

## **IMPACT OF COAL FLY ASH ON PHYSICAL CHARACTERISTICS OF SOIL**

Trilok Kumar, Govt. N.P.G. College of Science, Raipur, C.G., India (trilokdev111@gmail.com)  
S.V.K. Prasad, Rtd. Principal, Govt. College, Pakhanjur, C.G., India (svksunny@gmail.com)  
V.K. Kanungo, Govt. N.P.G. College of Science, Raipur, C.G., India (vimal.kanungo@gmail.com)  
Sonal Mishra, Govt. N.P.G. College of Science, Raipur, C.G. India (sonalmishra2017@gmail.com)

### **ABSTRACT**

Coal fly ash is a byproduct of coal combustion, produced in a huge quantity, due to increased need of power supply, the growing population in our country, the increasing number of industries, developing urban areas, all are emphasizing pressure on thermal power plants to produce more energy and this increasing demand of energy is leading to more and more production of coal combustion byproducts like coal flyash and the disposal of this coal fly ash had become matter of concern for scientists and environmentalists all over the globe. In present study, its impact on physical characteristics of soil was investigated and the potential of coal flyash explored as a soil amendment agent.

**KEYWORDS:** Coal combustion, coal fly ash, physical characteristics, soil amendment agent.

### **INTRODUCTION**

The continuous increase of industrialization, urbanization and linear population curve in the developing countries like India has elevated the demand of energy. The production of energy is largely dominated in India by coal based thermal power plants. As the energy demand had increased to many folds this is emphasizing pressure on coal based thermal power plants to produce more energy which is leading to increased generation of byproducts of coal combustion like coal fly ash which is formed as the end product of coal combustion at 400-1500<sup>0</sup>C (Mattigodet al.,1990). The texture of coal fly ash was described as particle of <10 μm in diameter with low bulk density having high surface area and is of light texture (El-Mogaziet al.,1988).

Coal fly ash management and disposal has become a burning issue in last few decades because of its huge production and improper disposal methods. The disposal sites pollute air, water and soil quality (Carlson and Adriano,1993). The disposal sites also require the millions of acres of land which can be used for other productive purposes like agriculture, so its proper management has become need of an hour.

Earlier coal fly ash was treated as waste material but in last few decades its various potential uses had been recognized due to presence of many essential elements in it, which make it a good fertilizer and excellent soil amendment agent. It has become product of interest instead of waste material because of its unique structure and composition; it has potential to be used as soil amendment agent for plant growth and can correct the nutrient deficiency in soil (Mittra et al.,2005); Jala and Goyal(2006). The chemical constituent of coal fly ash was investigated by many workers like Adriano et al., (1980); Karla et al.,(1998); Gupta et al.,(2007); Surabhi(2017), they investigated that chemically 90-99% fly ash is consist of Si, Al, Fe, Ca, Mg, Na, S, P, Mn and K. It has all essential macro and micro nutrients which are found in soil except nitrogen and organic carbon, which make fly ash potential fertilizer in place of chemical fertilizer and can bring another green revolution in India (Ray et al.,2012).

In present study the impact of coal fly ash on physical characteristics of soil was investigated to explore its potential as soil amendment agent.

### **LITERATURE REVIEW**

With the development of science and technology and increased awareness for environment has make people think to convert all the waste in useable form to decrease the load of waste material on earth and preserve the environment to possible extent.

In the same concern many scientists tried to use the unavoidable waste byproduct of coal combustion the coal fly ash in varied beneficial forms and still the gate of research is open in the concerned field. Some marked researches are shown in Table 1.

<b>Year</b>	<b>References</b>	<b>Journal</b>
2018	Gorai	Journal of Materials and Environmental Science
2017	Surabhi	International Journal of Applied Chemistry
2016	Dhindsa et al.	Agricultural Science Digest
2014	Masto et al.	Journal of Energy Sources, Part A: Recovery, Utilization and Environmental Effects
2012	Ray et al.	International Journal of Engineering Research and Applications
2007	Gupta et al.	Environmental Monitoring and Assessment
1980	Adriano et al.	Journal Environmental Quality

## **METHODOLOGY**

### **➤ Collection and preparation of samples**

The soil from the agricultural field was taken, the top soil up to depth of 30 cm of the agricultural field was chosen for the experiment in various treatments. Coal fly ash was collected from ACC cement factory, Jamul, C.G.

In present study nine soil treatments were designed and details of the treatments were C = 100% soil (Control), T<sub>1</sub> = 5% Fly ash + 95% Soil, T<sub>2</sub> = 10% Fly ash + 90% Soil, T<sub>3</sub> = 15% Fly ash + 85% Soil, T<sub>4</sub> = 20% Fly ash + 80% Soil, T<sub>5</sub> = 25% Fly ash + 75% Soil, T<sub>6</sub> = 50% Fly ash + 50% Soil, T<sub>7</sub> = 75% Fly ash + 25% Soil and T<sub>8</sub> = 100% Fly ash.

### **➤ Analysis of physical characteristics of soil samples**

Particle size distribution of fly ash treated soil samples was assessed by the method of Misra et al., (1970) and soil textures were determined by soil texture triangle given by Palmer and Troeh, (1977). Bulk density and particle density of soil sample treated with fly ash were determined by following the method of Blake and Hartge (1986). Porosity percentage and soil solids percentage were determined by following the method of Misra et al., (1970). Water holding capacity (WHC) was estimated by following the method of Pandey et al., (1968).

## **RESULTS AND ANALYSIS**

Physical characteristics of soil sample treated with fly ash were analyzed.

### **Texture**

The pure soil was found to be sandy loam texture class with 62.1% sand, 26.2% silt and 11.7% clay. The pure fly ash was found to be of silty clay texture class with 53.3% silt, 34.6% clay and 11.1% sand. A gradual change in texture of soil from sandy loam (C to T<sub>4</sub>) to silty clay (T<sub>5</sub> to T<sub>8</sub>) was observed as shown in Table 2.

### **Bulk density and particle density**

The bulk density decreased with increasing fly ash amount in the soil. Maximum bulk density was observed in C (1.53 g cm<sup>-3</sup>) and minimum bulk density was observed in T<sub>8</sub> (1.05 g cm<sup>-3</sup>). The particle density decreased with increasing fly ash amount in the soil. Maximum particle density was observed in C (2.94 g cm<sup>-3</sup>) and minimum particle density was observed in T<sub>8</sub> (2.22 g cm<sup>-3</sup>) as shown in Table 2 and Figure 1.

### **Porosity and soil solids**

Porosity was found to increase with increasing amount of fly ash in the soil. The maximum porosity was observed in T<sub>8</sub>(52.70%) and minimum porosity was obtained in C(47.95 %). Soil solids percentage decreased with increasing amount of fly ash in soil. Highest percentage was observed in C (52.04 %). Lowest percentage was observed in T<sub>8</sub> (47.29%) as shown in Table 2 and Figure 2.

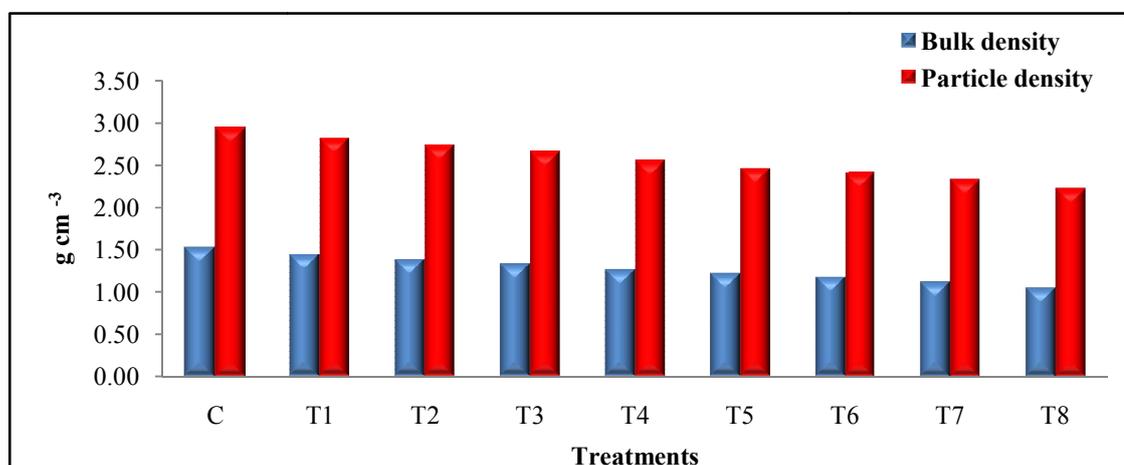
**Water holding capacity (WHC)**

The capacity of soil to hold water increased with increasing amount of fly ash in soil. The values ranged from 38.10% to 61.52%. Highest value was found in T<sub>8</sub>(61.52%) and lowest value was found in C(38.10%) as shown in Table 2 and Figure 2.

**Table 2 : Physical characteristics of coal fly ash ameliorated soil.**

S.No.	Treatments	Coal fly ash (%)	Texture	BD* (gcm <sup>-3</sup> )	PD* (gcm <sup>-3</sup> )	Porosity (%)	Solids (%)	WHC* (%)
1	C	0	Sandy loam	1.53	2.94	47.95	52.04	38.10
2	T <sub>1</sub>	5	Sandy loam	1.45	2.82	48.58	51.41	41.51
3	T <sub>2</sub>	10	Sandy loam	1.39	2.74	49.27	50.72	48.67
4	T <sub>3</sub>	15	Sandy loam	1.34	2.66	49.62	50.37	49.99
5	T <sub>4</sub>	20	Sandy loam	1.27	2.56	50.39	49.60	53.16
6	T <sub>5</sub>	25	Silty sand	1.22	2.47	50.60	49.31	56.42
7	T <sub>6</sub>	50	Silty clay	1.18	2.41	51.03	48.96	58.79
8	T <sub>7</sub>	75	Silty clay	1.12	2.33	51.93	48.06	60.12
9	T <sub>8</sub>	100	Silty clay	1.05	2.20	52.70	47.29	61.52

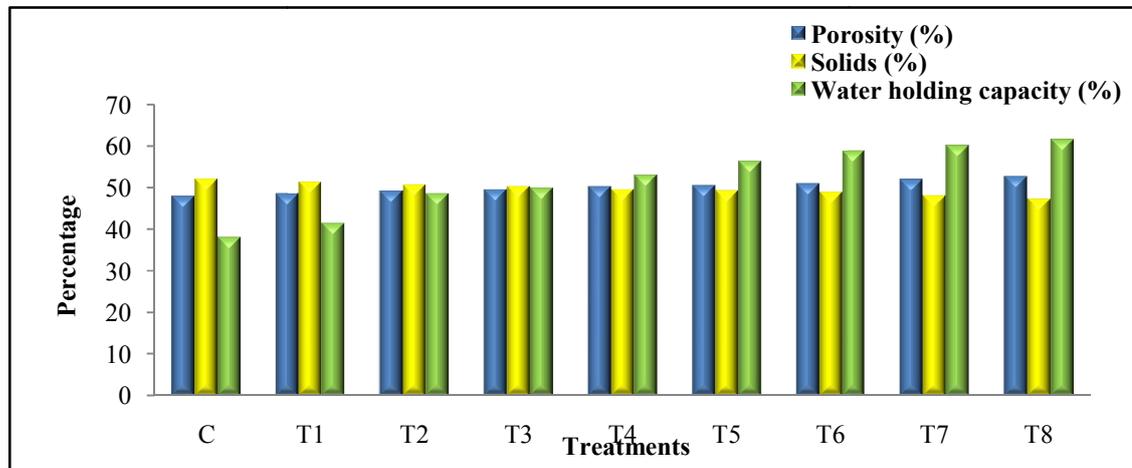
\* BD= Bulk density; PD = Particle density; WHC= Water holding capacity



**Figure 1: Bulk density and particle density of coal fly ash ameliorated soil**

Coal fly ash can change the texture of soil because the hollow sphere of fly ash replace the bigger soil particles so that small sized particles can accumulate the voids. Bulk density and particle density are inversely proportional to quantity of fly ash as silty clay texture of coal fly ash makes soil more porous because the structure of fly ash shifts the pore size distribution of soil hence decrease the porosity percentage. Fly ash consist of hollow structure due to which it increase the surface area and capillary action which increase water holding capacity similar findings were made by Fisher et al.,(1978); Pathan et al.,(2001); Gupta et al.,(2002); Shrivastava, (2008); Pradhan, (2017). By improving soil characteristics and nutrient status of soil,coal fly ash inturn increases the productivity and yield of many crop plants as

investigated by Adriano and Weber (2001); Masto et al., (2014); Dhindsa et al., (2016); Pradhan (2017); Gorai (2018).



**Figure 2:** Porosity, solids and water holding capacity of coal fly ameliorated soil

## CONCLUSION

Coal fly ash is a byproduct of coal combustion which is if used in a unplanned, improper and in unjudicial manner can cause pollution of air, water and soil and cause problems with surrounding environment but when used in judicial and planed manner can save millions of barren land get wasted as fly ash lagoons and it can be converted in useful byproduct of low cost which can develop economy of India by increasing soil nutrient capacity by improving its characteristics.

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