384}$

  = **17.31%**

## 2.3 Fine aggregates

### 2.3.1 Description

Fine aggregate normally consists of natural, crushed, or manufactured sand. Natural sand is the usual component for normal weight concrete. In some cases, manufactured lightweight particles used for lightweight concrete and mortar. The maximum grain size and size distribution of the fine aggregate depends on the type of product being made. The locally available river sand was used as fine aggregate in the present investigation. The sand is free from clayey matter, salt and organic impurities. It is found that the sand collected is conforming to IS: 383-1970.

### 2.3.2 Sieve analysis of fine aggregates

The Sieve Analysis of fine aggregates as sand is carried out to know the zone of the sand. The results of sieve analysis is given in Table below,

Table 2.3.2(a) : Sieve analysis of fine aggregate as sand

| IS Sieve Designation(mm) | Weight retained in gm | Percentage of Weight retained | Cumulative percentage of weight retained | Percentage of passing | Requirements as per IS 383 | remarks |
|---|---|---|---|---|---|---|
| 10 | 0 | 0.00 | 0.00 | 100.00 | 100 | |
| 4.75 | 82 | 8.20 | 8.20 | 91.80 | 90-100 | |
| 2.36 | 85 | 8.50 | 16.70 | 83.30 | 75-100 | |
| 1.18 | 175 | 17.50 | 34.20 | 65.80 | 55-90 | |
| 600 micron | 264 | 26.40 | 60.60 | 39.40 | 35-59 | |
| 300 micron | 199 | 19.90 | 80.50 | 19.50 | 8-30 | |
| 150 micron | 193 | 19.30 | 99.80 | 0.20 | 0-10 | |
| Pan | 2 | 0.20 | 100.00 | 0.00 | 0.0 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Total | 1000 | - | - | - | - | |

Fineness modulus = sum of cumulative percentage of aggregates retained on each sieve / 100

$$= \frac{(0 + 8.20 + 16.70 + 34.20 + 60.60 + 80.50 + 99.80)}{100}$$

= **3.00**

From the sieve analysis result, Sand falls under **Zone II** because fineness module is between range 3.37 - 2.1.

## 2.4 Pond Ash

### 2.4.1 Description

Ash is the residue after combustion of coal in thermal power plants. Particle size of the ash varies form around one micron to around 600 microns. The very fine particles (fly ash) collected from this ash generated by electrostatic precipitators are being used in the manufacture of blended cements. Unused fly ash and bottom ash (residue collected at the bottom of furnace) are mixed in slurry form and deposited in ponds which are known as pond ash. Among the industries, thermal power plants are the major contributor of pond ash. Be sides, this steel, copper and aluminum plants also contribute a substantial amount of pond ash. During the combustion of pulverized coal at the thermal power station the product formed are bottom ash, fly ash and vapors. The bottom ash is that part of the residue which is fused into particles and is collected at the bottom of the furnace.

### 2.4.2 Properties of pond ash

The properties of Pond ash were determined in laboratory. The physical properties of Pond ash are shown below table.

Table 2.4.2(a) : physical properties of Pond ash

| Sr no. | Parameter | Test result |
|---|---|---|
| 1 | Specific gravity | 2.02 |
| 2 | Fineness-passing 45 µm (%) | 61.05 |

## 2.5 Water

Water is the least expensive but most important ingredient of the concrete. Potable water was used for mixing and curing.The permissible limits were checked as per the I.S 456-2000.Water should be free from oil, salt, sugar, acid, alkali. The quality of water is important because contaminants can adversely affect the strength of concrete. Mixing water is the quantity of water that comes in contact with cement, impacts slump of concrete and is used to determine the water to cementitious material ratio w/cm of the concrete mixture.Strength and durability of concrete is controlled to a large extent by its w/cm.

Table 2.5(a) Permissible Limits For Solids as per IS 456 - 2000

| No. | Test as per | Content | Max. Permissible Limit |
|---|---|---|---|
| 1 | IS-3025 (PART-18) | ORGANIC | 200 mg/l |
| 2 | IS-3025 (PART-18) | INORGANIC | 3000 mg/l |
| 3 | IS-3025 (PART-24) | SULPHATES | 400 mg/l |
| 4 | IS-3025 (PART-32) | CHLORIDES | 2000 mg/l |
| 5 | IS-3025 (PART-17) | SUSPENDED MATTER | 2000 mg/I |

## 2.6 Methods:

### 2.6.1 Mix design M-25 grade (As per IS: 10262 -2009)

Table 2.6.1(a) : Mix Design of concrete M-25 Grade (As per Is 10626:2009)

| **A-1 Stipulations for Proportioning** | | |
|---|---|---|
| 1. | Grade Designation | M25 |
| 2. | Type of Cement | OPC 53 grade |
| 3. | Maximum Nominal Aggregate Size | 20 mm |
| 4. | Minimum Cement Content | 400 kg/m 3 |
| 5. | Maximum Water Cement Ratio | 0.45 |
| 6. | Workability (slump) | 120-/+25mm |
| 7. | Exposure Condition | severe |
| 8. | Degree of Supervision | Good |
| 9. | Type of Aggregate | Crushed Angular |
| 10. | Chemical admixture type | Superplasticizer |
| **A-2 Test Data for Materials** | | |
| 1. | Cement Used | Ultratech OPC 53 Grade |
| 2. | Sp. Gravity of Cement | 3.15 |
| 3. | Sp. Gravity of Water | 1.00 |
| 4. | Sp. Gravity of 20 mm Aggregate | 2.81 |

| | | |
|---|---|---|
| 5. | Sp. Gravity of 10 mm Aggregate | 2.80 |
| 6. | Sp. Gravity of Sand | 2.64 |
| 7. | Water Absorption of 20 mm Aggregate | 1.00% |
| 8. | Water Absorption of 10 mm Aggregate | 1.22% |
| 9. | Water Absorption of Sand | 1.26% |
| 10. | Free (Surface) Moisture of 20 mm Aggregate | Nil |
| 11. | Free (Surface) Moisture of 10 mm Aggregate | Nil |
| 12. | Free (Surface) Moisture of Sand | Nil |
| **A-3 Target Strength for Mix Proportioning** | | |
| 1. | Target Mean Strength | 36 N/mm2 |
| 2. | Characteristic Strength @ 28 days | 25 N/mm2 |
| **A-4 Selection of Water Cement Ratio** | | |
| 1. | Maximum Water Cement Ratio ( IS10262:2009 fig.2) | 0.45 |
| 2. | Adopted Water Cement Ratio | 0.35 |
| **A-5 Selection of Water Content** | | |
| 1. | Maximum Water content (IS10262:2009 table-2) | 186 lit. |
| 2. | Estimated Water contet | 160 lit. |
| **A-6 Calculation of Cement Content** | | |
| 1. | Water Cement Ratio | 0.35 |
| 2. | Cement Content (160/0.35) | 460 kg/cum |
| **A-7 Proportion of Volume of Coarse Aggregate & Fine Aggregate Content** | | |
| 1. | Vol. of C.A. as per table 3 of IS 10262 | 0.62 |
| 2. | Adopted Vol. of Coarse Aggregate | 62.0% |
| | Adopted Vol. of Fine Aggregate ( 1-0.62) | 38.0% |
| **A-8 Mix Calculations** | | |
| 1. | Volume of Concrete | 1.00 |
| 2. | Volume of Cement | 0.146 m3 |
| 3. | Volume of Water | 0.160 m3 |
| 4. | Volume of All in Aggregate in<br>Sr. no. 1 – (Sr. no. 2+3) | 0.694 m3 |

| | | |
|---|---|---|
| 5. | Volume of Coarse Aggregate<br>Sr. no. 4 x 0.62 | 0.43 m3 |
| 6. | Volume of Fine Aggregate in m3<br>Sr. no. 4x 0.38 | 0.264 m3 |
| **A-9 Mix Proportions for One Cum of Concrete (SSD Condition)** | | |
| 1. | Mass of Cement in kg/m3 | 350 kg |
| 2. | Mass of Water in kg/m3 | 158 liters |
| 3. | Mass of Fine Aggregate in kg/m3 | 762 kg |
| 4. | Mass of Coarse Aggregate in kg/m3 | 1237 kg |
| 5. ` | Mass of 20 mm in kg/m3 | 742 kg |
| 6. | Mass of 10 mm in kg/m3 | 495 kg |

**A-10 Proportion Mix**

| | Cement | Sand | Coarse Aggregate |
|---|---|---|---|
| | 350 | 762 | 1237 |
| | 1 | 2.177 | 3.534 |

### 2.6.2 Preparation of test specimen

For conducting compressive strength test on concrete cubes of size 150×150×150 mm are casted. A rotary mixture is used for thorough mixing and a vibrator is used for good compaction. After successful casting, the concrete specimens are de-moulded after 24 hours and immersed in water for 28 days maintaining 27±1□C. Fig.shows some concrete specimen casted in laboratory.


Fig. 2.6.2 (a): concrete cubes casted in the mould

### 2.6.3 Curing

Curing is the process of preventing the loss of moisture from concrete while maintaining a satisfactory temperature. More elaborately curing is defined as process of maintaining satisfactory moisture content and favorable temperature. In concrete during the period immediately following placement, so that hydration of cement may continue until the desired properties are developed to a sufficient degree to meet the requirement at service. After casting the mould specimens are stored in the laboratory and at a room temperature for 24 hours from the time at addition of water to dry ingredients. After this period the specimens are removed from the mould immediately submerged in clean and fresh water. The specimens are cured for 7, 28days in the present work.

### 2.6.4 Slump Test

Slump test is the most commonly used method for measuring consistency of concrete 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 is used conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch. Slump cone - a mould of 1.6 mm thick galvanized metal in the form of the lateral surface of the frustum of a cone with the base 200 mm in diameter, the top 100 mm in diameter and the height 300 mm. The base and the top shall be open and parallel to each other and at right angles to the axis of the cone. The mould shall be provided with a foot piece on each side for holding the mould in place, and with handles for lifting the mould from the sample. Tamping Rod - A round, straight steel rod 16 mm in diameter and approximately 600 mm in length. The tamping end shall be a hemisphere 16mm in diameter.

Fig. 2.6.4 (a): Slump test of concrete

Experimental slump result is 170mm after 30min. And 130mm after 60min. …..Hence slump is ok as per mix design.

### 2.7 Tests on hardened concrete

#### 2.7.1 Compressive strength test:

The compressive strength of specimens is determined after 7 and 28 days of curing with surface dried condition as per Indian Standard IS: 516-1959. Three specimens are tested for typical category and the mean compressive strength of three specimens is considered as the compressive strength of the specified category.

Fig. 2.7.1 (a): compressive strength of concrete3

## 3 Experimental evidence and Analysis

### 3.1 General

This chapter is concerned with the presentation of results of the experiments carried out wards the objective of the project. It includes results from compressive strength Test. The results are supplemented with graphs in order to have a better analysis of the Results.

### 3.2 Experimental result

### 3.2.1 Compressive strength test result

Table 3.2.1(a): Compressive Strength of pond ash concrete

| Sr. No. | Mix | % Replace of PA | Slump(mm) | Compressive Strength (Mpa) At various days | |
|---|---|---|---|---|---|
| | | | | 7 | 28 |
| 1 | Control | - | 120 | 24 | 32 |
| 2 | M1 | 15 | 116 | 20.1 | 28 |
| 3 | M2 | 25 | 114 | 17.8 | 26.2 |
| 4 | M3 | 35 | 114 | 14.3 | 23.5 |
| 5 | M4 | 45 | 118 | 11.6 | 22.8 |
| 6 | M5 | 55 | 119 | 9.7 | 17.5 |

## 4 Conclusion

- From the compressive strength results, It was observed that rate of increase of Compressive strength at early ages mainly 7 and 28 days was low but during later age this Rate was faster which indicates that pond ash concrete has good later age strength.
- The rate of chemical reaction of pond ash is slow at early ages with calcium hydroxide Which is liberated during hydration of cement but when rate of reaction increases it forms Stable calcium silicate and aluminate hydrates. This chemical reaction improves strength And durability of concrete.
- Table 5.2.1(a) shows compressive strength of pond ash concrete cubes with different Percentage of pond ash, number in bracket shows the percentage compressive strength of Cube in comparison to 28 days strength. It is also known that strength of pond ash Concrete goes on decreasing as percentage of pond ash increases; this is mainly due to Less availability of binding material i.e. cement and higher un-burnt carbon contents of Pond ash.
- In present study workability of concrete in term of slump was maintained between 100-120 mm. For first three replacement level of pond ash namely 15%, 25% and 35% the Workability is obtained within the range. But at 45% and 55% replacement level, Workability of concrete was less than 100 mm and hence super plasticizer dose was Added. This phenomenon may be due to coarse nature of pond ash and more carbon Content. The dose of super plasticizer was varied from 0.1%, 0.2%, and 0.3% and finally An optimum dose of 0.1 % was selected for getting desired workability.
- Specific gravity of pond ash is 2.02 which is less than general value of specific gravity of Cement, this reduces density of concrete. Table 6 shows linear decrease in density of Pond ash concrete. Fineness of pond ash passing through 45 μm is 61.05% which Indicates coarseness of pond ash.
- Initial and final setting time of pond ash concrete goes on increasing as replacement level Of pond ash with cement increases. That is perhaps due to less content of cement.

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