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Influence of Oxide of Calcium and Pulverised Fuel Ash on Cation Exchange Capacity and Unconfined Compressive Strength of Soils

Ganesh Kumar Tulabandula, Asst. Prof. D. Jayanth
Dept. of Civil Engineering
Sri Sunflower College of Engineering and Technology, Challapali

Abstract- The use of fly debris in India differs between 50-60% and the rest are arranged in debris lakes. The fly debris which are used for recovery of low lying regions or which are utilized in geotechnical designing application has the inclination of filtering the weighty metal poisons and along these lines dirtying the groundwater, surface water and encompassing soil. Additionally the release of effluents from squander water treatment plants might prompt contamination of the ground water. On the off chance that these ground water contamination can be constrained by expanding the Cation Exchange Capacity of the sub soil through utilization of any of the added substances like lime, fly debris, concrete and so on which likewise prompts expansion in strength of the dirt then that added substance would be favorable if there should be an occurrence of geotechnical projects where ground water contamination is of extraordinary concern. The current work plans to discover the impact of added substances in particular Lime and Fly debris on Cation Exchange Capacity (CEC), Compaction attributes, and Unconfined Compressive Strength (UCS) of two soils. The two soils utilized in this review are Sandy Clay (SC) and Low Plasticity Clay (CL). First the dirts were blended exclusively with differing substance of lime and fly debris to discover their impacts on Cation Exchange Capacity (CEC) and for leading Light compaction test to discover the compaction qualities. Then, at that point, the treated soil tests compacted at Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) were tried for Unconfined Compressive Strength (UCS) at various Curing periods. From the trial results got, it is seen that for the two soils, Cation Exchange Capacity (CEC) diminishes more with expansion in fly debris content than with Lime content. Additionally Optimum Moisture Content (OMC) increments and Maximum Dry thickness (MDD) diminishes with expansion in Lime and Fly debris content for both the dirt examples. The Unconfined Compressive Strength (UCS) increments with lime and fly debris content up to a specific cutoff past which further expansion in lime and fly debris content doesn't build the Unconfined Compressive Strength (UCS). The Unconfined Compressive Strength (UCS) increments more with expansion in Lime content than by expansion in fly debris content. The Unconfined Compressive Strength (UCS) increments with restoring time.

Keywords- Fly ash, UCS, CEC

I. INTRODUCTION

In India, there is an expansion in the number and limit of the nuclear energy stations on account of the increment sought after for power.

The greater part of these nuclear energy stations use coals which are of substandard quality. These mediocre quality coals produce gigantic measure of fly debris. As per the Central Electricity Authority (CEA) report on fly debris age and use, 61% and

57.63 percent of the fly debris created was used during the year 2012-2013 and 2013-2014 individually.

In this way the use of fly debris in India shifts between 50-60% and rests are arranged in debris lakes. These arranged fly debris and surprisingly the fly debris which are used for recovery of low lying regions has the inclination of draining the weighty metal poisons and subsequently dirtying the groundwater.

This ground water contamination can be constrained by expanding the Cation Exchange Capacity (CEC) of sub soil through use of added substances like lime, fly debris, concrete and so on so the singular soil colloids can hold the poison cations at their trade destinations.

Thus, if any of the added substances which doesn't influences or builds the Cation Exchange Capacity (CEC) of the dirt alongside expanding the strength of the dirt then the added substance would be helpful if there should be an occurrence of geo-ecological activities.

The surface properties of the fine grained soil may enormously impact their physical and compound properties. Fine grained soils vary in their surface properties like Cation Exchange Capacity (CEC) and Specific Surface Area (SSA) for the most part in light of the kind and measure of various earth minerals, contrasts in grain size dispersion.

Cation Exchange Capacity (CEC) is characterized as the limit of a dirt to hold a specific measure of interchangeable particles at a given pH esteem and is generally expressed in mill equivalent per 100 gram of soil (meq/100 g). In SI units, it is communicated as cent mole per kilogram of soil (cmol/kg). The qualities introduced in one or the other meq/100 g or cmol/kg are same. Generally the Cat ion Exchange Capacity (CEC) is estimated at impartial pH esteems (pH=7). Soils vary in their Cat ion Exchange Capacity (CEC) values as per grain size conveyance, type and measure of various earth minerals present.

For instance, surmised worth of CEC for Sand is 2 meq/100 g, Kaolinite 3 meq/100 g, Illite 25 meq/100 g, Montmorillonite 100 meq/100 g. Other than these, Cation Exchange Capacity (CEC) of soil is likewise affected by presence of natural matter and pH worth of soil.

II. MATERIAL CHARACTERIZATION AND METHODOLOGY

1. Specific Gravity:

The specific gravity of both the soil sample and fly ash was determined as per IS: 2720-Part 3 (1980)

Table 1. Specific gravity of soils and fly ash

Sample	values
Sesa Sterlite soil sample (Sandy Clay)	2.62
NTPC Darlipalli soil sample (Low Plastic Clay)	2.66
Fly ash	2.30

2. Atterberg limit test:

Shrinkage limit of soil samples was determined as per IS 2720-Part 6 (1972) and is presented in the Table 2. Plastic limit and liquid limit were determined as per IS 2720-Part 5(1985) and the results are given in table 2.

Table 2. Atterberg limits.

Limits And Indices	Sesa Sterlite soil sample (Sandy Clay)	NTPC Darlipalli soil sample (Low Plastic clay)
Shrinkage limit (%)	13.72	5.82
Plastic limit (%)	16	24
Liquid limit (%)	24	33
Plasticity index	8	9

3. Cation Exchange Capacity (CEC):

There are two standardised method given by International Soil Reference and Information Centre namely

- Extraction with ammonium acetate method.
- Silver thiourea method.

The Ammonium acetate method at neutral pH value is the most commonly used method for determining Cation exchange capacity (CEC). The ASTM D7503 – 10 method was used to determine Cation exchange capacity (CEC) of soil sample. The Cation Exchange Capacity (CEC) of the soil sample and soil mixtures was found as per ASTM D7503 – 10 method.

III. RESULTS AND DISCUSSIONS

A large number of studies have been done on the geotechnical properties of the soil but the studies on electro kinetic properties of the soil such as Cation Exchange Capacity (CEC) are limited in literature. In this Chapter, a series of experiments have been done to study the effect of the additives such as lime and fly ash on the electro kinetic properties like Cation Exchange Capacity (CEC) and geotechnical properties such as Compaction Characteristics and Unconfined compressive strength.

1. Effect of Lime:

The Cation Exchange Capacity (CEC) values decreased with the increase in lime content for both the soil samples as can be seen in Figure 4.1. The decrease in Cation Exchange Capacity (CEC) obtained are similar to that obtained by Akbulut and Arasan (2010).

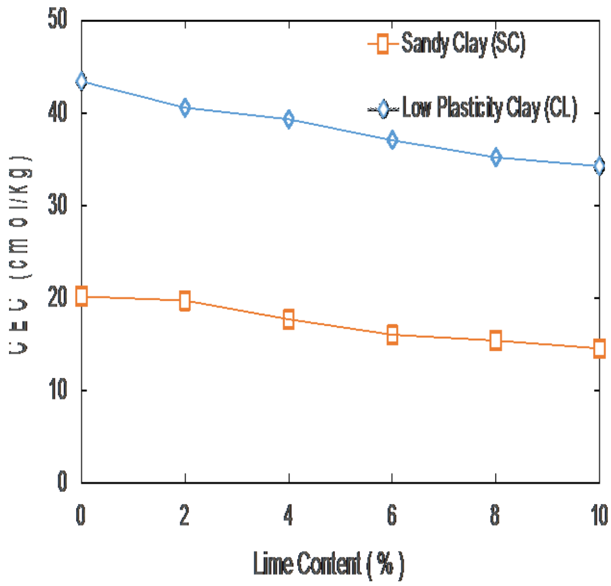

Fig 1. Variation in Cation Exchange Capacity (CEC) with lime content.

2. Effect of Fly ash

As can be seen from Figure 4.2, with the increase of fly ash content in soil, the Cation Exchange Capacity (CEC) values decreased for both sandy clay (SC) and Low Plasticity clay (CL).It was observed that increase in fly ash content decreases Cation Exchange Capacity (CEC) values more rapidly when compared with increase in lime content. Similarly Akbulut and Arasan (2010) reported that fly ash is more effective in decreasing the Cation Exchange Capacity (CEC) values. Also, Nalbantoglu (2004) reported decrease in Cation Exchange Capacity (CEC) values with increase in fly ash content.

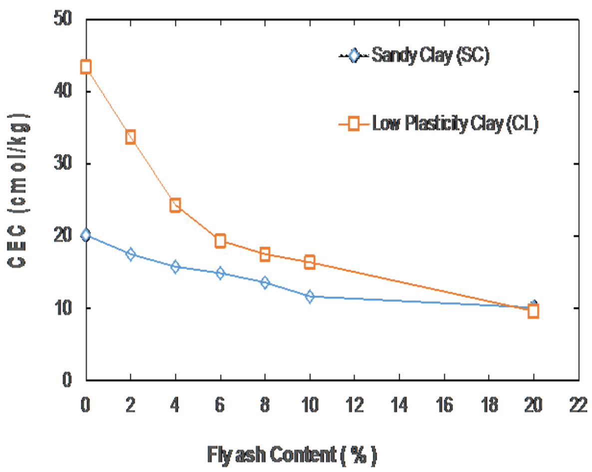

Fig 2. Variation in Cation Exchange Capacity (CEC) with Fly ash content.

IV. COMPACTION CHARACTERISTICS

1. Effect of Lime:

The addition of lime in sandy clay and low plasticity clay results in decrease in maximum dry density and increase in optimum moisture content as can be seen from the compaction curve shown in Figures 4.3 and 4.4. Most of the researchers reported that with increase in lime content the maximum dry density decreases and optimum moisture content increases.

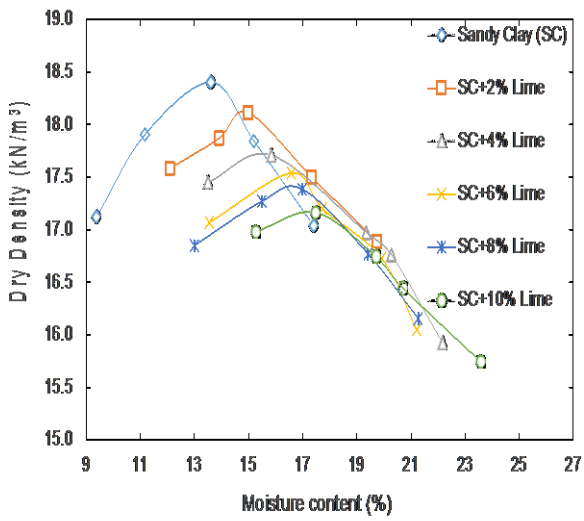

Fig 3. Light Compaction curve for sandy clay (SC) with varying percentage of lime.

2. Effect of fly ash:

The increase in fly ash content leads to the decrease in maximum dry density and increase in optimum moisture content for both sandy clay and low plasticity clay as can be seen from the compaction curve shown in Similarly, Most of the researchers reported decrease in maximum dry density and increase in optimum moisture content with the increase in fly ash content.

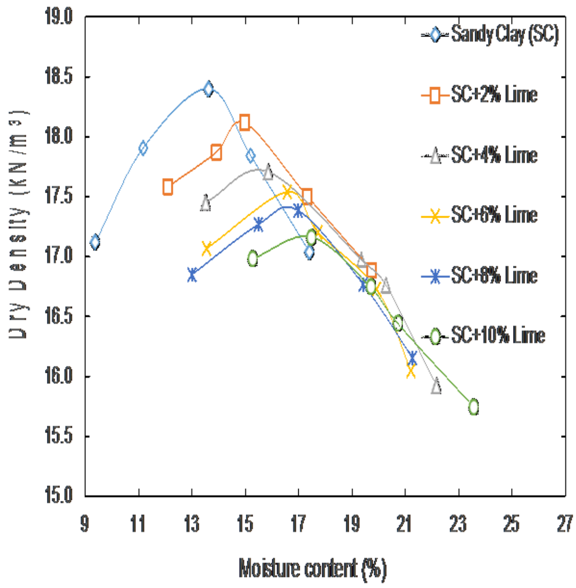

Fig 4. Light Compaction curve for sandy clay (SC) with varying percentage of Fly ash Unconfined Compressive strength.

3. Effect of lime:

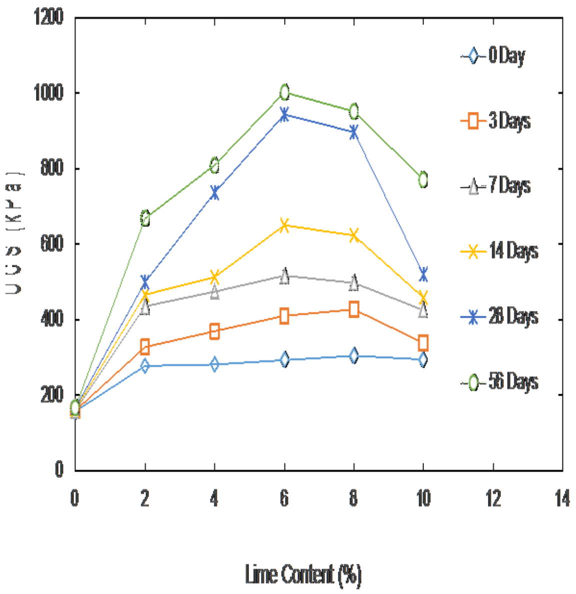

Fig 5. Variation in UCS for sandy clay stabilized with lime for different curing periods.

The unconfined compressive strength of soil increases significantly with increase in lime content upto a certain percentage after which there is a decrease in unconfined compressive strength. The unconfined compressive strength of sandy clay (SC) and low plasticity clay (CL) increased with varying lime content for different curing periods as can be seen in Figures.

4. Effect of fly ash:

The increase in fly ash content leads to increase in unconfined compressive strength of soil upto a certain percentage after which there is a decrease in unconfined compressive strength. The unconfined compressive strength of sandy clay (SC) and low plasticity clay (CL) increased with varying fly ash content for different curing periods as can be seen from Figures.

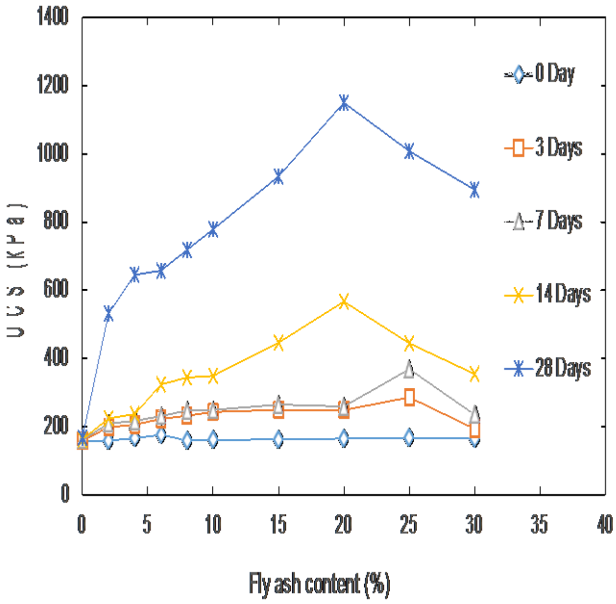

Fig 6. Variation in UCS for Sandy Clay (SC) stabilized with Fly ash at different curing periods.

V. CONCLUSIONS

The Cation Exchange Capacity (CEC) values decreased more with increase in fly ash content than with increase in lime content.The optimum moisture content (OMC) increases and maximum dry density (MDD) decreases with increased lime content and fly ash content for both sandy clay and low plasticity clay. The Optimum Lime Content (OLC) for Sandy Clay (SC) and low plasticity clay (CL) is 6 % and 8 % respectively based on Unconfined Compressive Strength (UCS) test.

Similarly, the optimum fly ash content for Sandy Clay (SC) and low plasticity clay (CL) is 20 % and 25 % respectively. The Unconfined Compressive strength increases with increase in curing period for both soils treated with lime and fly ash.

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