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Experimental Study of Soil Stabilization by Partial Replacement of Fly Ash

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Abstract

Expansive soil is clay that is prone to large volume changes. They are hard when dry but lose all strength when in wet state. Due to this property expansive soil pose problems for construction of infrastructural projects because due to volume changes there are damages to underlying structures. One of the methods for improvement of engineering property of expansive soil is by soil stabilization. Soil stabilization is a physical, chemical, biological method of changing an expansive soil to meet an engineering property. One of the methods of soil stabilization is by adding fly ash. Addition of fly ash results in decrease of plasticity of expansive soil and increase in workability. The present paper describes the study in improvement of expansive soil by adding fly ash in different proportions.

Keywords: Soil, Soil stabilization, Plasticity index, Workability, Fly ash, Volumetric index

1. INTRODUCTION

Expansive soil, also known as swelling soil, is a type of soil that undergoes significant volume changes due to variations in its moisture content. These soils expand when they absorb water and shrink when they lose water, which can lead to serious engineering and structural challenges. Here is a detailed overview:

Characteristics of Expansive Soil

1. Clay Content: High clay content, particularly montmorillonite, is the primary characteristic of expansive soils. Montmorillonite has a high shrink-swell potential.
2. Plasticity: Expansive soils are highly plastic, meaning they can deform significantly without cracking.
3. Water Sensitivity: They absorb water readily and exhibit significant swelling pressure.
4. Shrink-Swell Behavior: These soils exhibit cyclic swelling and shrinking, depending on moisture changes.

2. LITERATURE REVIEW

Srivastava et al. (1997) studied the effect of additions of lime sludge and fly ash to expansive soil andhe found that best stabilization takes place by adding 16% lime sludge and 16% fly ash.

Pandian et al. (2002) studied the effect of two types of fly ashes Raichur fly ash (Class F) and Neyveli fly ash (Class C) on the CBR characteristics of the black cotton soil. The fly ash content was increased from 0 to 100%. Generally, the CBR/strength is contributed by its cohesion and friction. The CBR of BC soil, which consists of predominantly of finer particles, is contributed by cohesion. The CBR of fly ash, which consists predominantly of coarser particles, is contributed by its frictional component. The low CBR of BC soil is attributed to the inherent low strength, which is due to the dominance of clay fraction. The addition of fly ash to BC soil increases the CBR of the mix up to the first optimum level due to the frictional resistance from fly ash in addition to the cohesion from BC soil.

Further addition of fly ash beyond the optimum level causes a decrease up to 60% and then up to the second optimum level there is an increase. Thus, the variation of CBR of fly ash-BC soil mixes can be attributed to the relative contribution of frictional or cohesive resistance from fly ash or BC soil, respectively. In Neyveli fly ash also there is an increase of strength with the increase in the fly ash content, here there will be additional puzzolonic reaction forming cementitious compounds resulting in good binding between BC soil and fly ash particles Phanikumar and Sharma (2004): A similar study was carried out by Phanikumar and Sharma and the effect of fly ash on engineering properties of expansive soil through an experimental Programme. The effect on parameters like free swell index (FSI), swell potential, swelling pressure, plasticity, compaction, strength, and hydraulic conductivity of expansive soil was studied. The ash blended expansive soil with fly ash contents of 0, 5, 10, 15 and 20% on a dry weight basis and they 12 inferred that increase in fly ash content reduces plasticity characteristics and the FSI was reduced by about 50% by the addition of 20% fly ash. The hydraulic conductivity of expansive soils mixed with fly ash decreases with an increase in fly ash content, due to the increase in maximum dry unit weight with an increase in fly ash content. When the fly ash content increases there is a decrease in the optimum moisture content and the maximum dry unit weight increases. The effect of fly ash is akin to the increased compactive effort. Hence the expansive soil is rendered more stable. The undrained shear strength of the expansive soil blended with fly ash increases with the increase in the ash content.

3. METHODOLOGY

A waste material extracted from the gases emanating from coal fired furnaces, generally of a thermal power plant, is called fly ash. The mineral residue that is left behind after the burning of coal is the flyash. The Electro Static precipitators (ESP) of the power plant collect these fly ashes. Essentially consisting of alumina, silica and iron, fly ashes are micro- sized particles. Fly ash particles are generally spherical in size, and this property makes it easy for them to blend and flow, to make a suitable concoction. Both amorphous and crystalline natures of minerals are the content of fly ash generated. Its content varies with the change in nature of the coal used for the burning process, but itbasically is non- plastic silt. To investigations in this study, fly ash was obtained from parricha thermal, District- Jhansi, Uttar Pradesh. To separate out the vegetation and foreign material, this flyash was screen through a 2 mm sieve. The samples were dried in the oven for about 24 hours before further usage.

4. CONCLUSIONS

Based on the results obtained and comparisons made in the present study, the following Conclusions can be drawn:

- The Maximum dry density (MDD) showed increment with increasing fly ash content.
- The maximum value of MDD was observed for a mixture of soil and 25% of fly ash content by weight. MDD value consistently decreases thereafter.
- Un-soaked California Bearing Ratio (CBR) increased gradually with the increase in fly ash content maximum valuation was 20% of fly ash content. Un-soaked CBR value decreases thereafter.
- The change in case of soaked California Bearing Ratio (CBR) tests of soil with varying fly ash content was not even. It decreased with the initial addition of fly ash and then increased till fly ash content reached 30% of fly ash. It decreases thereafter.
- The Unconfined Compressive Strength (UCS) of the soil with variation of fly ash content showed similar trend as then of the MDD value, except the fact that the peak value was observed for a fly ash content of 20% by weight.

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