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Research Paper

EFFECT ON CONCRETE PROPERTIES BY REPLACEMENT OF SAND AS THERMAL POWER PLANT POND ASH

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An effects on concrete by replacement of sand as thermal power plant pond ash on properties such as compressive strength, split tensile strength, flexural strength and Modulus of Elasticity, are studied. The natural sand was replaced with pond ash by 0%, 20%, 40%, 60%, 80%, and 100% by weight, at fixed water-cement ratio 0.48. Results shows that the harden properties of concrete such as compressive strength, split tensile strength and flexural strength decreased as the percentage of replacement of pond ash increase up to 40% and decreases as replacement percentage increase more than 40% compared to controlled concrete. In this slump was kept constant 100 ± 10 mm respectively and achieve the required slump Emceplast BV Plastizer were used as directed by the manufacturer, for this work dosage was 0.21% to 0.25%. It was observed that up to 40% replacement of sand as pond ash, the Harden properties are approximately same as that of the controlled concrete.

Keywords: Pond ash, Compressive strength, Flexural strength, Split tensile strength, Modulus of elasticity

INTRODUCTION

Mix design M-25 grade of concrete was used to study the different harden properties of concrete. Pond ash was taken from Eklahare thermal power plant, Nashik city in Maharashtra. Pond ash has coarse particle size, higher water absorption and usually less pozzolanic effect than fly ash. It is dumped or discharged in pond, in mass quantity and is easily available with minimum cost. By studying previous research papers, it shows that, thermal power plant pond ash has a potential to be used as fine aggregate in concrete. The thermal power plants are the main source of power generation in India. These thermal power plants have been generating about two thirds of the power demands of the country. There are about 40 major thermal power plants in India. World at present produces around approximately 1528 million tons of coal fly ash where India at present produces around 120 million tons of coal ash per annum. The

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beneficial use of fly ash in concrete is the preferable option for safe and economical utilization of million tons of fly ash. There is a critical need to find new methods for using pond ash for its highest and best use. The major obstacle in use of pond ash in a concrete is that the chemical properties of pond ash are different from place to place and are depends upon the origin of the coal and also the porosity is high. Malohtra (1996) reported that at least 70% of total fly ash is generally suitable for the use of cement replacement in concrete.

LITERATURE REVIEW

It was reported by Chai Jaturapitakkul and Raungrut Cheerarot (2003) that bottom ash has a high potential to develop to be a good pozzolanic material. The detailed investigation was done on mechanical properties of concrete mixtures by replacing fine aggregate with class F fly ash by weight by Rafat Siddique (2003). Trakool Aramraks (2006) reported that and bottom ash concrete has less permeability compared to normal concrete and bottom ash concrete requires approximately 25 to 50% more water content compare to normal concrete to obtain suitable workability. It was reported by Aggarwal *et al.* (2007) that the increase in the percentage of bottom ash reduces the workability of concrete due to increase in water demand. The detailed investigation carried out by Kim and Lee (2011) found that both of fine and coarse bottom ash aggregates had more influence on flexural strength than compressive strength. Andrade *et al.* (2009) reported that the porosity of bottom ash is high so that the w/c ratio of the concrete cannot be taken as exact.

MATERIALS AND METHODS

Cement-Birla A1 53 grades Ordinary Portland cement is used for this work. This cement is the most widely used one in the construction industry in India. Course and fine aggregates-Coarse aggregates of 10 mm and 20 mm size was used which are taken from Vilohli, Nashik, Maharashtra, and natural sand of Tapi river Nandurbar, Maharashtra was used for this study. Pond ash is obtained from Eklahare thermal power plant Nashik pond ash also confirms Zone-1 city in Maharashtra. Plastizer-Emceplast BV is used as directed by the manufacture to improve the workability concrete. Number of trials was taken to decide the doses of plastizer in concrete to achieve the required 100 mm slump. Up to 20% replacement of pond ash no plastizers was required, but remaining replacement plastizers was required.

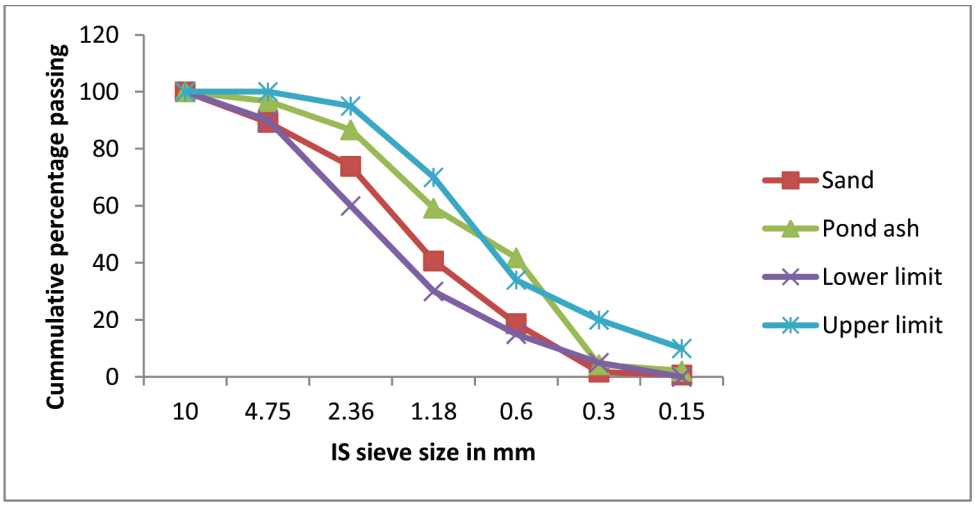
Physical Properties

The physical properties of coarse aggregate, fine aggregates and pond ash was determined. The fineness modulus of pond ash was found to be 3.09, whereas coarse aggregate and sand was 5.76 to 6.79 and 3.75, respectively. The specific gravity of pond ash was less as compared to fine aggregates. It was found that the water absorption was very high of pond ash as compared with sand and coarse aggregates. Table 1 show the fineness modulus, specific gravity and water absorption of coarse aggregates, sand and pond ash respectively. Figure 1 shows the grain size distributions for natural sand and pond ash. Generally the pond ash was well graded. A majority of the sizes occurred in a range

Table 1: Physical Properties

Material	Course Aggregates (10 mm)	Course Aggregates (20 mm)	Sand	Pond Ash
Fineness modulus	5.76	6.79	3.75	3.10
Specific gravity	2.75	2.67	2.62	1.93
Water absorption	0.601	0.601	1.01	10.062

Figure 1: Particle Size Distribution for Sand and Pond Ash Conforming Zone-I



between 4.75 mm to 0 .6 mm, very small portion was in between 0.3 mm to 0.075 mm. The grain size of natural sand and pond ash was within the limit given by IS: 383-1970 except that 600 microns.

LABORATORY TESTING PROGRAM

Mix design was carried out as per IS:10262-2009 concrete mixture with different proportions of pond ash ranging from 0% (for control mix) to 20%, 40%, 60%, 80% and 100 % replacement for sand were considered. The M-25 grade mix design was selected for w/c ratio 0.48 and slump was considered 100 ± 10 mm. For this work testing was carried out at 7 days, 28 days, and 56 days. Total 54 cubes specimen, 54 cylindrical specimens and 54 beam specimens were casted and tested for compressive strength, split tensile strength, and flexural strength. For this work total 162 test specimen were casted and tested. Table 2 shows mix proportions and mix ratio. Table 3 shows the material consumed with different proportions of pond ash with cement in kg/ m^3.

Preparation of Test Specimens

For mixing the concrete a half bag mixture was used. First coarse aggregates of 20 mm, 10 mm were placed in the mixture then sand and cement were mixed together in dry state then after water was added and mixed until the

Table 2: Mix Proportions (Kg/m³) and Mix Ratio				
Cement	**Fine Aggregates (Sand)**	**Coarse Aggregates (20 mm)**	**Coarse Aggregates (10 mm)**	**Water**
400.00	642.00	678.00	451.00	192.00
1.00	1.60	1.70	1.10	0.48

Table 3: Concrete Mixtures with Different Proportions of Replacement in kg/m³							
Mix Material Percentage Replacement	**Cement**	**Pond Ash**	**Water**	**Sand**	**CA 10 mm**	**CA 20 mm**	**Admixture**
cc kg/m³	400	-	192.00	642.00	451.00	678.00	-
20 kg/m³	400	128.40	192.00	513.60	451.00	678.00	-
40 kg/m³	400	256.80	192.00	385.20	451.00	678.00	0.800
60 kg/m³	400	385.20	192.00	256.80	451.00	678.00	0.840
80 kg/m³	400	513.60	192.00	128.40	451.00	678.00	0.920
100 kg/m³	400	642.00	192.00	-	451.00	678.00	1.00

homogeneous mixture were obtained. Each batch is mixed around 3 to 5 min and then mixture was placed in a metallic try and immediately slump was checked before the concrete was placed in different mould. For this work drinking water was used for mixing and curing process.

Cube

Cube of size 150 mm × 150 mm × 150 mm were used. The cube were cleaned thoroughly a waste cloth and then properly oil was applied along its faces. Concrete was then filled in mould in three layers, while filling the mould concrete was compacted using tamping rod of length 600 mm having a cross sectional area of 25 mm^2 and then the mould are kept on plane and level surface in the laboratory for 24 h and cubes are removed from the mould and kept for curing

Cylindrical

Cylindrical mould of diameter 150 mm and height 300 mm were used. The oil was applied along the inner surface of the mould for easy removal of cylinder from the mould. Concrete was poured in three layers and well compacted by tamping rod.

Beam

Beam mould of size 100 mm × 100 mm × 500 mm was used. The oil was applied along the inner surface of the mould for easy removal of beam from mould. Concrete was poured throughout its length and well compacted by tamping rod.

Curing

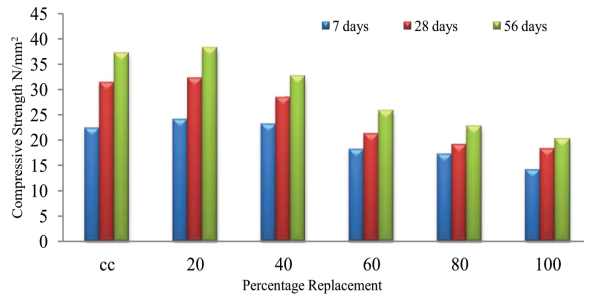
After casting of all cubes, cylindrical specimen and beam specimen are kept for curing in curing tank and drinking water was used for throughout curing process.

RESULTS AND DISCUSSION

Effect of Pond Ash on Compressive Strength

Compressive strength of concrete made with and without pond ash of cubes size 150 mm × 150 mm × 150 mm was determined at 7, 28, and 56 days. The test results are as shown in Figure 2. The maximum load at failure reading was taken and the average compressive strength was calculated using the following relation.

Figure 2: Effect of Pond Ash on Compressive Strength



Here 0% to 100% of pond ash was replaced with sand and optimum percentage of replacement was found at 40% replacement of pond ash with sand. For controlled concrete the compressive strength was found for 7, 28, and 56 days. It was observed that for 20% sand replacement the compressive strength was increased as compared with controlled concrete. Then after that compressive strength were decreased from 40% to 100% replacement. The pond ash concrete gains strength at a slower rate in the initial period and acquires strength at faster rate

Effect of Coal Pond Ash on Split Tensile Strength

The specimen of size 150 mm in diameter and length of 300 mm were cast and tested under the digital CTM of capacity 300 ton. The specimen was kept under CTM at the center load was applied with pace rate 1.2 KN/s and ultimate loading was noted. Split tensile strength was shown in Figure 3. The spilt tensile strength was calculated according to IS - 5816-1970 and IS 516 – 1959 code by the $\sigma_{bt} = 2p/\pi DL$ Where σ_{bt} = split tensile strength in N/mm^2, P = Maximum load at failure, L = span, D = Diameter of specimen. The split tensile strength for concrete was found for 7, 28, and 56 days respectively. It was observed that for 7 days the split tensile strength was increased from for 20% to 40% replacement after that there was decreased in strength from 60% to 100% replacement. It was found that the split tensile strength for 28 days was increased up to 20%. It was also found that for 56 days up to 20% the split tensile strength was approximately same as that of the controlled concrete and after that decreased. It was observed that from the Figure 3 that the splitting tensile strength of concrete decreases with the increase in the percentage of fine aggregates replacement with the pond ash, but the splitting tensile strength increases with the age of curing.

Effect of Coal Pond Ash on Flexural Strength

The beam specimen of size 100 mm × 100 mm × 500 mm was tested for single point load at the midpoint under the UTM of capacity 100 ton. The flexural strength was calculated as per IS 456 – 2000 and IS 516 – 1959 by using the relation $\sigma_{bt} = PL/bd^2$ Where σ_b = Modulus of rupture in N/mm^2, P = Maximum load, L = span, b = width of specimen, d = depth of specimen. The flexural strength was increased for 20% and 40% replacement and decreases from

60% to 100% replacement; the split tensile strength was decreased as compared to controlled concrete for 7 and 28 days, respectively.

The pond ash concrete gains flexural strength with the age that It is believed to be due to the poor interlocking between the aggregates, as pond ash particles are spherical in nature. Figure 4 shows the variation in flexural strength for different replacement with respect to controlled concrete for 7 days, 28 days, and 56 days, respectively.

Figure 3: Effect of Pond Ash on Split Tensile Strength

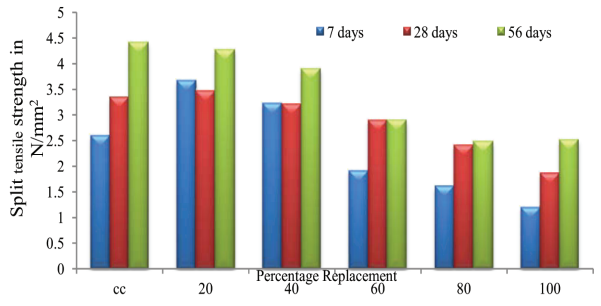
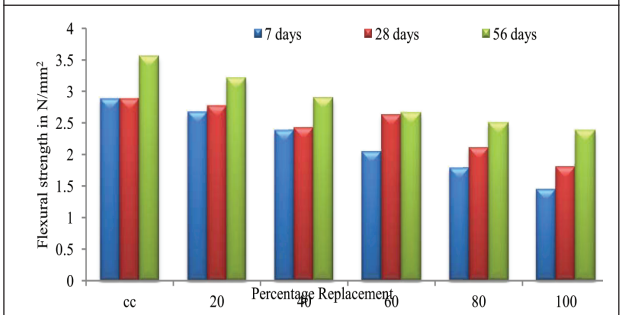


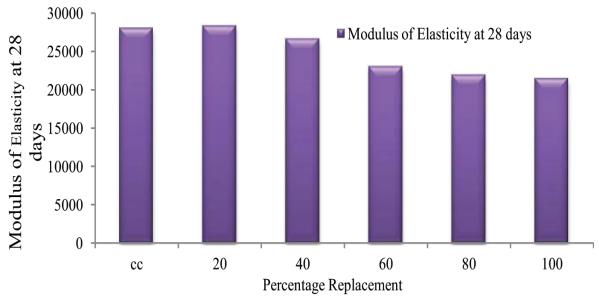
Figure 4: Effect of Pond Ash on Flexural Strength



Effect of Coal Pond Ash on Modulus of Elasticity at 28 Days

The modulus of Elasticity of cube specimen was calculated according to IS: 456-2000 by the formula $E = 5000 \sqrt{F_{ck}}$ where f_{ck} is 28 days cube compressive strength. It was found that the modulous of elasticity decreased in accordance with an increase of replacement of natural sand by pond ash. The modulus of elasticity for 20% replacement was increased with respect to controlled concrete and further addition of pond ash decrease the modulous of elasticity as compared to controlled concrete. Figure 5 shows the variation in modulous of Elasticity for 28 days.

Figure 5: Effect of Pond Ash on Modulus of Elasticity



CONCLUSION

In this report experimental results are presented to evaluate the possibility of utilizing of pond ash as sand in concrete with compressive strength of 25 Mpa for slump as 100 mm.

The compressive strength for 7, 28, and 56 days was increased up to 20% replacement and after that compressive strengths were decreased from 40% to 100% replacement.

The split tensile strength was increased at 7, 28, and 56 days for 40% replacement and after that it was decreased for remaining replacement.

The flexural strength was increased up to 40% replacement and after that it was decreased.

It was found that the Modulus of Elasticity decreased in accordance with an increase in replacement of natural sand by pond ash.

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