Investigation on effects of Partial Replacement of Fine Aggregate by Pond Ash in Concrete

Jayprakash J Patil[1], Vinay B Chakrasali[2], and Vishwajeet O Biradar[3]
[1]*M. Tech Scholar, Padmabhooshan Vasant Dada Patil Institute of Technology, Bavdhan*
[2]*Professor, Padmabhooshan Vasant Dada Patil Institute of Technology, Bavdhan*
[3]*Professor, Padmabhooshan Vasant Dada Patil Institute of Technology, Bavdhan*

***Abstract*: Concrete is the most common construction material because it has very versatile properties. But the over-extraction of natural aggregates like sand has caused serious environmental problems. Pond ash, a thermal power plant coal combustion by-product, has proved to be a good substitute for partial replacement of fine aggregates in concrete. This research investigates the mechanical characteristics of concrete with different percentages of sand replaced by pond ash. Compressive strength was evaluated for mixes having 0%, 25%, 50%, 75%, and 100% sand replacement with pond ash. Results indicated that replacement up to 25% by pond ash produced compressive strengths equal to conventional concrete, thus suggesting pond ash as a viable green substitute for natural sand..**

***Index Terms*— Concrete, Pond Ash, Fine Aggregate Replacement, Sustainable Construction, Compressive Strength, Environmental Impact, Material Properties, Cost Analysis, Concrete Mix Design, Aggregate Alternatives**

I. INTRODUCTION

The high pace of growth in infrastructure development has created a surging demand for construction material, especially natural aggregates. Any construction work requires a considerable amount of natural aggregates. The 21st century is known to be an age of witnessing many construction wonders and advancements. It is an obvious fact that all these construction activities will require much more natural aggregates. The large amount of consumption of natural aggregates for construction work has become a serious environmental issue. Unchecked sand mining drastically impacts the environment, prompting the necessity to seek alternative, sustainable ones. One such alternative comes from pond ash, a byproduct of coal-based thermal power plants. Ash materials such as volcanic ash have been utilized by Romans throughout history for concrete and mortar, registering remarkable durability and longevity. This research investigates the potential of pond ash as a potential substitute for partial fine aggregates in concrete.

II. LITERATURE REVIEW

In their study, Phanikumar and Sofi [1] investigated the impact of pond ash in concrete as a partial replacement for sand. They found that the use of pond ash enhanced the workability and compressive strength of concrete up to some level of replacement.

Kshirsagar and Hegde [2] had studied the viability of pond ash as a partial substitution for fine aggregate in concrete. They concluded that concrete with similar strength and durability to the normal mixes was obtained by substituting up to 20% of the natural sand with pond ash.

Subsequent studies by Tushar G. More and Pankaj B. Autade [3] targeted the behavior of concrete when pond ash was employed as a fine aggregate substitute. According to them, 20% of the replacement level produced the best results in compressive strength as well as workability.

Sreelakshmi and Reshmi [4] investigated the durability characteristics of pond ash replacement concrete as fine aggregate. They showed that pond ash can improve the durability properties of concrete to be a potential substitute for natural sand.

Sharma and Ritu [5] carried out a characterization study of pond ash as an alternative to sand in concrete. They determined that pond ash has appropriate physical characteristics that qualify it as a good alternate for fine aggregate in concrete mixtures.

Madheswaran et al. [6] examined the use of pond ash as fine aggregate in concrete. The results of their experiments showed that pond ash can be utilized effectively up to a percentage without adversely affecting the strength and durability of concrete

III. METHODOLOGY

The concrete obtained by replacing natural sand with pond ash was tested for compressive strength. This was, in order to carry out the compressive test in view of examining the influence of pond ash as fine aggregate for concrete

Fig. I Concrete casts

As seen in Fig. I, mixes of M20 grade were developed according to IS 10262-1982 specifications. Pond ash partially replaced natural sand by weight at 0%, 25%, 50%, 75%, and 100%. Cubes of 150 mm size were cast and subjected to compressive strength tests after 7, 14, and 28 days of curing

The geometry of the cubes is standard and were tested on the UTM setup available.

Table I. Detailed Mix Proportions

Mix ID	Cement (kg/m³)	Fine Aggregate (kg/m³)	Pond Ash (kg/m³)	Coarse Aggregate (kg/m³)	Water (litre)
M1	1.428	2.850	0	5.71	0.6
M2	1.428	2.138	0.713	5.71	0.6
M3	1.428	1.425	1.425	5.71	0.6
M4	1.428	0.713	2.138	5.71	0.6
M5	1.428	0	2.850	5.71	0.6

Table I shows the Proportions in which the sand was mixed along with water.

IV. RESULTS AND DISCUSSION

Table II. Average Compressive Strength (MPa)

Mix	7 days	14 Days	28 Days
M1 (0%)	19.54	23.11	28.91
M2 (25%)	18.28	23.57	28.37
M3 (50%)	17.54	18.66	26.17
M4 (75%)	12.85	16.29	19.67
M5 (100%)	12.85	15.37	18.48

In Table II it can be seen that, M2 which contains a mix of 25% is quite minorly deviated from the 0% mix M1 value throughout the period with the least deviation seen at 14 days where it is seen to be almost un-distinguishable and exceeding by a slight margin.

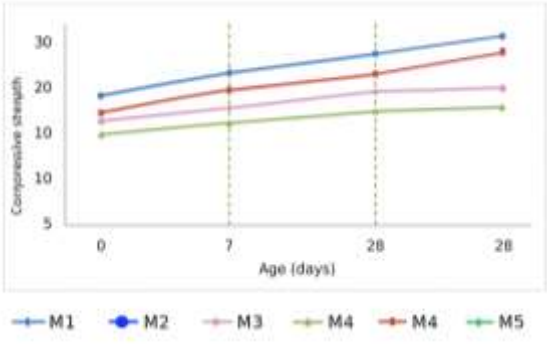

Fig. II Graph of Compressive strength of Experiments

As seen in Fig II The strength of M1and M2 are nearly similar to each other. The strength achieved was 28.91 and 28.37 mpa respectively. The strength of M3, M4, and M5 are 26.17Mpa, 19.67Mpa, and 18.48Mpa

Regardless, the real benefit here is the cost savings when using Pond ash. Cost considerations suggest some savings in concrete costs of production with higher pond ash content owing to reduced material costs. Strength limitations make only about 25% replacements feasible.

Special care was taken as to keep contamination out, keeping all the parameters in check so as to keep unaccountable errors out.

V. CONCLUSION

Pond ash is successful in replacing fine aggregates in concrete by up to 25% without seriously affecting strength. Replacement percentages greater than this substantially reduce compressive strength. The use of pond ash supports environmentally friendly practices and relieves pressure on environmental damage from sand mining. Production of bricks and pavement

blocks is possible. Production of timber substitute products is possible. Application in road construction and embankments is also a viable Option.

ACKNOWLEDGMENT

Thanks to Dr D B Jasutkar, Head of the department for allowing use of facilities at the Concrete technology lab at PVPIT, Bavdhan and invaluable support.

REFERENCES

1. *B. Phanikumar and A. Sofi, "Effect of pond ash in concrete as replacement of sand," Ain Shams Engineering Journal, vol. 7, no. 1, pp. 89–99, 2016.*
2. *A. Kshirsagar and R. Hegde, "Pond Ash as Partial Replacement of Fine Aggregate in Concrete," ResearchGate, May 2020. [Online]. Available: https://www.researchgate.net/publication/341293795_Pond_Ash_as_Partial_Replacement_of_Fine_Aggregate_in_Concrete*
3. *T. G. More and P. B. Autade, "A Study on Concrete Properties by Partial Replacement of Sand by Pond Ash," International Journal of Engineering Research and General Science, vol. 3, no. 6, pp. 95–207, 2015.*
4. *R. Sreelakshmi and P. Reshmi, "Durability performance of concrete replaced with pond ash as fine aggregate," IOSR Journal of Mechanical and Civil Engineering, vol. 13, no. 3, pp. 12–18, 2016.*
5. *S. Sharma and Ritu, "Characterization and use of pond ash in concrete as replacement of sand," International Journal of Technical Research, vol. 4, no. 3, pp. 57–60, 2015.*
6. *R. Madheswaran, M. Bharath, and M. Anjalidevi, "Utilization of pond ash as fine aggregate," International Research Journal in Advanced Engineering, vol. 3, no. 3, pp. 245–248, 2017.*