

# Study on Strength and Durability of Concrete with Partial Replacement of Fine Aggregate by Pond Ash

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**Abstract**— Use of alternate material in concrete such as industrial by-product Fly Ash and Pond Ash are an important eco efficiency drive. It is also the social responsibility of researchers to encourage the beneficial use of industrial by-product in order to preserve natural resources. The structures have to be designed taking care of both strength and durability factors. In recent years the durability of structures is given more importance along with the strength due to the behaviour of RCC structures which have assumed serious problems. This paper deals with suitability of Pond Ash from Raichur Thermal Power Station at different levels of replacement such as 0%, 10%, 20%, 30% and 40% of Fine Aggregate in concrete. Detailed characterization of Pond Ash as Fine Aggregate and concrete design mix for M30 grade was arrived as per IS code. Studies on its compressive strength, Flexural strength, Split tensile strength, Flexural strength of Beam and durability properties such as Sorptivity, Porosity, Water absorption tests were carried out and compared with conventional concrete specimens. A maximum of 30% partial replacement of fine aggregate by Pond Ash was observed as optimum replacement. And compressive strength, flexural strength and split tensile strength at 7 & 28 days curing period were tested. Total 6 number of beams were casted of which three beams were of conventional concrete and three beams were of optimum 30% replacement. The average ultimate load carrying capacity of conventional beam specimens was found to be 96.66KN and that of beams with optimum 30% replacement was found to be 102.33KN

**Key words:** Pond Ash, compressive strength, flexural strength, split tensile strength flexural strength of Beam, Durability, sorptivity, porosity

## I. INTRODUCTION

Over the last few years, environmental and economic issues have large interest in the development of alternative materials and reuse of industrial waste or by-products. Thermal power plants release waste materials as by-products which are threat to environment. Disposal of them is a major concern now-a-days. It consumes a large area and also has many environmental hazards. The pond ash is one of the waste product of thermal power plants. The current rate of generation of Pond ash in India has reached 130 million tons per annum with about 75,000 acres of precious land under the cover of large ash ponds. The current rate of utilization of pond ash is about 35%. It is of prime importance to carry out research works on the feasibility of using alternative materials like Pond ash its suitability for constructions, which can replace sand partially or fully contributing to sustainability burden on environment. The utilization of pond ash can result not only in reducing the magnitude of the environmental problems, but also to

exploit pond ash as a raw material for value added products and converse traditional materials.

## II. LITERATURE REVIEW

- (1) Arumugam.k conducted the experimental study to investigate the possibility of using pond ash in varying % as fine aggregate substitute in cement concrete. Pond ash differs from fly ash collected from electrostatic precipitators in a dry form in that it contains significant amount of relatively coarser particles. Concrete matrices were designed with 0%, 20%, 40% and 60% pond ash by replacing natural sand as fine aggregate and test specimens were prepared for compressive, flexure and split tensile strength, the concrete shows the compressive strength at 7, 28 and 56 days curing 16.5N/mm<sup>2</sup>, 36N/mm<sup>2</sup> and 42.7N/mm<sup>2</sup> respectively. For these mixes the flexural strength at 7 days curing period was 9.3N/mm<sup>2</sup> and for same mix the split tensile strength at 7 and 28 days curing period was 12 and 23N/mm<sup>2</sup>.
- (2) Bharathi Ganesh conducted the experimental investigation to determine the hardened properties of concrete such as compressive strength and durability parameters of M30 grade replacing sand by Pond ash partially by 12.5%, 25%, 37.5% and 50%. The concrete of M30 grade with 25% pond ash for 3, 7, 28 and 56 days curing shows the compressive strength 26.07mpa, 41.33mpa, 45.92mpa and 47.41 mpa.
- (3) R. Ilangovan conducted the experiment to determine the compressive strength, split tensile strength and flexural strength with those of conventional concrete with pond ash as fine aggregate. It was observed that the compressive strength varies from 53.77 to 37.70 N/mm<sup>2</sup> for 56 days and 43.18 to 29.85 N/mm<sup>2</sup> for 28 days and 33.63 to 21.48 N/mm<sup>2</sup> for 7 days.

## III. EXPERIMENTAL WORK

### A. Materials:

The materials used in this experiment were cement, pond ash; fine aggregate, coarse aggregate, water.

#### 1) Cement:

OPC 43 grade cement from a single batch will be using throughout the course of the project work. The properties of cement used are shown in table 1

#### 2) Fine Aggregate:

Locally available river sand belonging to zone II of IS 383-1970 was used in this project work with specific gravity 2.61.

3) *Coarse Aggregate:*

Crushed ballast stone of size 12mm and 20mm down confirming to IS 383-1970 was used in this project work. The specific gravity for 12mm size was 2.81 and for 20mm size was 2.83.

4) *Water:*

Potable water was used in the experimental investigation for both casting and curing.

5) *Pond Ash:*

Pond ash was used in this project work as partial replacement to sand. The sample was collected from Raichur Thermal Power Station. The result of sieve analysis of pond ash are shown in the table 2. The specific gravity of pond ash was 1.75.

7	Pan	0.723
8	Specific gravity = 1.75	

Table 2: Sieve Analysis of Pond Ash

IV. TEST SPECIMEN DETAILS

Test specimens are designed for M30 grade concrete with 0.5w/c ratio. In all the designations P0, P10, P20, P30 and P40 indicates the % of fine aggregate replacement by pond ash in concrete.

Test specimen	Mould size	NO of specimens casted
Cubes	150mmx150mmx150mm	55
Cylinders	150mm dia & 300mm height	40
Prisms	75mmx100mmx500mm	40
Beams	150mmx150mmx700mm	6

Sl no	Character	Experimental values
1	Normal Consistency	34%
2	Specific gravity	3.13
3	Initial Setting Time	32 minutes
4	Final Setting Time	4hr 12minutes
5	Finess modulus	3%

Table 1: Properties of cement

Sl No	IS Sieve size	Cumulative % passing
1	4.75mm	99.187
2	2.36mm	98.644
3	1.18mm	96.480
4	600mic	91.049
5	300mic	79.114
6	150mic	59.044

Sl no	Designation	% replacement of fine aggregate by pond ash
1	CB1, CB2, CB3	0
2	PB1	10
3	PB2	20
4	PB3	30
5	PB4	40

Table 3: Notation for Beam Specimens

V. MIX PROPORTIONS

Shows the details of mix proportions used in this project work for different % of replacement of sand by Pond ash

Mix Designation	% Pond ash fraction of fine agg.	Cement in kg	Pond Ash in kg	Fine aggregate in kg	Coarse aggregate in kg	Water in ltr	w/c ratio
P0	0	450	0	776.13	1028.85	225	0.5
P10	10	450	77.613	698.51	1028.85	225	0.5
P20	20	450	155.226	620.90	1028.85	225	0.5
P30	30	450	232.83	543.29	1028.85	225	0.5
P40	40	450	310.452	465.670	1028.85	225	0.5

Table 4: Concrete mix proportions

A. *Designed Concrete Mix:*

C	FA	CA	W/C
1	1.72	2.28	0.5

ash of different % replacement for 7 days & 28 days curing period are shown in Graph1, Graph2 and Graph3. The results for Conventional Beam and Optimum percentage Beam are shown in table 5. The Durability test results are shown in table 6

VI. RESULTS AND DISCUSSION

The compressive strength, Flexural strength, Split tensile strength with partial replacement of fine aggregate by pond

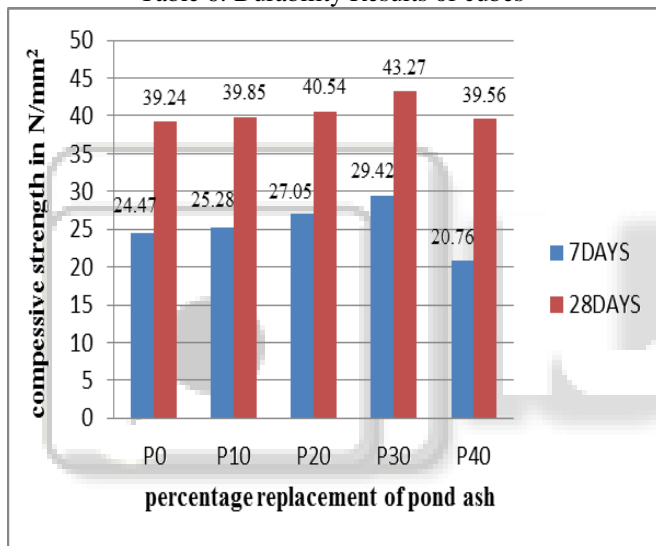
Sl no	Designation	Average Load (KN)	Average Deflection (mm)	Average Flexural Strength (N/mm <sup>2</sup> ) of Beams at 28 days	Remarks
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1	CB1	25.3	1.17	17.173	Average First crack load and Deflection
		96.6	3.46		Average Ultimate load and Deflection
2	PB3	20.66	0.59	18.133	Average First crack load and Deflection
		102	3.37		Average Ultimate load and Deflection

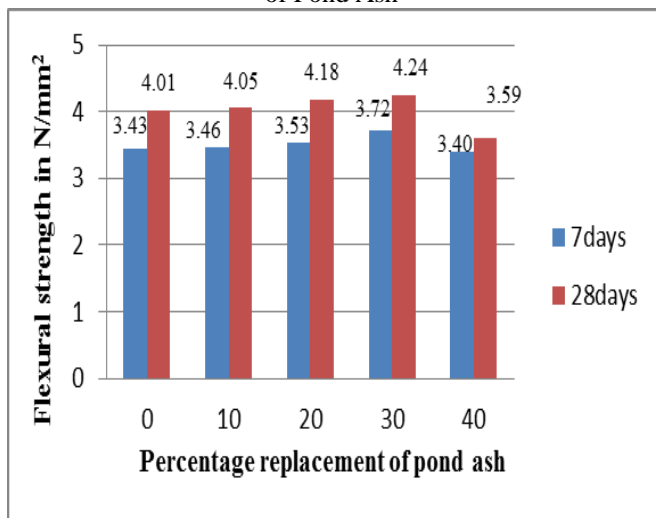
Table 5: Load and Deflection results for Conventional Beam and Optimum percentage Beam

Sl no	Designation	% Water absorption	% Porosity
1	P0	1.812	10.622
2	P10	0.667	5.250
3	P20	1.818	4.873
4	P30	2.229	6.438
5	P40	2.298	5.332

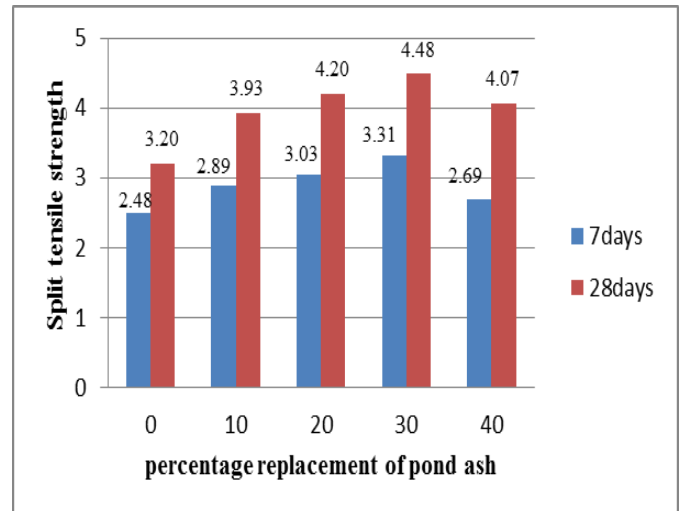
Table 6: Durability Results of cubes



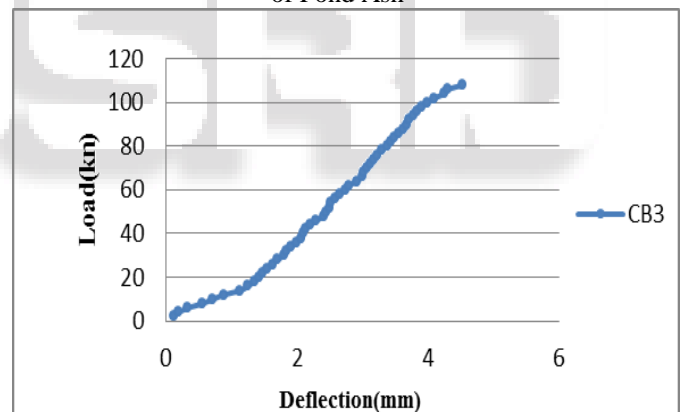
Graph 1: Compressive strength v/s percentage replacement of Pond Ash



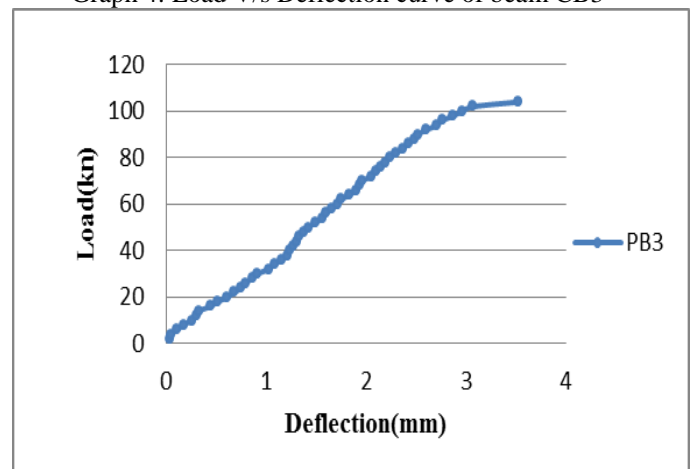
Graph 2: Flexural strength v/s percentage replacement of Pond Ash



Graph 3: Split tensile strength v/s percentage replacement of Pond Ash



Graph 4: Load V/s Deflection curve of beam CB3



Graph 5: Load V/s Deflection curve of beam PB3



Fig. 1: showing the crack pattern of conventional beam

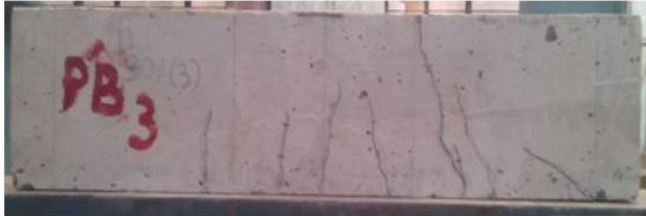


Fig. 2: showing the crack pattern of Pond Ash Beam

## VII. CONCLUSIONS

Based on limited experiment work conducted on strength and durability of concrete with partial replacement of fine aggregate by pond ash.

Following conclusions were drawn.

- (1) Porosity of pond ash concrete is considerably less than that of conventional concrete. Lowest porosity was observed at 20% partial replacement of fine aggregate by pond ash.
- (2) As the replacement of pond ash proportion is increases, the water absorption is increases compared to the conventional concrete. The highest water absorption was observed with 40% replacement of pond ash.
- (3) As the pond ash replacement increases there is increase in compressive strength, flexure strength and split tensile strength compared to that of conventional concrete. A maximum @ 30% partial replacement of fine aggregate by pond ash was observed the optimum strength.
- (4) The average load carrying capacity of optimum 30% replacement beams increased by 5.67% by that of conventional beam specimens. Hence we conclude that the use pond ash with river sand given a good results than that of conventional concrete beam
- (5) From the Strength And Durability test results it can be concluded that the use of pond ash is suitable for construction industries and aslo environmental friendly.

### A. Further Scope:

Following are the scope for future work.

- (1) Durability performance with reference to acid attack test can be studied.
- (2) Studies on corrosion resistance of pond ash can be conducted.

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