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A Study on Concrete Properties by Partial Replacement of Sand by Pond Ash

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Abstract – ***Pond ash is wastes and by-products of Thermal power plant, have been introduced into Indian concrete industry to conserve natural resources of ingredients of concrete. In India, most of the Thermal power plants adopt wet method of ash disposal. Pond ash is collected from Thermal power plant at the bottom, in that it contains significant amount of relatively coarser particles (spanning from 150 microns to 2.36 mm). Pond ash utilization helps to reduce the consumption of natural resources. Also it is help to solve the problem of disposal of Pond ash because it contains huge amount of chemical compounds such as SiO2, Al2O3 etc. These chemical compounds (SiO2, Al2O3) are plays an important role in hydration reaction and helps to produce bond between two adjacent particles. Use of Pond Ash in concrete is an important eco efficiency drive. It is necessary to find the exact suitable percentages of pond ash so that it is decided to use in varying percentage as 0%, 5% 10%, 15%, 20%, 25%, 30%. And to check the properties of fresh concrete and hardened concrete such as slump and compressive strength, tensile strength, flexural strength respectively. Also concrete plays an important role in long life period of structure so it is also important to check effect on durability by using sulphate attack, chloride ion penetration, drying shrinkage.***

Study shows the basic properties of Pond ash. It also compares these properties with natural sand. Partial replacement does not cause any adverse effect on properties of fresh concrete. The result shows that concrete giving good strength with partial replacement of fine aggregate. As well as Pond ash is the good if used as filler material in concrete. Thus, it is suitable to use pond ash as fine aggregate or partial replacement with natural sand.

Keywords— *pond ash, concrete, natural recourses, wet method, SiO2, Al2O3, hydration, bond, eco friendly, compressive, tensile, flexural, durability, sulphate, chloride.*

1.INTRODUCTION

Waste and by-products have been introduced into Indian concrete industry to conserve natural resources and environment as well as to reduce the cost of concrete (Kasemchaisiri et.al)[1]. As an example, fly ash, a by-product from thermal power plants, has been widely used in Indian concrete industries as a pozzolanic material for replacing a part of cement due to its main benefits on workability and durability. The idea of using by-products to replace natural aggregates is another alternative solution to achieve environmental conservation as well as to obtain a reasonable concrete cost.

Unused fly ash and bottom ash (residue collected at the bottom of furnace) are mixed in slurry form and deposited in ponds which are known as pond ash (Bhangale et.al)[2]. Pond fly ash and contains relatively coarse particles. The coal fly ashes contain toxic metals in much higher concentrations that are released into the environment by thermal power plants based on coal combustion. Bottom ash is the companion to fly ash in process of coal-burning with an approximate amount of 20 % by volume of the total ash, depending on the type of boiler, dust collection system, burning temperature and the type of coal. Its particle is porous, irregular, and coarser than that of fly ash but its chemical composition is not much different (Cheriaf et.al)[3]. Some studies on the usage of bottom ash in concrete had been focused on its potential to replace or partially replace fine aggregate due to its similar particle size to that of normal sand (Bai et.al)[4]. Various attempts to apply bottom ash as a pozzolanic material had also been reported (Targan et.al)[5].The fly ash produced annually in India, with an estimated amount of 110 million tonnes(Central Electricity authority of India)[6], has been mostly dumped in landfill sites. Though, fly ash had been proved to enhance various properties of Concrete. In this research work an attempt is made to find out the possibility of using pond ash in conventional concrete. The part of the sand is replaced by pond ash in different composition and the concrete is made in conventional method.

Most of the Thermal Power plants in Indian adopt wet methods of disposal and storage of the ash in large ponds and dykes. In the wet method, both the fly ash collected

from electrostatic precipitators and the bottom and grate ash are mixed with water and transported to the ponds in a slurry form. Pond ash is being produced at an alarming rate and efforts are required to safely dispose it and if possible find ways of utilizing it. Fly ash collected through hoppers has been widely accepted as pozzolonic and is being used by the construction industry. Pond ash being coarser and less pozzolonic is not being used, or more importantly in places where the fine aggregate is contaminated with harmful chemicals such as sulphates and chlorides and pond ash accumulation posing environmental problems. The partial replacement of sand by pond ash in concrete is attempted. It is found that it is possible to use only pond ash as fine aggregate without compromising on strength and durability. This study opens up a major avenue for utilization of pond ash.

With a growing content of pond-ash, there has been are relatively greater increase in compressive strength, compared to normal concrete, and such trend might be a consequence of decreased water/cement ratio induced by the absorption of mixing water. (Lee Bong Chun et.al, 2008)[15]. The purpose of this study is to investigate the possibility of using alternative fine aggregates such as Pond ash. The disposal of fly ash will be a big challenge to environment, especially when the quantum increases from the present level to high. Hence worldwide research work was focused to find alternative use of this waste by product and its use in concrete industry is one of the effective methods of utilization in proper manner. Increase in demand of fine aggregate and decrease in natural resource of fine aggregate for the production of concrete has resulted in the need of identifying a new source of fine aggregate. It is also very important to study the effect of this partial replacement of sand on concrete, to find the optimum replacement of fine aggregate. energy generation is increasing day by day due to rapid industrialization. Energy generation through thermal power plants is very typical now days. Pond ash from these thermal plants is available in large quantities. Pond ash utilization helps to reduce the consumption of natural resources. In current time natural sand are using and a it is costly so it's require to replace by Pond Ash. Use of alternative material in concrete such as industrial by product coal Ash (Fly Ash and Pond Ash) is an important eco efficiency drive. It is also the social responsibility of researchers to encourage the "beneficial use of industrial by products in order to preserve resources, conserve energy and reduce or eliminate the need for disposal of industrial waste in landfills. This research paper reports the basic properties of Pond ash. It also compares these properties with natural sand. Basic changes in both type of aggregate properties were determined by various test as per require IS code, thus, it is a suitable to use pond ash as fine aggregate or partial replacement with natural sand.. Concrete is a construction material composed mainly of Cement, Fine Aggregate (Sand), Coarse Aggregate, Water and Admixture. River sand is the most commonly used Fine aggregate in many parts of the world. The huge demand for concrete has made this natural resource to get impoverished. On one side extraction of river sand in excess has conspicuous environmental impacts, on the other side, large quantity of coal ash is being produced every day in Thermal Power Plants, leading to many environmental problems. It is of prime importance to carry out research works on the feasibility of using alternative materials like Pond Ash, a waste by product and its suitability for potential utilization in concrete constructions, which can replace sand partially or fully as an alternative construction material contributing to sustainability and reducing burden on environment.

2.OBJECTIVES

To develop the conventional concrete of grade M25, and investigates the influence of the use of Pond ash as a replacement for natural fine aggregates on the properties of concrete in the fresh and hardened state and also on durability. Use of Pond Ash in concrete is an important eco efficiency drive to conserve natural recourses of sand. Ash is the residue after combustion of coal in thermal power plants. Fly ash and Bottom ash (residue collected at the bottom of furnace) are mixed in slurry form and deposited in ponds which are known as POND ASH. Most of the Thermal Power plants in Indian adopt wet methods of disposal and storage of the ash in large ponds and dykes. In the wet method, both the fly ash collected from electrostatic precipitators and the bottom and grate ash are mixed with water and transported to the ponds in a slurry form. Pond ash is being produced at an alarming rate and efforts are required to safely dispose it and if possible find ways of utilizing it. As it is very important to do disposal of this waste product of Thermal Power Plant, this study gives some ideas to utilization of Pond ash. Natural sand is commonly used as fine aggregate in concrete. There is scarcity of natural sand due to heavy demand in growing construction activities which forces to find the suitable substitute, also due to extensive construction activity natural sand is becoming expensive and scarce. The purpose of this study is to investigate the possibility of using alternative fine aggregates such as Pond ash. The disposal of fly ash will be a big challenge to environment, especially when the quantum increases from the present level to high. Hence worldwide research work was focused to find alternative use of this waste by product and its use in concrete industry is one of the effective methods of utilization in proper manner. Increase in demand of fine aggregate and decrease in natural resource of fine aggregate for the production of concrete has resulted in the need of identifying a new source of fine aggregate. The possibility of utilization of thermal power plant by-product pond ash as replacement to fine aggregate in concrete is taken into consideration for work. Disposal of coal fly ash in open and unlined ash ponds

causes serious adverse environmental impacts due to its elevated metals concentrations and its leaching into soils and groundwater. (Lokeshappa B, Anil Kumar Dikshit)[7]
It is also very important to study the effect of this partial replacement of sand on concrete, to find the optimum replacement of fine aggregate. Therefore the study of properties of concrete with different proportion of replacement of sand by pond ash is covered in this project work. It is not just the study of concrete properties by partial replacement of sand but also one eco friendly drive to do disposal of waste product of Thermal Power Plant that is Pond ash, because by using pond ash in concrete we are not going to disturb environment any way.

2.1 POND ASH

Ash is the residue after combustion of coal in thermal power plants. Particle size of the ash varies form around one micron to around 600 microns. The very fine particles (fly ash) collected from this ash generated by electro static precipitators are being used in the manufacture of blended cements. Unused fly ash and bottom ash (residue collected at the bottom of furnace) are mixed in slurry form and deposited in ponds which are known as pond ash (Bhangale et.al)[8]. 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.

3. ADVANTAGES OF USE OF POND ASH

Following are the main advantages of Pond ash while using in Concrete.

1. Use of Pond ash as partial replacement of Sand is Eco-friendly drive.
2. Pond ash acts as filler material as well as bonding agent as it shows the bonding property also.
3. Use of pond ash in concrete can save the thermal industry disposal costs and produce a 'greener' concrete –for construction.
4. Environmental effects from wastes and residual amount of cement manufacturing can be reduced through this way.
5. Pond ash can be use to form various higher concrete grades.
6. The cement content can be reduced a lot by increasing the fly ash content to make it more economical and also we can achieve designed compressive strength .
7. Use of Pond ash as partial replacement of Sand is help to solve issue of ash disposal.
8. Use of pond ash is good Option for natural Sand.
9. Partial replacement of natural sand is does not change original strength of concrete.
10. Manufacturing of cement mortar also possible.
11. The cement content can be reduced a lot by increasing the fly ash content to make it more economical and also we can achieve designed compressive strength.
12. The quantity of pond ash is available enormously at thermal power stations at free of cost.
13. It is easy to investigate the properties of pond ash.
14. When pond ash is used in brick construction the compressive strength of brick is increase with increase in lime content.

4. LIMITATIONS OF STUDY

As the famous phrase says that, every coin has two sides. Till this moment we saw only the easy way of use of pond ash as replacement of natural sand but from the another side there are some limitations on such replacement. This study is work on the concept of partial replacement of sand (one of the important ingredient of concrete) by pond ash (waste byproduct of thermal power plant), with different proportions.
The investigation of previous research paper shows that, if the partial replacement of sand exceeds some limit that affects the properties of concrete on large scale, it will prove dangerous or it is not possible to use such concrete practically.
While adding pond ash in concrete it will need skilled supervision. At the time of replacing the sand in concrete, it is very important to replace the sand in desired proportions only, therefore it is required skilled supervision. This is also one of the limitation of this study.
This replacement is suitable only for mass concreting projects as like construction of dam structures. This partial replacement is not economical if the concreting is on small scale.
Also pond ash may not available easily, availability of pond ash depends upon the distance of construction site and ash ponds.
The CaO content is less in the pond ash so that the plasticizer property of pond ash is decreased. Hence, the compressive strength is decreased(after some limit only).
The water absorption of pond ash is on large scale and is generally dependent on which type of coal is used in its manufacturing. Pond ash cannot be used in large proportions for replacement (Prof. Jayeshkumar Pitroda, Gaurav Patel, Dr F S Umrigar)[9]
While the pond ash is used the workability is reduced. For obtaining the required workability, superplasticizers are added while preparing the concrete. (Arumugam et.al (2011)[10]

5. PROBLEM STATEMENT AND METHODOLOGY

This study investigates the interpretation of tests results on concrete in which fine aggregate (natural sand) is partially replaced by pond ash. Pond ash is wastes and by-products of Thermal power plant, have been introduced

into Indian concrete industry to conserve natural resources of ingredients of concrete. In India, most of the Thermal power plants adopt wet method of ash disposal. In wet method of disposal of ash, bottom ash and fly ash are mixed with water and the slurry is disposed on vacant land to reduced the excess water from that slurry. After the drying of that slurry clinkers are formed and that can be collected as Pond ash. Sometimes it becomes the problem of such ash disposal because it requires the large vacant land to disposal of ash. Bottom ash is collected from Thermal power plant at the bottom, in that it contains significant amount of relatively coarser particles (spanning from 150 microns to 2.36 mm). Pond ash utilization helps to reduce the consumption of natural resources. Also it is help to solve the problem of disposal of Pond ash because it contains huge amount of chemical compounds such as SiO2, Al2O3 etc. These chemical compounds (SiO2, Al2O3) are plays an important role in hydration reaction and helps to produce bond between two adjacent particles. Also sand does not use only to fill gap between two particles of aggregate but also to increase the volume of concrete. Pond ash plays this both role very well.

Thermal Power Plants using coal is chief source of energy in our country and it is likely to remain so in near future. The total production of fly ash per annum has already crossed 100 million tones and the disposal of the fly ash is causing several challenges. Utilization of fly ash has picked up but till the percentage utilization is far below satisfaction and power plants are no option but to dispose the fly ash in ash pond

Pond ash is cheaply available and is available on large scale. Use of Pond Ash in concrete is an important eco efficiency drive. It is necessary to find the exact suitable percentages of pond ash so that it is decided to use in varying percentage as 0%, 5% 10%, 15%, 20%, 25%, 30%. And to check the properties of fresh concrete and hardened concrete such as compacting factor, slump and compressive strength, tensile strength, flexural strength respectively. Also concrete plays an important role in long life period of structure so it is also important to check effect on durability by using sulphate attack, chloride ion penetration, drying shrinkage.

5.1 PROBLEM OF COAL ASH DISPOSAL

It is becoming very major problem of generated coal ash disposal Presently, out of 110 million tonnes of total ash generated, about (55%) is being utilized and remaining 45% remains dumped. Therefore it is very important to do utilization of coal ash. Presently majority of the coal ash generated is being handled in wet form and disposed off in ash ponds which is harmful for the environment and moreover ash remains unutilized for gainful applications. Nearly, 73% of India‟s total installed power generation capacity is thermal of which coal based generation are nearly 90% (by diesel, wind, gas and steam adding about 10%). Indian coal gives 35 to 45% ash which is responsible for large volumes of pond ash. Thermal Power Plants using coal is chief source of energy in our country and it is likely to remain so in near future Construction of large ash disposal areas results in resettlement issues and loss of agricultural production, grazing land and habitat as well as other hand use impacts from diversion of large areas of land to waste disposal. (Alok Sharan),[21].

The total production of fly ash per annum has already crossed 100 million tones and the disposal of the fly ash is causing several challenges. Utilization of fly ash has picked up but till the percentage utilization is far below satisfaction and power plants are no option but to dispose the fly ash in ash pond. Presently Bhusawal Thermal Power Station (M.S.) has 1500 MW capacity of thermal power station and BTPS alone, nearly 1000 MT. of pond ash is produced every day. Effective utilization of pond ash is very essential to reduce the environmental problems caused by the accumulation of pond ash. If it is found suitable for construction industry, large scale utilization of pond ash would be possible and this will become a major contribution factor for reducing pollution. Future more a precious Natural resource as sand is becoming scare and quarrying of sand has been restricted in many places near BTPS. This has lead to look for possibility of partial replacement of sand by pond ash without compromising on strength (Prof. P. P. Bhangale, Prof. P. M. Nemade)[8].

The coal fly ashes contain toxic metals in much higher concentrations that are released into the environment by thermal power plants based on coal combustion. Disposal of coal fly ash in open and unlined ash ponds causes serious adverse environmental impacts due to its elevated metals concentrations and its leaching into soils and groundwater. (Lokeshappa B, Anil Kumar Dikshit)[7].

The fly ash gets mixed with bottom ash and disposed off in large pond or dykes as slurry. It is also termed as ponded fly ash and contains relatively coarse particles. The large areas of land are used to store such a mixture of pond ash resulting in land degradation near the thermal power plants. As the pond ash is being produced at an alarming rate, hence the efforts are required to safely dispose it and if possible find ways of utilizing it. In the pond ash the dissolvable alkalies present are washed with water. The metal oxides, sulphur, siliceous & aluminous materials with less pozzolonic properties than fly ash, are some main constituents of pond ash. These ash produced, if disposed off unscientifically, can cause environmental risks i.e. air pollution, surface water and groundwater pollution and thus its safe disposal is indispensable. In fact, the pond ash is a mixture of fly ash and bottom ash. The main difference between pond ash and fly ash is in their particle size. The pond ash being coarser and less pozzolonic and hence is not being accepted as pozzolona. (Prashant G. Sonawane, Dr. Arun Kumar Dwivedi)[19]

Though fly ash is known to be an inert material, there is an appearansion about certain soluble chemicals in the

decanted water which can have adverse effect if such decanted water is let into a river body or ground water. For this purpose, the norms of Pollution Control Board insist on providing a plastic liner over the entire bottom of the pond and upstream face of the ash dyke. New ash ponds being constructed have to provide the plastic liner to prevent pollution of ground water. Due to the presence of plastic liner, provision of the drainage becomes difficult and as result the deposited sediments could not get consolidated to the same extent as that anticipated in the pond without plastic liner. For this reason, whenever plastic liner is provided, it is important to check the adequacy of strength parameters for the deposited ash for supporting the next section of the dyke if upstream method of construction is adopted.

Apart from pollution to ground water, another major concern is dust pollution in the surrounding area during heavy wind. To prevent dust pollution, water sprinklers shall be arranged in the beach area which is in dry condition. The dust pollution is more from the pond which is not in operation and where construction is in progress by excavating the fly ash. For the pond which has reached the ultimate height and no further extension of height is warranted, the surface shall be covered with a 300mm thick soil layer. Suitable vegetation shall be grown over the area which ensures no dust pollution.

6.TESTS ON CONCRETE SPECIMEN

In this chapter the description of experimental tests investigation carried out on M25 grade concrete to determine its fresh state properties, hardened state properties and durability of concrete when natural sand is replaced by pond ash are presented. The following tests were conducted to assess the various properties.

1. Fresh property test on concrete-
   - Slump cone test.
2. Hardened concrete tests-
   - Compressive Strength Test.
   - Split tensile strength test.
   - Flexural strength test.
3. Durability tests-
   - Weight loss due to SULPHATE ATTACK.
   - Weight loss due to ACID ATTACK.
   - Loss of Compressive Strength due to immersion in MgSO4 solution.
   - Loss of Compressive Strength due to immersion in HCl solution.

7.TEST RESULTS AND DISCUSSION

This chapter gives the interpretation of various test results as below, also present the short discussion on respective results as stated

7.1 SLUMP CONE TEST

The higher the slump flow (SF) value, the greater its ability to fill formwork. Test results are tabulated as below:

Table 1) Slump flow value

Sr. No.	% Pond ash	Slump (mm)
01	0	113
02	5	105
03	10	100
04	15	96
05	20	90
06	25	80
07	30	75

Discussion on test results- As percentage of pond ash is increased the workability is reducing. Main reason for this is the water absorption of pond ash.

7.2 COMPRESSION STRENGTH TEST

Compressive strength of concrete mixes made with various percentage of partial replacement of sand by pond ash was determined at curing period of 3rd, 7th, 28th and 56th days. The results are as follows:

Table 2 Average Compressive Strength

Sr no	Replacement of Pond Ash	Average Compressive Strength			
		3 days N/mm^2	7 days N/mm^2	28 days N/mm^2	56 days N/mm^2
1	0%	13.36	17.15	26.78	28.59
2	5%	9.66	17.07	27.05	29.13
3	10%	9.07	16.74	27.44	30.28
4	15%	8.68	16.36	27.94	30.71
5	20%	8.00	16.06	28.24	31.20
6	25%	7.41	15.20	24.95	27.20
7	30%	6.81	14.99	23.17	25.57

Discussion on test results- Experimental results proves that, as percentage of pond ash increases in concrete it leads to the increase in compressive strength of concrete only up to partial replacement of 20% of natural sand by pond ash and beyond that percentage of pond ash there is reduction in strength of concrete. Also the pond ash concrete gains strength at slower rate in the initial period

and acquires strength at faster rate beyond 28 days, due to pozzolonic action of pond ash. The graphical representation of results is shown in respective figures:

Figure 1) 3 days Compressive strength of concrete with varying % of pond ash

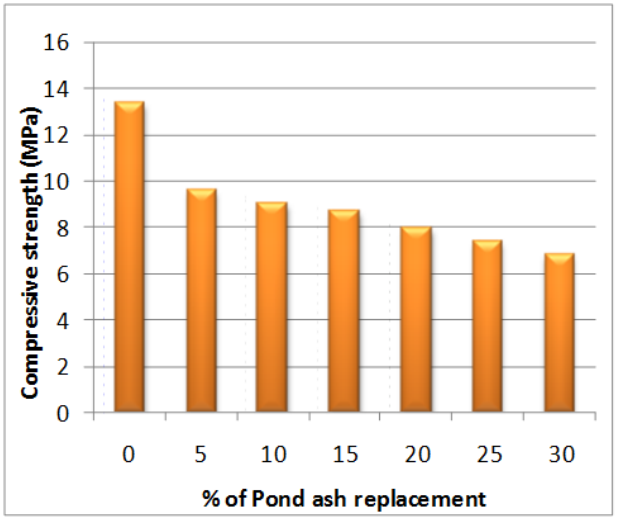


Figure 2) 7 days Compressive strength of concrete with varying % of pond ash

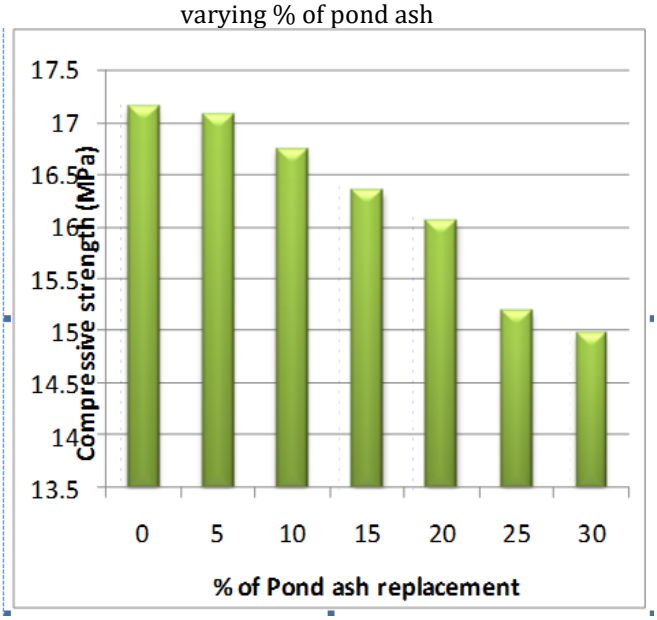


Figure 3) 28 days Compressive strength of concrete with varying % of pond ash

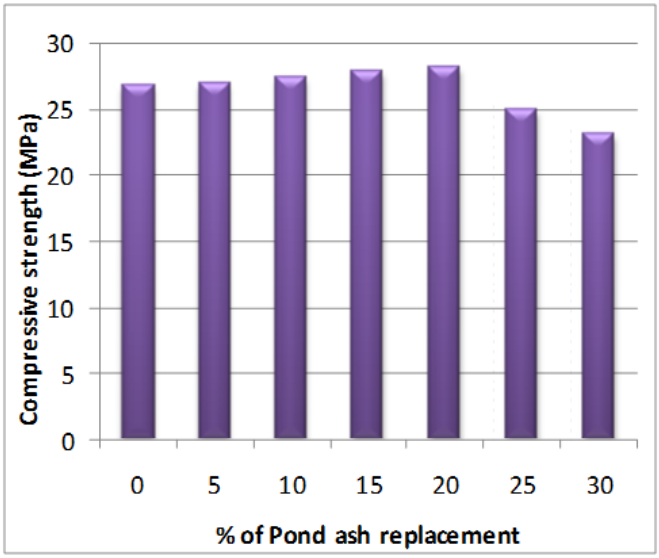
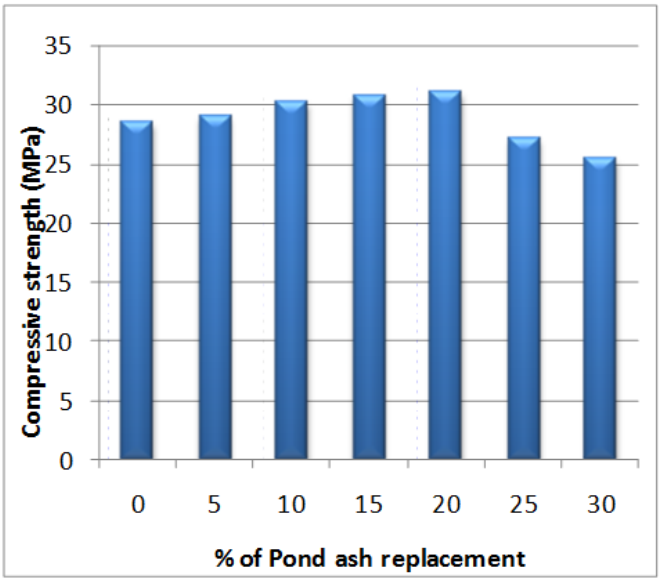


Figure 4) 56 days Compressive strength of concrete with varying % of pond ash



7.3 SPLIT TENSILE STRENGTH TEST:

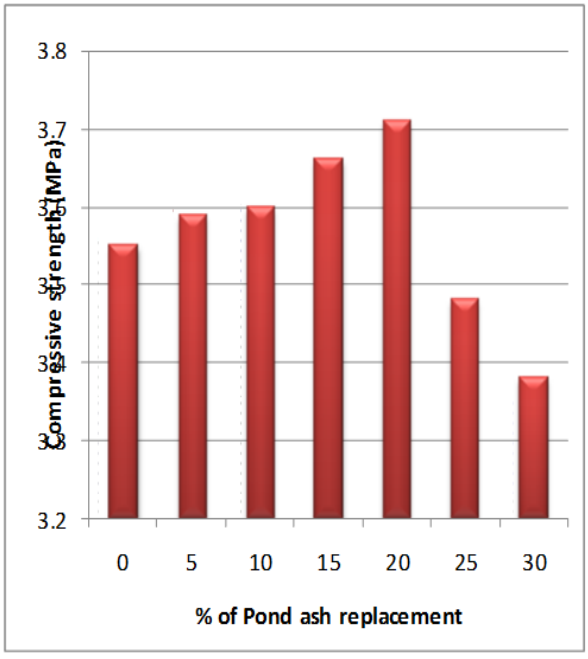
The results of split tensile strength for various replacements of partial replacement of natural sand by pond ash are as follows:

Sr no	Replacement of Pond Ash	Average Split tensile Strength (N/mm^2)
1	0%	3.55
2	5%	3.59
3	10%	3.60
4	15%	3.66
5	20%	3.71
6	25%	3.48
7	30%	3.38

Table 3) Average Split tensile Strength

Discussion on test results- It is observed from results that the splitting tensile strength of concrete increases only up to partial replacement of 20% of natural sand by pond ash, beyond that it decreases with the increase in the percentage of fine aggregates replacement with the pond ash.

Figure 5) 28 days Split tensile strength of concrete with varying % of pond ash



7.4 FLEXURAL STRENGTH TEST:

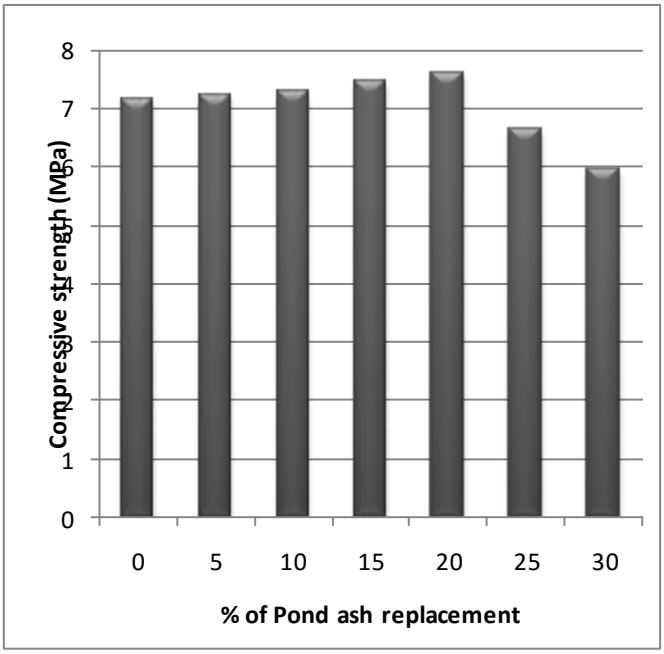
The results of flexural strength strength for various replacements of partial replacement of natural sand by pond ash are as follows:

Sr no	Replacement of Pond Ash	Average Flexural Strength (N/mm^2)
1	0%	7.14
2	5%	7.23
3	10%	7.28
4	15%	7.46
5	20%	7.6
6	25%	6.64
7	30%	5.94

Table 4) Average Flexural Strength

Discussion on test results- It is observed from results that the splitting tensile strength of concrete increases only up to partial replacement of 20% of natural sand by pond ash, beyond that it decreases with the increase in the percentage of fine aggregates replacement with the pond ash.

Figure 6) 28 days flexural strength of concrete with varying % of pond ash



Pond ash %	Initial wt.	Final wt.	% wt. loss	Compressive strength (Mpa)
0	7.882	7.896		27.11
	7.736	7.748		27.47
	7.96	7.975		26.84
Ave	**7.859**	**7.873**	**-0.18%**	**27.14**
5	7.746	7.76		27.20
	7.816	7.831		27.56
	7.534	7.55		27.91
Ave	**7.698**	**7.713**	**-0.19**	**27.56**
10	7.404	7.426		28.00
	7.882	7.902		27.91
	7.754	7.776		28.18
Ave	**7.68**	**7.701**	**-0.27%**	**28.03**
15	7.444	7.464		28.36
	7.806	7.828		28.09
	7.606	7.63		27.91
Ave	**7.618**	**7.64**	**-0.29%**	**28.12**
20	7.882	7.908		28.53
	7.736	7.76		28.89
	7.642	7.668		28.09
Ave	**7.753**	**7.778**	**-0.32%**	**28.50**
25	7.49	7.499		25.33
	7.653	7.665		24.98
	7.872	7.882		24.80
Ave	**7.671**	**7.682**	**-0.14%**	**25.04**
30	7.288	7.292		23.38
	7.564	7.568		23.20
	7.414	7.42		23.02
Ave	**7.422**	**7.426**	**-0.05%**	**23.20**

7.5 RESISTANCE TO SULPHATE ATTACK ON CONCRETE:

Average % weight loss and compressive strength results are listed in adjacent table:

Table 5) Weight loss and Compressive strength variation due to Sulphate attack on Concrete after 28 days:

Discussion on test results- Experimental results show that there is no effect of sulfate solution on concrete when partial replacement of natural sand by pond ash is used in concrete. The solution is not affect on the compressive strength of concrete also. That mean when natural sand is replaced by pond ash then there is no any adverse effect on durability of concrete.

Pond ash %	Initial wt.	Final wt.	% wt. loss	Compressive strength (Mpa)
0	7.404	7.416		28.18
	7.526	7.536		28.80
	7.366	7.378		28.89
Ave	**7.432**	**7.443**	**-0.15%**	**28.62**
5	8.162	8.176		29.24
	8.206	8.218		29.42
	7.986	8.001		30.22
Ave	**8.118**	**8.131**	**-0.16%**	**29.63**
10	7.526	7.538		29.78
	7.404	7.413		30.31
	7.422	7.436		30.58
Ave	**7.45**	**7.462**	**-0.16%**	**30.22**
15	7.67	7.688		30.76
	7.356	7.374		30.58
	7.876	7.892		31.02
Ave	**7.634**	**7.651**	**-0.22%**	**30.79**
20	7.67	7.696		31.56
	7.356	7.38		32.09
	7.495	7.514		31.58
Ave	**7.507**	**7.53**	**-0.31%**	**31.68**
25	8.062	8.07		27.02
	7.894	7.904		27.56
	8.1	8.11		27.82
Ave	**8.018**	**8.028**	**-0.12%**	**27.47**
30	7.894	7.904		26.67
	8.062	8.07		26.49
	7.975	7.983		25.78
Ave	**7.977**	**7.985**	**-0.10%**	**26.31**

7.6 RESISTANCE TO CHLORIDE ATTACK ON CONCRETE:

Average % weight loss and compressive strength results are in adjacent table:

Table6) Weight loss and Compressive strength variation due to Chloride attack on Concrete after 28 days:

Discussion on test results- Experimental results show that there is no effect of chloride solution on concrete when partial replacement of natural sand by pond ash is used in concrete. The solution is not affect on the compressive strength of concrete also. That mean when natural sand is replaced by pond ash then there is no any adverse effect on durability of concrete.

8. CONCLUSIONS

The conclusions based on experiments conducted and observations from the present study are listed below

1. Indian Standard method is easy method for the mix design of M25 grade concrete.
2. Pond ash shows the more water absorption as compared to natural sand.
3. As percentage of pond ash is increased the workability is reducing.
4. 20% of pond ash as sand replacement is found to be the optimum amount in order to get a favorable strength.
5. The pond ash concrete gains strength at slower rate in the initial period and acquires strength at faster rate beyond 28 days, due to pozzolonic action of pond ash.
6. Strength of pond ash concrete decreases with increase in percentage of replacement of sand by pond ash.
7. The compressive strength of concrete with pond ash increases with increased curing period.
8. It is observed from results that the splitting tensile strength of concrete increases only up to partial replacement of 20% of natural sand by pond ash, beyond that it decreases with the increase in the percentage of fine aggregates replacement with the pond ash.
9. It is observed from results that the splitting tensile strength of concrete increases only up to partial replacement of 20% of natural sand by pond ash, beyond that it decreases with the increase in the percentage of fine aggregates replacement with the pond ash.
10. There is no any adverse effect of sulfate solution on concrete when partial replacement of natural sand by pond ash is used in concrete.
11. The sulfate solution is not affect on the compressive strength of concrete also. That mean when natural sand is replaced by pond ash then there is no any adverse effect on durability of concrete.
12. There is no any adverse effect of chloride solution on concrete when partial replacement of natural sand by pond ash is used in concrete.
13. The chloride solution is not affect on the compressive strength of concrete also. That mean when natural sand is replaced by pond ash then there is no any adverse effect on durability of concrete.

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