

# A Study on Behaviour of Fine Grained Soil Mix with Pond Ash

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**Abstract**— Due to rapid industrialization energy generation is increasing day by day. This energy generation by numerous power plants causes production of industrial waste. Generation of these wastes is a big threat to our society and environment. So we either have to find ways to dump these wastes safely or to use these wastes in a constructive manner. Due to specific advantages, materials like fly ash, pond ash have been considered as a replacement to natural soils. Soil stabilization is any process which improves the physical properties of soil, such as increasing bearing capacity, shear strength etc. which can be done by addition of suitable admixtures like cement, lime and waste materials like Pond ash etc. In this paper, the test results such as Index properties, Proctors compaction, and California Bering Ratio obtained on clayey soil mixed at different proportions of pond ash are presented and discussed. From the results, it is observed that at optimum percentages, i.e., 80% soil and 20% pond ash hit noticed that there is a marked improvement in the strength of soil. The combination of 80% soil and 20% pond ash addition at the optimum moisture content to the clay soil is found to be a suitable measure to increase the strength of the soil.

**Key words:** Fine Grained Soil Mix, Pond Ash

## I. INTRODUCTION

The growing environmental and economic issues over the past few years, paved the way for the development of alternative materials and use of industrial waste/by-product that can fulfil specification. Pond Ash is a fine-coarse, powder recovered from the gases of burning coal during the production of electricity. These micron-sized earth elements consist primarily of silica, alumina and iron. It is a non-plastic and lightweight material having the specific gravity relatively lower than that of the similar graded conventional earth material. Massive generation of Pond Ash by the thermal power plants has become a major cause of concern for people living in and around the thermal power plants as it is difficult to dispose. It requires a lot of land use and also have hazardous effect to environment. To minimize these problems, Pond Ash has been used in several fields like filling of low lying area, used in concrete as small replacement of cement, used in bituminous pavement etc. According to an estimate the current rate of generation of coal ash in India has reached 150 million tons per annum with about 85,000 acres of precious land under the cover of abandoned ash ponds. It is estimated that the generation of Pond Ash from coal fired generation units in India will reach 210 million tons per annum by the year 2020 whereas, the current rate of utilization of ash is about 35%. This replace with requires an ever-increasing area for storing ash and related environmental issues. On the other hand, the construction of highways and roads in India, which has taken a boom in the recent years, requires a huge amount of natural soil and aggregates. To meet this demand ruthless exploitation of fertile soil and natural aggregate is being adopted. This has brought the

situation to an alarming state. To address these problems, Pond Ash has been tried in the low-lying areas as structural fills and embankment construction for highways. However, due to lack of sufficient knowledge and confidence its use has not taken momentum. The basic parameters of Pond Ash that allow it to be used either as structural fill or embankment material. This Paper highlights the potential of Pond ash in the geotechnical field.

## II. POND ASH

Since, pond ash is the residue after combustion of coal in thermal power plants, so its properties depends upon the coal used and may vary from one power plant to other power plant. Particle sizes of the ash vary from around one micron to around 600 microns. The very fine particles (fly ash) collected from this ash generated by electrostatic 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 and Nemade 2013). About 120 million tons of pond ash is produced in India (Havanagi et al. 2011). This huge amount of industrial waste can cause serious hazards to the world. The fly ash and pond ash are one of the responsible pollutants of air, soil and water. These wastes require huge space for their disposal. Therefore it is necessary to increase the constructive use of these wastes in construction industry (Patil and Patil 2013). About 25% is utilized for Roads, Buildings and other Civil engineering applications. Bulk utilization of Pond ash is being carried out for road embankment construction in the ongoing massive road development programs taken up by the Government of India viz. National Highway Development Program (NHDP) and Pradhan Mantri Gram Sadak Yojana (PMGSY) (Havanagi et al. 2011). Many studies are done to evaluate the effect of the pondash on the behavior of soil. All researchers havereported that soil mixed with pond ash can used indifferent applications like for construction of embankment, under foundation or as fill material etc. (Satyanarayana et al. 2013, Sonawane and Dwivedi 2013, Marrapu and Jakka 2012, Ghosh et al. 2004, Patel et al. 2013). Pond ash has potential to improve the engineering behavior of soil. Engineering properties of Soil and Pond Ash are presented in Table 1 and Table 2 respectively. It can be observed from the Table 1 that specific gravity of pond ash is less as compared to the specific gravity of soil particles.

Property	Values
Grain Size Distribution	
Gravel Size (%)	0
Sand Size (%)	18.20
Fines Size (%)	81.80
(a) Silt Size (%)	
(b) Clay Size (%)	
Consistency	

Liquid limit (%)	40.10
Plastic limit (%)	24.03
Specific Gravity	2.677
Maximum Dry Density (g/cc)	1.620
Optimum Moisture Content (%)	16.50
California Bearing Ratio (%)	3.94

Table 1: Engineering Property of Soil

Property	Values
Grain Size Distribution	
Gravel Size (%)	0
Sand Size (%)	18.20
Fines Size (%)	81.80
(a) Silt Size (%)	
(b) Clay Size (%)	
Consistency	
Liquid limit (%)	Non-Plastic
Plastic limit (%)	Non-Plastic
Specific Gravity	2.249
Maximum Dry Density (g/cc)	1.340
Optimum Moisture Content (%)	28.80
California Bearing Ratio (%)	11.68

Table 2: Engineering Property of Pond Ash

### III. EFFECT OF POND ASH ON THE SOIL PROPERTIES

Many researchers have conducted different type of experiments to find out the properties of soil mixed with Pond ash. Table 3 shows the Geotechnical behavior of Pond ash. The effect of mixing of Pond ash on the engineering Properties.

Soil-100% + Pond Ash-0%	1.620	16.50	3.94
Soil-95% + Pond Ash-5%	1.640	15.90	4.38
Soil-90% + Pond Ash-10%	1.654	15.00	4.53
Soil-85% + Pond Ash-15%	1.671	14.10	5.62
Soil-80% + Pond Ash-20%	1.691	13.60	8.32
Soil-75% + Pond Ash-25%	1.688	14.20	7.52

Table 3: Effect on Soil Property by Adding Pond Ash

### IV. EFFECT ON PLASTICITY OF SOIL

Plasticity of soil depends upon the minerals and the properties of the soil. Pond ash itself is non-plastic material (Table 1). By mixing of Pond Ash in the soil, plasticity behavior of soil changes with amount of Pond Ash and it also changes the values of Atterberg limit (Bera et al. 2010). Due to mixing of the pond ash plasticity index decreases (Bera et al. 2010, Nicholson and Kashyap 1993). Also, from the similar type of behavior is found for liquid. With increase in the pond ash the liquid limit decreases (Bera et al. 2010, Bairwa et al. 2013). Pond ash has non-plastic particles, due to which when it is added in the soil plasticity behavior of soil decreases. Similarly, because of change in the amount of plastic particles in the mix of soil and pond ash liquid limit decreases.

#### A. Effect on Compaction Properties of Soil

Compaction behavior of soil depends upon the type of soil. The maximum dry density (MDD) and optimum moisture content (OMC) are the benchmark for determination of quality compaction for any earth work project. For coarse grained soil maximum dry density is greater than fine grained soil. While optimum moisture content (OMC) of coarse

grained soil is less than OMC of fine grained soil. An increase in MDD and decrease in OMC up to a percentage of pond ash and after that decrease in MDD and increase in OMC with addition of pond ash content has been obtained by experimentation for fine grained soil.

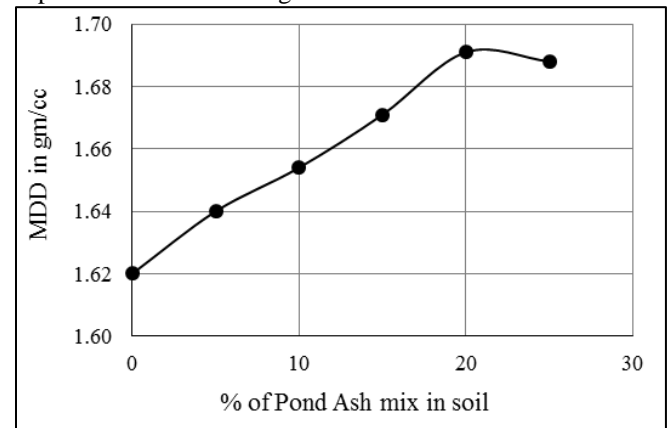


Fig. 1: Effect on Maximum Dry Density by % Increase of Pond Ash

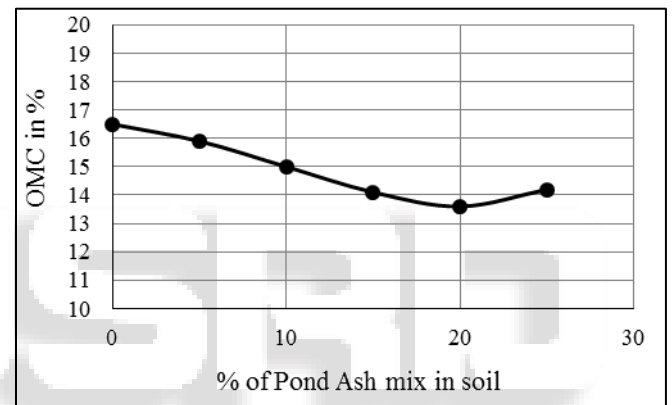


Fig. 2: Effect on Optimum Moisture Content by % Increase of Pond Ash

### V. EFFECT ON STRENGTH OF SOIL

With the increase in the amount of pond ash, the Strength of soil increases. California Bearing Ratio (CBR) has shown that increase in pond ash content also increases strength properties of soil. It has silica content, which shows the pozzolonic reaction. The pozzolonic reaction increases the strength quality in the soil. It has shown by study that with increase in the quantity of Pond Ash, strength of soil increases (Alok Sharan 2011). The California bearing ratio (CBR) of a soil is one of the important parameter in evaluating design criteria for use as a pavement construction material. CBR value also increases with increase in the Pond Ash Content (Bera, et al. 2010, Alok Sharan 2011, Santos et al. 2011, Deb et al. 2014) It may be due to that with increase in pond ash contents, the fine-grained soil altered into more friable "less clayey" form as a result; there cohesive strength may decline (Bera et al. 2010)

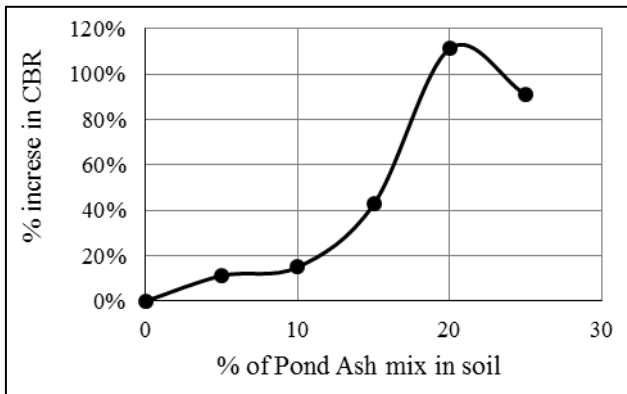


Fig. 3: Effect on CBR by % Increase of Pond Ash

## VI. CONCLUSIONS

The effect on engineering properties on soil mixed with the Pond Ash. The CBR value (soaked) of virgin soil increased by 111% on addition of 20% pond ash. Maximum Dry Density (MDD) increased up to addition of 20% Pond ash and after that the MDD decreases on addition of Pond Ash corresponding to virgin soil. Also, Optimum Moisture Content (OMC) decreases on addition of Pond ash and further OMC increases. Due to improvement of soil bearing capacity, the sake of protecting the environment and the better utilization of the industrial waste material for geotechnical purposes. It is found out that the shape and size of the Pond Ash, particle size distribution, Physical Properties, chemical constituents etc. are mainly affecting the geotechnical properties of Mix. Yet further Research is required to understand the mechanism and potential of Pond ash with different type of soil for the improvement of Behavior and properties of soil.

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