Impact Factor (SJIF): 5.301

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 5, Issue 8, August-2018

LABORATORY STUDY ON M-30 GRADE CONCRETE BY PARTIALLY REPLACEMENT OF M-SAND BY POND ASH

Praveen kumar P[1], Dr. Kiran kumar B V[2], P B Gnanamurthy[3], Rashmi G S[4]

[1]*Department of Civil engineering, Sri Krishnarajendra Silver Jubilee Technological Institute, Bengaluru-01*
[2]*Department of Civil engineering, Sri Krishnarajendra Silver Jubilee Technological Institute, Bengaluru-01*
[3]*Department of Civil engineering, Sri Krishnarajendra Silver Jubilee Technological Institute, Bengaluru-01*
[4]*Department of Civil engineering, Sri Krishnarajendra Silver Jubilee Technological Institute, Bengaluru-01*

Abstract—***This study presents the experimental investigation on concrete with fully replacement of fine aggregate by M-sand and is partially replaced by Pond ash. Concrete is the most abundantly used material in the present development world. Many researches are carried out in making concrete as environment friendly which means Green Concrete and low cost concrete by using industrial by-products effectively. The desired concrete with varying percentage of pond ash by weight of fine aggregate 0%, 10%, 20%, 30%, 40% and 50%. Properties of pond ash concrete in fresh and hardened state were stated for 7 and 28 days of curing, and results are compared with conventional concrete. The Mix design is done for M-30 grade of concrete adopted mix ratio is of 1:2.15:3.53. Compressive strength, split tensile strength, and flexural strength increases with increase in curing period due to pozzolonic property of pond ash. Hence usage of pond ash in concrete as replacement for M-sand becomes a sustainable material in the field of construction.***

Keywords- *Pond Ash, M-Sand, Slump, Compressive Strength, Split Tensile Strength, Flexural Strength*

I. INTRODUCTION

Concrete is the composed material consists of cement, fine aggregate, coarse aggregate and water. In concrete fine aggregate is act as a filler material, coarser aggregate act as dense mass and cement as a binder material which binds all the materials holds together. In recent days many researches are carried out to make concrete eco-friendly that is concrete can be manufactured using industrial waste products. Pond ash is one such alternative material which can utilize as replacement for fine aggregate, as filler material including construction of embankments. Pond ash is the by-product of thermal power station; India depends on coal for power generation. It is produced as a result of combustion of coal. On combustion of coal, fly ash and bottom ash are obtained. The production of pond ash is in great extent hence disposal of pond ash becomes a challenge to the environment.

Presently usage of M-sand as fine aggregate is more common as replacement for natural river sand. Excavation of river sand is banned due to environmental issues. While crushing rocks to the required gradation sizes in a specific rock crusher the crushed materials are subjected for washing to remove fines. And is allowed to dry in an open land the left over dried powder is the M-sand. Availability is not much complicated as natural sand. Hence M-sand is successively used as alternative for fine aggregate in the present study.

II. OBJECTIVES OF THE STUDY

- To know the basic properties of the materials used
- To find mix design for M-30 grade concrete, and to know the optimum dosage of pond ash percentage.
- To determine the workability of the fresh concrete for conventional and pond ash used concrete.
- To find the hardened properties of concrete with varying percentage replacement levels of pond ash.
- To compare the obtained results with the conventional concrete.
- Conduct cost comparative for all pond ash concrete with normal concrete.

III. LITERATURE REVIEW

Arumugam K,et.al(2011)[(1)]the study is about the use of pond ash in varying percentage as fine aggregate by 0%, 20%, 40% and 60% in cement concrete. The compressive strength, split tensile strength and flexural strength of concrete increases with addition of pond ash up to the 20% as sand replacement. On the addition of pond ash the workability reduces. With the increment in the percentage of pond ash in concrete shows gradual decrease in density due to lower specific gravity.

Bharathi Ganesh,et.al(2012)[2]the study depicts the properties of pond ash collected at different outlets the Raichur thermal power station, for its effective usage as fine aggregate. Pond ash after sieving and the fractions between 4.75mm-0.15mm shows improved fineness modulus. It confirms the effective usage of the pond ash as replacement for fine aggregate in terms of its durability and strength parameters.

Nimitha Vijayaraghavan.et.al.(2013)[3]here author used M-sand in place of natural sand with varying percentages of 0%, 30%, 40%, 50%, 60, 70% and 100% for different grades of concrete i.e. M30, M 40, and M 50. Strength tests are conducted and the result shows that 60% replacement of M-sand exhibits 20% more strength compared to normal concrete. Acid attack test, sulphate attack test and Rapid chloride tests are conducted as durability tests and the result enhance that the 60% M-sand concrete inhibits greater durability when compared to conventional concrete.

Biju Mathew.et.al.(2016)[4]his study is to know the optimum percentage replacement of natural sand by lateritic soil and manufactured sand for M20 grade. Concrete mixes with different percentage levels of 0%, 10%, 20%, 30% and 40% is adopted. Tests on hardened concrete are done, and the result revels that the 20% replacement of laterite sand as fine aggregate shows 20% more strength for all the three strength parameters. Further increment of laterite soil is not workable with lesser strength.

IV. MATERIALS AND METHODOLOGY

4.1 Materials

a) Cement

Cement of type Ordinary Portland with 53 Grade pledge to IS-12269-1987 is taken in present experimental work. Physical characteristics related to cement is tabulated in the below table-4.1.

Table.4.1.Physical properties of Cement

Sl. No	Test	Results obtained
1	Specific gravity	3.15
2	Fineness modulus	06 %
3	Normal consistency	31 %
4	Time for initial setting	40 min
5	Time for final setting	480 min

b) Pond ash

Pond ash is obtained at the bottom of the Thermal power plant, having slightly greater specific gravity compared to fly ash. It is the ash which may contains partially burnt coal particles. In the present study it is procured from the Raichur Thermal Power Plant, Raichur, Karnataka, India. Chemical composition and Physical properties of pond ash are tabulated in table.4.2.and table.4.3.Its gradation size comes under Zone IV. In the graph.4.1 grain size distribution curve is drawn.

Table.4.2.Chemical Composition of Pond Ash
(Ref. Cashutec, Raichur thermal power plant, Shakthinagara)

Chemical	Composition (%)
$SiO_2 + Al_2O_3 + Fe_2O_3$	91.04
Silicon dioxide (SiO_2)	67.24
Magnesium oxide (MgO)	0.74
Sulphur trioxide (SO_3)	0.19
Loss of Ignition	3.19
Insoluble residue	91.22
Calcium oxide (CaO)	3.53

c) M –sand

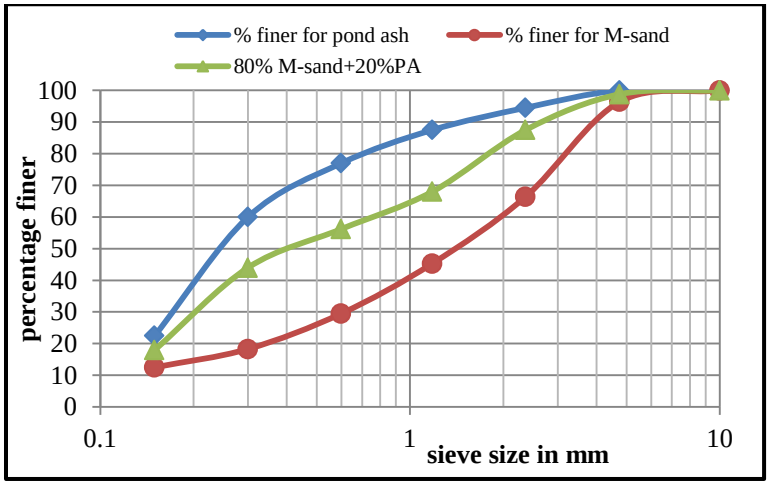
In the present study locally available M-sand with good quality is used. Maximum size of fine aggregate that is M-sand is of 4.75mm. Basic test results of the fine aggregate are listed in table.4.3. Sieve size analysis of M-sand and pond ash is in table.4.4. As per IS 383-1987 it falls under Zone I grade. Combined Gradation curve for M-sand and Pond ash is showed in Graph.4.1.

Table.4.3.Basic test results of M-sand and Pond ash

Sl. No.	Tests	Obtained Results for M-sand	Obtained Results for Pond ash
1	Specific gravity	2.65	2.12
2	Fineness modulus, %	3.35	2.59
3	Water absorption, %	1.74	0.5

Table.4.4.Sieve Analysis of Pond Ash and M-sand

Sl. No.	Sieve size (mm)	% finer for M-sand	% finer for Pond ash	20% PA + 80% M-sand
1	10	100	100	100
2	4.75	96.4	100	98.8
3	2.36	66.4	100	87.5
4	1.18	45.3	94.5	68
5	0.6	29.5	87.5	56.2
6	0.3	18.3	77	44
7	0.15	12.5	59.5	18



Graph.4.1.Grain size distribution curve for Pond ash and M-sand

d) Coarse aggregate

For this study locally available coarse aggregate is procured from the nearest quarry. 20mm down sized aggregates are preferred, Basic tests were conducted in the laboratory and results are tabulated in table.4.5.

Table.4.5.Coarse Aggregate Test results

Sl no	Tests	Results obtained
1	Specific gravity	2.67
2	Water absorption	0.98%
3	Impact value	15.6%
4	Los Angeles abrasion value	20.4%
5	Combined index	19.52%

e) Super plasticizer

Pond Ash is a type of material which requires larger quantity of water which affects workability. Use of a water reducer is an effective option. Super plasticizer is a supreme water reducing agent. Therefore Poly carboxylic ether (PCE) based super-plasticizer (Kalmatron, KF-A) is used.

V. RESULTS AND DISCUSSION

5.1 Tests on fresh concrete:

Workability testes are done to know the fresh concrete properties for desired modified concrete. The most common tests which are adopted to find the workability standard of the modified concrete at fresh condition are - Slump cone test, Compaction factor test, Vee- bee consistometer test. The obtained shows that the workability values decreases with increase in pond ash percentage due to irregular shape of its particles.

Table.5.1.Obtained results of workability tests.

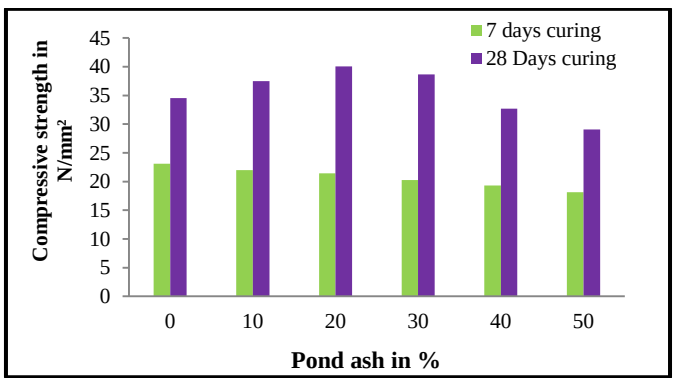
Sl. No.	Pond ash (%)	Slump (mm)	Compaction factor	Vee-Bee time in seconds
1	0	22	0.81	8
2	10	20	0.82	9
3	20	18	0.80	10
4	30	17	0.78	10
5	40	15	0.77	12
6	50	14	0.75	13

5.2 Compression strength

Compression test is done for the cube specimens with size 150 mm×150 mm×150 mm is subjected to test as per BIS standards. The obtained results shows that maximum compressive strength of 40.07 N/mm² is attained by the concrete with replacement of M-Sand by 20% replacement of pond ash at 28 days of curing with approximately 16% more on compared to conventional concrete.

Table.5.2.Compressive Strength test results

Pond ash (%)	Density (kg/m^3)	Compressive strength(N/mm^2)	
		7days curing	28days curing
0%	2477	23.1	34.53
10%	2430	22.3	37.50
20%	2380	21.43	40.07
30%	2315	20.26	38.67
40%	2260	19.3	32.70
50%	2205	18.16	29.07



Graph.5.1.Graphical representations of Compressive Strength results

5.3 Splitting Tensile Strength

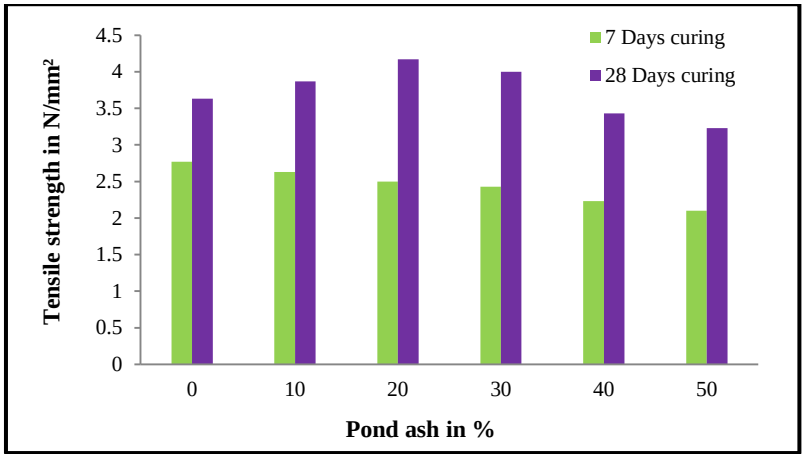
Tensile strength is done for pond ash used concrete cylindrical specimen with dimension of 150mm diameter and 300mm long. The maximum tensile strength of 4.17 N/mm² is attained by the concrete with replacement of M-Sand by 20% replacement of pond ash at 28 days of curing with approximately 15% more than conventional concrete.

5.3 Flexure Strength

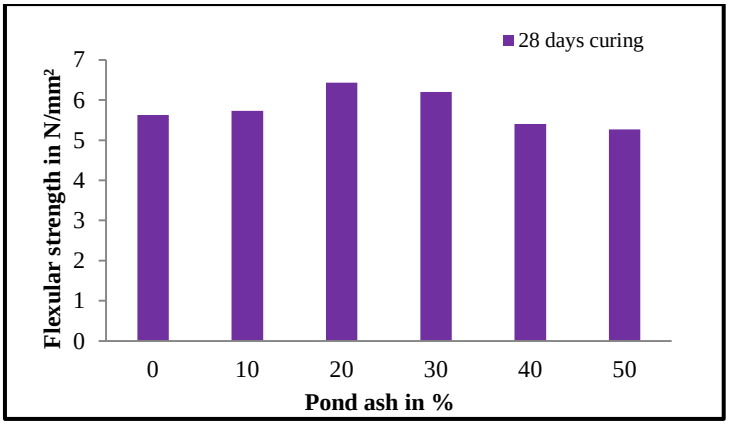
Flexural strength test is conducted to determine the modulus of rupture of the concrete, test is conducted for the beam specimen as per BIS standards. The dimension of beam is about 100 mm x100 mm x500 mm size. The maximum flexural strength of 6.43 N/mm² is attained by concrete with 20% pond ash replaced as M-Sand with approximately 15% more on compared to conventional concrete.

Table.5.3.Split Tensile and Flexural Strength of Pond ash concrete

Pond ash (%)	Split Tensile Strength(N/mm^2)		Flexural strength (N/mm^2)
	7days curing	28days curing	28days curing
0%	2.77	3.63	5.63
10%	2.63	3.87	5.73
20%	2.50	4.17	6.43
30%	2.43	4.0	6.20
40%	2.23	3.43	5.40
50%	2.10	3.23	5.27



Graph.5.2.Tensile Strength test results of pond ash concrete



Graph.5.3.Flexural Strength test results of pond ash concrete

5.4 Cost comparison

The cost for construction of 1m³ of concrete with respect to varying percentage of pond ash is tabulated in below Table 5.4. Cost of the materials is referred from Schedule of rates 2014-15, PW.P & IWTD, Bangalore circle.

Table 5.3.Cost comparison of concrete with varying % of pond ash

Sl. No	Mix Proportion	Cost per m³ of concrete (Rs)
1.	0% PA + 100% M-sand	4331
2.	10% PA + 90% M-sand	4290
3.	20% PA + 80% M-sand	4249
4.	30% PA + 70% M-sand	4208
5.	40% PA + 60% M-sand	4166
6.	50% PA + 50% M-sand	4125

VI. CONCLUSION

- Basic properties of cement, Fine aggregate, pond ash and coarser aggregate are tested in the laboratory and the materials satisfies the standard specifications. Optimum dosage of pond ash is obtained at 20% replacement.
- Fresh concrete test results increases with increase in pond ash content because pond ash makes the concrete stiffer and reduces flow property.
- Compression strength values for 7days test is in decreasing order, but at 28 days the strength values upto 20% and then gradually decreases. The obtained results shows that maximum compressive strength of 40.07 N/mm² is attained by the concrete with replacement of M-Sand by 20% of pond ash at 28 days of curing with approximately 16% more on compared to conventional concrete.
- Similarly the maximum Split tensile and flexural strength of 4.17 N/mm² and 6.43 N/mm² is attained by concrete with 20% pond ash replaced as M-Sand which is nearly 15% more on compared to conventional.
- Density of concrete gets reduces with increase in pond ash percentage replacement. For 20%, the density is 2380 Kg/m³ nearly 4% less when compared to conventional concrete.
- Cost analysis shows that for 20% replacement of pond ash for M-sand, cost per cubic meter of concrete is nearly 2% reduction as compared to conventional concrete.

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[6] "Mix proportioning-Guidelines for concrete"IS code 10262(2009)(6)

1. Cube and cylindrical specimens are subjected to compression and tensile test in the CTM

2. Beam specimens are allowed for flexural test in the UTM