

Suitability Of Pond Ash As Partial Replacement Of Fine Aggregate In PPC Concrete

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Abstract—Exponentially increasing construction activities leads to rapid depletion of natural resources used in construction. Search of alternative material as partial replacement of conventional materials in construction is the imperative and unevitable. In the present investigation attempt is made to explore the possibility of use of pond ash as partial replacement of fine aggregate in concrete. Pond ash obtained from thermal power station was used as partial replacement of fine aggregate in M 25 grade of concrete. Replacement levels were 10%, 15%, 20%, 25%, and 30% by weight of fine aggregate. Specimens were tested for workability immediately after mixing and compressive strength after 7, 28 and 56 days curing. Result showed that pond ash (up to 20%) can effectively been used in PPC concrete without much compromising the compressive strength.

Keywords—Pond ash, Workability, Compressive strength, Lime, Workability

I. INTRODUCTION

Pond ash is a by- product of thermal power station. About 25% of total ash generated in thermal power plants is pond ash however; rest 75% is fly ash. Pond ash consists of fused coarser particle which are porous and appear like volcanic lava. Due to its pozzolanic nature it has potential to be used as supplementary and alternative material in construction industry. Use of pond ash in concrete will not only result in conservation of natural aggregate but also solve the problem of disposal of huge quantity of pond ash produced regularly and kept in abundance. Bhangale and Nemade (2013) reported that the density of concrete reduces with the increase in the percentage of pond ash. Arumugam, et al, (2011) reported that the compressive strength of concrete with ponded ash increases with increase in curing period. Ganesh, et al, (2012) reported that effective utilization of pond ash as a constituent in various concrete constructions encouraged the large scale utilization of industrial waste. Ghugal and Pateriya (2012) observed that 25 % pond ash with natural sand as fine aggregate gives consistently higher compressive strength. Agarwal et al, (2007) investigated that the workability of concrete decreased with the increase in bottom ash content

due to the increase in water demand .In the present investigation attempt is made to explore the possibility of use of pond ash as partial replacement of fine aggregate in concrete. Pond ash obtained from thermal power station was used as partial replacement of fine aggregate in M 25 grade of concrete. Replacement levels were 10%, 15%, 20%, 25%, and 30%. Specimens were tested for workability immediately after mixing and compressive strength after 7, 28 and 56 days curing.

II. MATERIALS AND METHODOLOGY

A. Cement

In this present investigation, Pozzolana Portland Cement (PPC) of Birla Gold brand obtained from single batches throughout the investigation was used. The Portland cement contents mainly two basic ingredients namely argillaceous and calcareous. The physical properties of cement are given in table 1.

Table1. Properties of Cement

Standard Consistency	31%
Initial Setting Time	245 minutes
Final Setting Time	310 minutes
7 days Compressive Strength	31 N/mm ²
28 days Compressive Strength	42 N/mm ²
Specific Gravity	2.70

B. Fine Aggregate

The fine aggregate, used in this investigation was locally available river sand which was passed through 4.75 mm sieve and its fineness modulus, specific gravity and moisture content were 2.83, 2.23 and 2.0 respectively.

C. Coarse Aggregate

The coarse aggregate, used in this investigation was obtained locally available quarry having two different sizes, one fraction was passing through 20mm sieve and its fineness modulus was 7.5, and another fraction passing through 10mm sieve and its fineness modulus is 6.8. The specific gravity and water absorption of coarse aggregate were 0.8 and 2.66 respectively for both fractions.

D. Pond ash

Pond ash obtained from NTPC, Tanda, Ambedkar Nagar (U.P) India was used in this investigation. The physical properties of ponded ash are given in table 2.

Table2. Physical Properties of Pond Ash

SI No.	Properties	Value
1	Specific gravity	2.4
2	Water absorption	15%
3	Fineness modulus	2.79

E. Concrete

The concrete mix design was done in accordance with IS 10262(2009). The cement content used in the mix design was taken as 380 kg/m³ which satisfies minimum requirement of 300 kg/m³ in order to avoid the balling affect. Good stone aggregate and natural river sand of Zone-II were used as coarse and fine aggregate respectively. Maximum size of coarse aggregate was 20mm. A sieve analysis conforming to IS 383-1970 was carried out for both the fine and coarse aggregates. Potable water was used for mixing and curing. The water cement ratio (w/c) used was 0.45.

F. Mix Design

M 25 grade of concrete was used in this investigation and fine aggregate was kept as 50% of the total volume of aggregate. Slump test was done to check the workability of concrete 45 control specimens of 150x150x150mm were casted to determine the compressive strength at 7, 28 and 56 days interval respectively. The resulting mix proportion of cement, fine aggregate and coarse aggregate was taken as 1:1.53:3 with water cement ratio of 0.45 and the quantity of cement is 380 kg/m³.

G. Super Plasticizer

KEM SUPLAST 101 S super plasticizer manufactured by Chembond Chemicals was used in this investigation. It was man made super plasticizer base forming sulphonated naphthalene and immediately dispersible in water having specific gravity 1.2.

H. Results and Discussion

Referral concrete as well as concrete made using pond ash as partial replacement of fine aggregate at different replacement levels were tested for workability and compressive strength.

I. Workability

The workability of concrete was determined by the slump test. It is used to describe the ease or difficulty with which the concrete is mixing, compacting and placing between the forms with minimum loss of homogeneity. The slump values of

concrete for different percentage of pond ash and super plasticizer is given in table 3.



Fig.1 Workability Measured by Slump Test

Table3. Workability of concrete

Sample	% of Pond ash	Dose of super plasticizer by wt. of cement (%)	Slump value (mm)
M ₁	0	0.6	35
M ₂	10	0.6	20
M ₃	15	0.8	15
M ₄	20	0.8	15
M ₅	25	1.0	10
M ₆	30	1.0	10

It is shown that workability of concrete made using pond ash decreases with increase in replacement level. The decrease in workability may be due to the increased volume of fine aggregate on equal weight basis as pond ash is lighter than the natural sand. For increased volume of fine aggregate more water is needed for lubrication thereby decreasing the workability.

J. Compressive strength

The compressive strength of different specimens for same concrete mix is different, so average compressive strength of three specimen sample was used for strength calculation. Compressive strength of referral concrete as well as concrete made using pond ash as partial replacement of fine aggregate is shown in table no. 4 and fig no.2.

Table4. Compressive strength of concrete.

S. NO	Cube designation	Compressive strength (N/mm ²)			% age of Pond ash
		7 days	28 days	56 days	
1	M ₁	19	31.3	37.4	0%
2	M ₂	20.37	33	39.1	10%
3	M ₃	20.1	32.3	38	15%
4	M ₄	18.3	28.1	36.5	20%
5	M ₅	16.7	25	34	25%
6	M ₆	15	23	31.5	30%

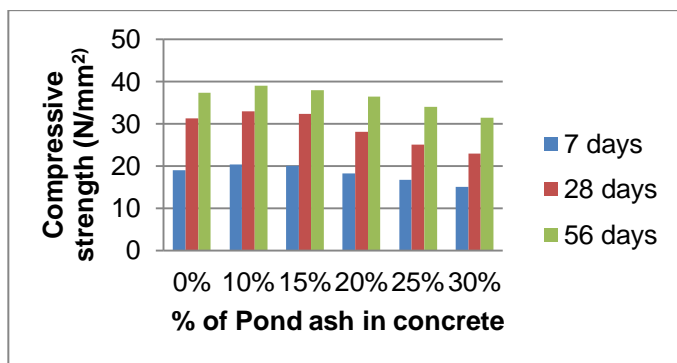


Fig.2 Compressive strength of concrete.

It is observed that on addition of pond ash up to 20% partial replacement of fine aggregate comparable increased in compressive strength is achieved at all ages as compared to the referral concrete. However the compressive strength is maximum at 15% replacement level. At this replacement level the compressive strength is 5.78%, 3.19% and 1.60% more than the referral concrete at 7, 28 and 56 days respectively.

The increase in compressive strength is due to the fact that pond ash being pozzolanic material reacts with free lime present in PPC and produce C-S-H gel, which has good binding properties thereby increase the compressive strength in general. Another reason of increase in compressive strength may be packing of voids in concrete by pond ash particles.

Further it seems that after 15% replacement level compressive strength is decreased with increase of replacement of pond ash at all the ages. This decrease may be due to fact that volume of pond ash replaced with fine aggregate is substantially more than that needed for packing of voids in concrete. This increase volume need more water for lubrication resulting decrease in compressive strength.

III. CONCLUSION

1. Workability is decreased with increase in replacement level.

2. Up to 15% replacement of fine aggregate by pond ash increase in compressive strength is achieved as compared to referral concrete.
3. At 20 % replacement level compressive strength is comparable to referral concrete however, beyond that compressive strength is substantial decrease at all ages.

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