

# Interrelationship between Strength and Durability Properties of Pond Ash Modified Concrete

Mr.Sakthivel<sup>1</sup>, G. Sakthivel<sup>2</sup>, M. Mokiwaran<sup>3</sup>, T. Ragulboopathy<sup>4</sup>

Assistant professor, Department of Civil Engineering, K. S. Rangasamy College of Technology, Tiruchengode, Tamil Nadu, India<sup>1</sup>

UG Student, Department of Civil Engineering, K.S. Rangasamy College of Technology, Tiruchengode, Tamil Nadu, India<sup>2,3,4</sup>

**ABSTRACT:** There Pulverized Coal Combustion (PCC) dry pond ash is a by-product of coal combustion that originates from the burning of pulverized coal to produce electricity. Because of the increasing costs associated with the disposal of pond ash and the environmental regulations in place, a significant need exists to develop alternate methods for profitable and environmentally safe uses of this waste material. Because of this Pond ash is used as a partial replacement for cement in concrete mix which may improve the quality of concrete structure in terms of strength and durability. Pond ash obtained from thermal power station was used as partial replacement of cement in concrete mix.

The 45 micron passing pond ash used for entire project with the replacement of 0%, 5%, 10%, 15% and 20% by cement in M25 grade of concrete. Specimens were tested for workability immediately after mixing and compressive strength after 28 curing. The mix design was carried out in accordance with IS 10262 2019. The optimum value was found the concrete using pond ash as cement with 10% replacement at M20 grade concrete which provides good result then conventional concrete and other mix proportion.

## I.INTRODUCTION

Concrete is a versatile civil engineering material. It is the most widely used building material. It can be moulded into any shape and the surface can be textured and colored for aesthetic purposes. It is produced with cost-effective materials. Concrete possesses good water-resistant properties and hence, it can be used in dams and canal linings for transporting water. Concrete is used to build various civil engineering infrastructures such as skyscrapers, bridges, sidewalks, highways, houses and dams. Structural elements are often built with reinforced concrete. When compared to wood or steel, concrete has an inherent fire-resisting property.

The cement and concrete industries continue to introduce sound, new technologies to meet municipal social, economic, and environmental challenges and strengthen our communities for generations to come. Concrete is durable since it resists weathering, erosion and natural disasters, needs few repairs and little maintenance, adding up to a solid investment. Concrete provides one of the most efficient and cost-effective means of constructing energy-efficient structures. A sustainable concrete building can yield life cycle savings of more than 2 Concrete is, as is well known, a thorough mixture of cement, coarse aggregate and fine aggregate. Concrete mixes can be varied to suit the purpose of different structures, designs, locations and types and magnitudes of stress 0% of total construction cost.

Currently, a large number of mineral admixtures, which are waste products of other industries, are being beneficially used in making good quality concrete. Some of the admixtures such as rice husk ash, silica fume, metakaoline, and ground granulated blast furnace slag, and coal bottom ash, fly ash and pond ash are used in concrete.

As the admixtures enhance concrete properties in terms of strength, durability and workability, the end product is also suitable for structures exposed to aggressive environments. Strength improving admixtures CONPLAST SP430 is used in the concrete Mix for improving the workability and also strength.

## II. MATERIALS AND METHODS

### MATERIALS

The details about various materials used for the present study and their test results. This was done in order to identify the most significant properties of structural concrete which should be investigated in this research work before establishing the limits within which pond ash can be used as a cement partial replacement material in structural concrete. The second reason was to achieve a good understanding of the factors which affect various properties of concrete, so that the experimental programmed can be designed to investigate the comparative influence of pond ash on properties of concrete.

1. OPC 53 Cement
2. Fine aggregate
3. Coarse aggregate
4. Water
5. Super plasticizer
6. Pond ash

#### CEMENT OPC 53

Selection of type of cement mainly depends on specific requirements of concrete; Ordinary Portland Cement (OPC) 53 has been used in the present study. Cement considered has been tested as per as per IS: 12269-1987.

#### FINE AGGREGATES (M SAND)

Fine aggregate produced by crushing hard stone. M-Sand is used in our project which is taken from sample passing through 4.75 mm in dry condition to avoid bleeding problem due to mixing. Aggregates give the dimensional stability and form bulk part of the concrete

Particularly in high strength concrete, it is pertinent to use good quality aggregates to get the desired properties since concrete uses more than 35 per cent of fine aggregates.

#### COARSE AGGREGATE

Coarse aggregate is considered to be the strongest and least porous component of concrete. As far as the shape of the aggregate is concerned, crushed granite coarse aggregate provides better interlocking and hence it helps achieve higher strength than rounded gravel aggregate. It should also be a chemically stable material. Locally available crushed granite aggregate of 20mm and 12.5mm down size conforming to IS 383-1970 was used as coarse aggregate for the present work.

#### WATER

The amount of water should theoretically be enough for complete hydration of cement and should not contain any harmful materials in it. Potable water has been used for making concrete in the present study. Potable water was used for mixing and curing of all concrete specimens.

#### SUPERPLASTICIZER

Super plasticizers are also known as high range water reducers. Requirement of right workability is the essence of good concrete and the concrete in different situations require different degrees of workability. Organic substances or combination of organic and inorganic substances, which allow a reduction in water content for the given workability or higher workability at the same water content, are termed as plasticizing admixtures. Super plasticizer constitutes a relatively new category and improved version of plasticizer.

#### POND ASH

The pond ash is a waste product from boilers, where the coal is burnt to heat the water for preparing the steam. Fig 4.5 shows the pond ash. It is mainly obtained from the wet disposal of fly ash. The fly ash gets mixed with bottom ash and disposed off in large pond or dykes as slurry. The main difference between pond ash and fly ash is in their particle size.

#### METHODS

Specimens were tested in compression testing machine of 1000 KN capacities and flexural testing machine. This compression testing machines are tested on various parameters to ensure their features such as corrosion resistant surface, long operational life and robust construction.

Flexural testing machines are designed to test the flexural strength of concrete beams. Two point loading method was used for determining the flexural of the specimen. Four tests to be conducted are

- Compressive strength



- Flexural strength test
- Sorptivity
- Sulphate resistance

**COMPRESSIVE STRENGTH TEST**

Compressive strength test is the most common test conducted on hardened concrete, partly because of its easiness to perform and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength.

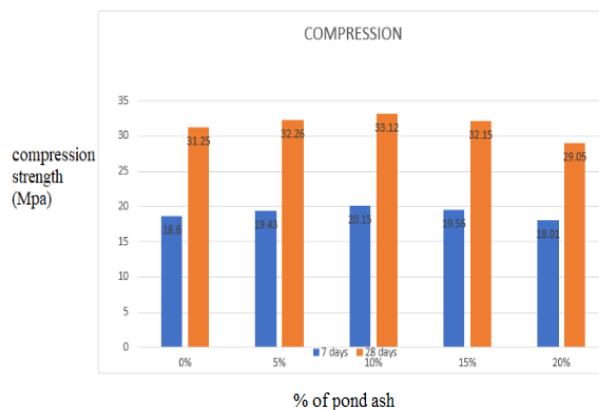
The cement was partially replaces with pulverized pond ash in various percentage of 0%, 5%, 10%, 15%, and 20%. Usually cubes and cylinder specimens are used to determine the compressive strength. Concrete cubes of 150 x 150 x 150 mm size were cast for compressive strength. The test specimens were subjected to compression test after 28 days of curing and desired degree of heating.

$$\text{Compressive strength} = \text{Ultimate Load/Cross Sectional Area}$$

$$= P/A \text{ N/mm}^2$$

Table 1 Compressive strength table

SI NO	% OF POND ASH	Compressive strength 7 days (Mpa)	Compressive strength 28 days (Mpa)
1	0	18.6	31.25
2	5	19.43	32.26
3	10	20.15	33.12
4	15	19.56	32.15
5	20	18.01	29.05



**FLEXURAL STRENGTH TEST**

Flexural strength also known as modulus of rupture, or bend strength, or transverse rupture strength is a material property, defined as the stress in a material just before it yields in a flexural test. The transverse bending test is most frequently employed, in which a specimen having either a circular or rectangular cross-section is bent until fracture or yielding using a three point flexural test technique. The flexural strength represents the highest stress



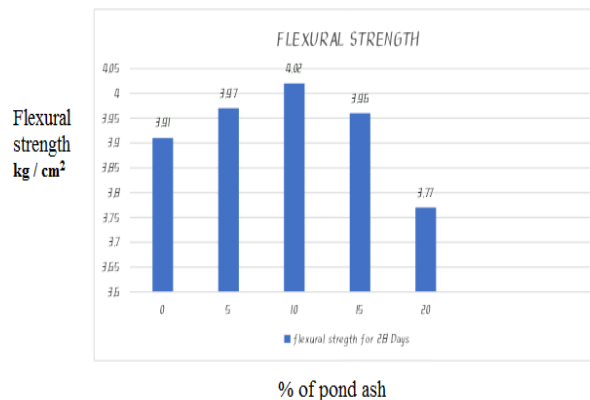
experienced within the material at its moment of yield. The flexural strength was determined using prisms of 100 x 100 x 500 mm size.

$$F=PL / bd^2$$

$$\text{Unit}= \text{kg} / \text{cm}^2$$

Table 2 Flexural strength table

SI NO	% OF POND ASH	FLEXURAL STRENGTH TEST FOR 28 DAYS
1	0	3.91
2	5	3.97
3	10	4.02
4	15	3.96
5	20	3.77



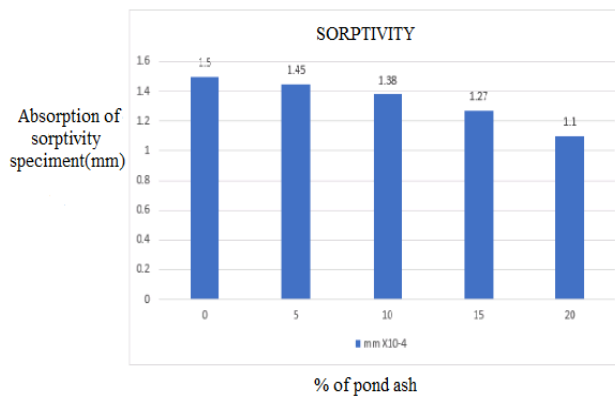
**SORPTIVITY TEST**

The sorptivity can be determined by the measurement of the capillary rise absorption rate on reasonably homogeneous material. Water was used as the test fluid. According to C Hall and D Hoff, the sorptivity express the tendency of a material to absorb and transmit water and other liquids by capillarity.

The sorptivity is widely used in characterizing soils and porous construction materials such as brick, stone and concrete.

Table 3 Sorptivity table

SI NO	% OF POND ASH	ABSORPTION OF SORPTIVITY SPECIMEN(MM)
1	0	1.5x10 <sup>-4</sup>
2	5	1.45 x10 <sup>-4</sup>
3	10	1.38 x10 <sup>-4</sup>
4	15	1.27x10 <sup>-4</sup>
5	20	1.10x 10 <sup>-4</sup>

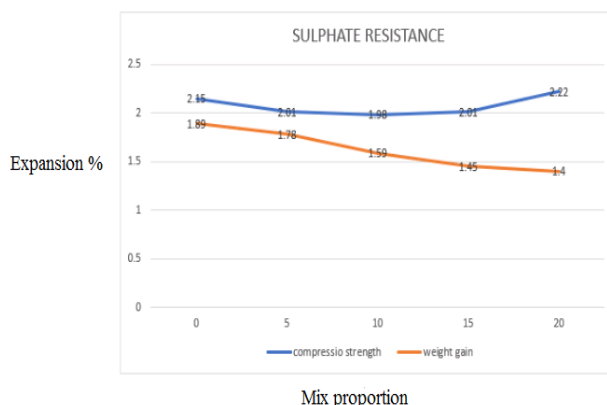


**SULPHATE RESISTANCE TEST**

The sulphate resistance of concrete was tested using drying-immersion cycles of varying duration in different sulphate solution. As this test appears to be suitable to determine the potential of concrete for expansion induced by ettringite formation due to sulphate ingress, it was introduced into the Swiss norms. ASTM C 1012 is employed to determine the sulphate resistance of the mixes. The cubes having 150 mm dimension were used in the test.

sulphate resistance table

SI. NO	MIX PROPORTION	COMPRESSION STRENGTH LOSS	WEIGHT GAIN
1	0	2.15	1.89
2	5	2.01	1.78
3	10	1.98	1.59
4	15	2.01	1.45
5	20	2.22	1.40



### III.CONCLUSION

From the experimental results on the replacement of pond ash with cement of concrete mix. Following can be drawn. The compressive strength for 7&28 days was increased. Due to pond ash replacement the initial strength gaining process is quite slow but later stages it gains very good strength as compare to traditional motor mixer. The problem of desponding pond ash is reduced by utilizing it in large quantity in engineering works. There is a marginal increase in the compressive strength and increase in flexural strength ash replacement on concrete.

Thus pond ash gives volume expansion results due to lower free time value in cement paste. The compressive strength of cement decrease with increase by the content of pond ash. From the examination on the pond ash in carpeted cement. It can be inferred that the pond ash acts as retarder and increases the initial setting time off cement paste. Pond ash should be utilized by identifying its qualities which greatly depends on the particle sizes

### REFERENCES

1. A.Sofi, B.R phanikumar (2015) "An experimental investigation on flexural behavior of fibre-reinforced pond ash-modified concrete", Ain shams engineering journal,(2015) 6,1133-1142.
2. Mukesh kumar, Vikas Srivastva, V.C Agarwal(2015) "Suitability Of Pond Ash As Partial Replacement Of Fine Aggregate In PPC Concrete", Journal of Multidisciplinary Engineering Science and Technology (JMEST)ISSN: 3159-0040.
3. Mahdi Rafieizonooz, Salmiati "Toxicity characteristics and durability of concrete containing coal ash as substitute for cement and river sand", construction and building materials 143 (2017) 234 -246.
4. B. Vidivelli and T. Subbulakshmi "Experimental Study on Durability Characteristics of High Performance Concrete Incorporating With Silica Fume, Bottom Ash & Steel Slag Aggregate", The International Journal Of Engineering And Science (IJES) Volume 5, Issue 6, Pages PP -103-109 and 2016 .
5. Manju Suthar, Praveen Aggarwal "Bearing ratio and leachate analysis of pond ash stabilized with lime and lime sludge", Journal of Rock Mechanics and Geotechnical Engineering 10 (2018) 769e777.
6. Malkit Singh, Rafat Siddique, (2015) "Effect of coal bottom ash as partial replacement of sand on workability and strength properties of concrete," Journal of Cleaner Production, vol.xxx, pp. 1-11.
7. Daniele Ricci, Fulvio Bassetti, Simone Savastano, (2018) "Beneficial effects of dry bottom ash extraction and recycling in modern PCF power plants," Fuel, vol.215, pp. 13- 21.
8. B.R. Phanikumar, A. Sofi, (2016) "Effect of pond ash and steel fibre on engineering properties of concrete," Ain Shams Engineering Journal, vol.7, pp. 89-99.
9. R.K. Mishra, R.K. Tripathi, Vikas Dubey, (2016) "Early age shrinkage pattern of concrete on replacement of fine aggregate with industrial by-product," Journal of Radiation Research and Applied Sciences, vol.9, pp. 386-391.
10. Min-Cheol Han, Dongyeop Han, Jae-Kyung Shin, (2015) "Use of bottom ash and stone dust to make lightweight aggregate," Construction and Building Materials, vol.99, pp. 192-199.
11. Hyeong-Ki Kim, (2015) "Utilization of sieved and ground coal bottom ash powders as a coarse binder in high-strength mortar to improve workability" Construction and Building Materials, vol.91, pp. 57-64.



12. Malkit Singh, Rafat Siddique, (2014) “Strength properties and micro-structural properties of concrete containing coal bottom ash as partial replacement of fine aggregate” Construction and Building Materials, vol.50, pp. 246-256.
13. Malkit Singh, Rafat Siddique, (2013) “Effect of coal bottom ash as partial replacement of sand on properties of concrete,” Resources, Conservation and Recycling, vol.72, pp. 20-32.
14. IS:456-2000 (fourth revision) code of practise for plain and reinforced concrete structures, BIS New Delhi.
15. IS:383-1970, Specification for coarse and fine aggregates from natural sources for concrete, BIS New Delhi.
16. IS:10262 – 2019, Concrete Mix proportioning – guidelines, 2019, BIS New Delhi.