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AN EXPERIMENTAL STUDY ON CONCRETE WITH PARTIALLY REPLACEMENT OF FINE AGGREGATE BY POND ASH

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ABSTRACT

Exponentially increasing construction activities across the globe leads to depletion of resources used in construction day by day. This condition obviously forces in search of alternative material as partial replacement of conventional materials in the construction is more essential and inevitable. In the present experimental work 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 as a waste product was used as partial replacement of fine aggregate in M25 grade of concrete. Fine aggregates are with replacement levels 10%, 15%, 20%, 25% and 30% by weight of fine aggregate. Specimens were tested for workability when the concrete is in green stat and compressive strength when the concrete is in hardened state after 7, 28 and 56 days curing. From the result it is concluded that how that pond ash (up to 20%) can effectively been used in PPC concrete without much compromising with the strength.

KEY WORDS: Pond ash, partially, replacement, fine aggregate, cement concrete, compressive strength, workability.

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INTRODUCTION

Continuous research efforts have proved concrete as a versatile material. Concrete needed for a wide range of construction activity can be made easily available since all the constituents of concrete are of geological origin. An increased demand for river sand as fine aggregate in the construction industry has resulted in the reduction of resources and an increase in cost. Under such circumstances, the pond ash which is a residue and by-product of thermal power plant can be used as an economic alternative to the natural sand.

Since the available sand as a fine aggregate is not able to meet the demand of construction sector, pond ash, defined as a residue and by-product of thermal power plants can be an inexpensive alternative to the river sand. The un-utilized electro static precipitator ash and bottom ash are mixed in slurry form and taken to lagoons for deposition which are known as pond ash. [12]

Pond ash

The most generally utilized undesirable materials to supplant bond and sand in concrete are Pond Ash, fly ash, Rice Husk Ash, Blast Furnace Slag, Red Mud, Phosphorus, Gypsum, Silica Fume, Crushed glass, Eggshells and so on [3].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 [4]. Flexibility, molding ability of concrete material, its high compressive strength and the steel reinforcing and pre-stressing technique in concrete facilitates to improve its strength as against its low tensile strength property and contributed largely for its wide spread use [6].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. The total production of fly ash in India is over 100 million tones and

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the disposal is major problem [7]. Pond ash is suitable as Fine aggregate in the manufacture of concrete masonry units (CMU) and similar products [8].

Advantages of Pond ash

- By using pond ash in cement concrete, we can reduce the cost of concrete without compromising the strength.
- This concrete is more useful in the areas where the cost of sand is expensive.
- By utilizing dumped pond ash we can protect the hectors of land from degradation.
- Compressive strength is high compared to the conventional.
- Pond ash to partially replace conventional fine aggregate in concrete mix, not only provides an effective solution to scarcity of sand / crushed stone, but also helps reduce the impact of coal ash disposal on the environment.

- Using of pond ash reduces the cost of concrete.
- Pond ash is suitable as Fine aggregate in the manufacture of concrete masonry units (CMU) and similar products.
- It is suitable for back filling of low lying areas.
- Suitable for saline soil/waste land reclamation.
- Appropriate quantity of Pond ash can increase production of agriculture, horticulture and forestry.
- It is suitable for stabilization of soil with appropriate amount of cement/lime & decrease the cost of foundation & pavement.
- Suitable for filing of Reinforced Earth (RE), wall pavements and flyover approaches.
- Utilizing of pond ash in concrete can reduce pond ash waste, conserve natural resources and reduce environmental impact on human health and living things.
- Low Value High Volume: Pond ash can be used for land and mine filling.
- Medium Value Medium Volume:
- For manufacturing bricks, blocks, paver blocks.

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- Acidic land (soil) can be improved by using pond ash.
- Geotechnical application as a substitute of earth dust.
- Road construction, embankment and flyovers.
- Raw material for cement**.**

MATERIALS

In this experimental work, ordinary Portland cement (PPC) 43 grade with cement content of 370 Kg /m3 conforming to IS: 8112 – 1989 was used. Natural sand confirming to IS 383-1970 of Zone II [8] and locally available crushed aggregates confirming to IS: 383-1970 is used in this work and Water fit for drinking was used. Concrete specimens with various percentages of the Pond Ash*10%, 15%, 20%, 25% and 30%* are used with partial replacement of fine aggregate by weight are prepared.

METHODOLOGY

A cement concrete Grade M30 with a proportion of 1:2.47:2.91 was prepared with a water cement ratio of 0.40. The cement is weighed as per the calculated amount and blended uniformly, later mixed with weighed quantities of fine and coarse aggregates with required amount of water, 0.5% -1% of super plasticizer in a batching tray. Filling each mould with concrete in 3 layers and compacting with 16 mm diameter rod with 25 blows and each each layer with vibrating. After 24 hours of filling concrete, specimens are demoulded and are kept for curing in water for 28 days. Workability tests such as Slump cone test is also carried out on hardened concrete in this experimentation. For compressive strength test, the cubes of size 150 mm x 150 mm x 150 mm were cast and tested under compression testing machine of 2000 kN the capacity as per IS: 516-1959 [7]. Specific gravities of materials used

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Material	Specific gravity
Cement	3.97
Fine aggregate	2.65
Coarse aggregate	2.63

TEST RESULTS AND DISCUSSIONOBSERVATIONS

From the table No. 1 it shows that the slump values are higher for every replacement of pond ash. As the pond ash content is increased the slump value also is decreased.

The fresh properties of concrete show that as there is an increase the content of pond ash, the flow characteristic of concrete decreases. This may due to the effect of bulk density and water absorption of Pond ash, which is higher to the fine aggregate

The compressive strength at 28days of curing is found to be increasing from B0 to B3 while after further addition of pond ash decreases the compressive strength in B4 and B5.

The compressive strength of concrete with 15% Pond ash replacement as fine aggregate has higher strength at 3, 7, 14, 28 days of curing.

Table No. 1 shows slump values for workability of the green concrete.

Table No 1 Slump cone test results

Sr. No	**Mix Designation**	**Cement (Kg)**	**CA (Kg)**	**FA (kg)**	**PA to FA (%)**	**PA (Kg)**	**Water (Kg)**	**Slump (mm)**
1	B0	370	1078	841	0	0	148	148
2	B1	370	1078	798.95	5	42.05	148	137
3	B2	370	1078	756.90	10	84.10	148	130
4								

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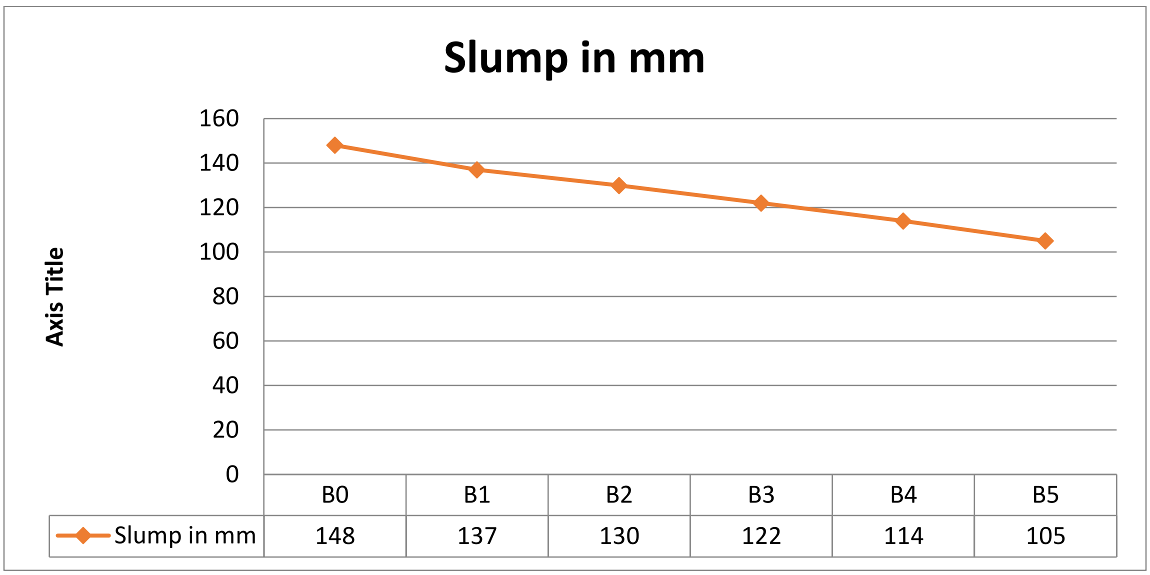
	B3	370	1078	714.85	15	126.15	148	122
5	B4	370	1078	672.80	20	168.20	148	144
6	B5	370	1078	630.75	25	210.25	148	105



Graph No. 1 Variation of slump values v/s various mix designations

Table No.2 Compressive strength of concrete.

Mix	Days	Weight of cube	Cross-sectional area (mm2)	Compressive strength (N/mm2)	Average compressive strength (N/mm2)
B0	3 Days	8.47	150x150	26.26 Mpa	26.44 Mpa
		8.5	150x150	27.55 Mpa	
		8.3	150x150	25.51 Mpa	
	7 Days	8.5	150x150	30.22 Mpa	29.91 Mpa
		8.12	150x150	27.86 Mpa	
		8.5	150x150	31.69 Mpa	
	14 Days	8.3	150x150	32.50 Mpa	31.84 Mpa
		8.5	150x150	29.87 Mpa	

		8.12	150x150	33.15 Mpa	
	28 Days	8.5	150x150	42.70 Mpa	42.87 Mpa
		8.12	150x150	39.80 Mpa	
		8.5	150x150	46.11 Mpa	
B1	3 Days	8.3	150x150	25.75 Mpa	26.76 Mpa
		8.00	150x150	27.10 Mpa	
		8.2	150x150	27.52 Mpa	
	7 Days	8.00	150x150	31.25 Mpa	30.55 Mpa
		8.2	150x150	28.75 Mpa	
		8.5	150x150	31.65 Mpa	
	14 Days	8.00	150x150	34.30 Mpa	33.89 Mpa
		8.2	150x150	32.85 Mpa	
		8.00	150x150	34.52 Mpa	
	28 Days	8.2	150x150	44.20 Mpa	43.56 Mpa
		8.1	150x150	40.87 Mpa	
		8.25	150x150	45.61 Mpa	

B2	3 Days	7.98	150x150	27.20 Mpa	27.05 Mpa
		7.25	150x150	26.40 Mpa	
		7.75	150x150	27.50 Mpa	
	7 Days	7.55	150x150	30.05 Mpa	31.20 Mpa
		7.89	150x150	31.55 Mpa	
		7.43	150x150	32.00 Mpa	
	14 Days	7.25	150x150	32.00 Mpa	33.90 Mpa
		7.75	150x150	33.67 Mpa	
		7.55	150x150	36.03 Mpa	
	28 Days	7.89	150x150	42.71 Mpa	43.67 Mpa
		7.43	150x150	43.52 Mpa	
		7.25	150x150	44.78 Mpa	
B3	3 Days	7.59	150x150	32.60 Mpa	31.80 Mpa
		7.02	150x150	34.55 Mpa	
		7.44	150x150	32.00 Mpa	
	7 Days	7.56	150x150	35.90 Mpa	33.43 Mpa
		7.23	150x150	34.55 Mpa	
		7.59	150x150	29.84 Mpa	
		7.02	150x150	40.80 Mpa	

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	14 Days	7.23	150x150	36.67 Mpa	38.23 Mpa
		7.02	150x150	37.20 Mpa	
	28 Days	7.44	150x150	50.40 Mpa	48.72 Mpa
		7.56	150x150	47.50 Mpa	
		7.23	150x150	48.30 Mpa	
B4	3 Days	7.18	150x150	31.72 Mpa	31.70 Mpa
		7.00	150x150	30.80 Mpa	
		7.23	150x150	32.58 Mpa	
	7 Days	7.45	150x150	33.87 Mpa	34.20 Mpa
		7.33	150x150	33.62 Mpa	
		7.15	150x150	35.10 Mpa	
	14 Days	7.00	150x150	36.60 Mpa	35.67 Mpa
		7.23	150x150	35.90 Mpa	
		7.45	150x150	34.50 Mpa	
	28 Days	7.33	150x150	49.80 Mpa	46.94 Mpa
		7.15	150x150	47.52 Mpa	
		7.00	150x150	43.50 Mpa	

B5	3 Days	6.87	150x150	25.30 Mpa	26.27 Mpa
		7.00	150x150	22.40 Mpa	
		7.95	150x150	31.10 Mpa	
	7 Days	6.91	150x150	30.20 Mpa	28.96 Mpa
		7.20	150x150	25.72 Mpa	
		6.87	150x150	30.95 Mpa	
	14 Days	7.95	150x150	29.52 Mpa	32.27 Mpa
		6.91	150x150	33.62 Mpa	
		7.20	150x150	33.67 Mpa	
	28 Days	6.87	150x150	38.20 Mpa	40.00 Mpa
		7.95	150x150	40.00 Mpa	
		6.91	150x150	41.20 Mpa	

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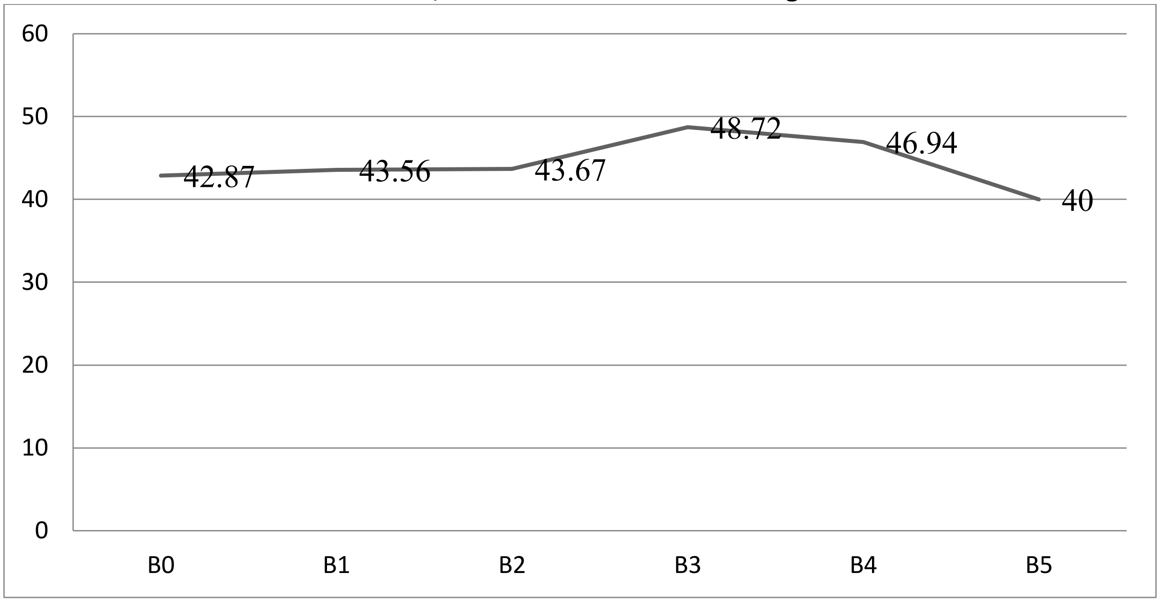

Fig no 2. Variation of Compressive strength per Batch Mix at 28 Days

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CONCLUSION

1. The specific gravity for fine aggregate is 2.61 and for pond ash it is 1.69. So the pond ash satisfies the limit of specific gravity criteria as per IS code. And can also be used to reduce the structural dead weight.
2. On replacement of Pond ash partially with Fine aggregate in mix B1 (5% replacement), B2 (10% Replacement), B3 (15% replacement), B4 (20% replacement), B5(25% Replacement), it is observed that the Unit weight of Pond ash Concrete reduces by 1.77 % to 18.89 % respectively in comparison to B0. The unit weight of concrete gets reduced through the addition of pond ash as replacement of fine aggregate since it has lower specific gravity than fine aggregate.

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3. The fresh properties of concrete show that as we increase the content of pond ash, the flow characteristic of concrete decreases. This may due to the effect of bulk density and water absorption of Pond ash, which is higher to the fine aggregate.
4. Due to mixing of Super Plasticizer an early strength of about 20% is achieved at early curing periods for all mixes. And as we increase the Pond ash, the admixture content also increases for making a pump able concrete (Slump ranges between 85-150mm) and to maintain the water cement ratio.
5. The compressive strength at 28days of curing is found to be increasing from B0 to B3 i.e. 42.87 MPa to 48.72 MPa while after further addition of pond ash decreases the compressive strength in B4 and B5 which is 46.94 MPa and 40.0 MPa respectively.
6. The compressive strength of concrete with 15% Pond ash replacement as fine aggregate has higher strength at 3, 7, 14, 28 days of curing. Hence the optimum replacement of fine aggregate by Pond ash is 15%.
7. The compressive strengths of Pond ash concrete are equal to or higher than the reference concrete at any given age. The utilization of pond ash enhances the strength considerably at later ages. The additional benefit in terms of strength can lead to economy.

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