STABILIZATION OF EXPANSIVE SOIL WITH CLASS F FLYASH

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Abstract - *Expansive clay soils are distributed worldwide, and are a source of great damage to infrastructure and buildings. These soils can cause heavy economic losses, as well as being a source of risk to the population. Expansive soils are soils that shrink when they dry out and expand when water is added. Shrink-swell soils which have expanded due to high ground moisture experience a loss of soil strength or capacity and the resulting instability can result in various forms of foundation problems and slope failure. Class F fly ash is used to stabilize expansive soil which is produced by the burning of harder, older anthracite and bituminous coal.*

Key Words: **Stabilization, Expansive soil, Class F fly ash.**

1. INTRODUCTION

Soil stabilization is the physical, chemical, biological, or combined method of changing a natural soil to meet an engineering purpose. Stabilization can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load bearing capacity of a sub-grade to support pavements and foundations. Soil stabilization takes poor quality soil and turns it into a valuable engineering material.

Expansive soil is a type of clay that is prone to large volume changes (swelling and shrinking) that are directly related to changes in water_content. Soils with a high content of expansive minerals can form deep cracks in drier seasons .Such soils are called vertisols. Soils with smectite clay minerals, such as montmorillonite and bentonite, have the most dramatic shrink-swell behavior. Expansive soil is hard in dry state and looses its strength in wet state. Expansive soils are found in USA, South Africa, Australia, Israel, Myanmar and India.

In the present investigation, clay collected locally was mixed with 15% bentonite to make it expansive due to difficulty in collecting expansive soil. Bentonite is an absorbent aluminium phyllosilicate clay consisting mostly of montmorillonite. Water absorption and swelling properties of bentonite can be used to make the soil expansive.

Class F fly ash is used to stabilize expansive soil. It originates from anthracite and bituminous coals and consists mainly of alumina and silica. The primary reason fly ash is used in soil stabilization applications is to improve the compressive and shearing strength of soils.

Class F Fly ash is used due to its pozzolonic properties and easy availability.

2. MATERIALS USED

2.1. FLYASH

Fly ash is a fine powder which is a byproduct of burning pulverized coal in electric generation power plants. It is a pozzolan which is siliceous or siliceous and aluminous material, which in a finely divided form and in the presence of water, react with calcium hydroxide at ordinary temperatures to produce cementitious compounds. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline), aluminium oxide (Al_2O_3) and calcium oxide(CaO), the main mineral compounds in coal-bearing rock strata. The unique spherical shape , pozzolanic nature, particle size distribution ,consistency and abundance of fly ash present unique opportunities for use in soil stabilization.

Class F fly ash, with particles covered in a kind of melted glass, greatly reduces the risk of expansion due to sulfate attack as may occur in fertilized soils or near coastal areas. Class F is generally low-calcium fly ashes with carbon contents less than 5 percent but sometimes as high as 10 percent.

2.2. BENTONITE

Bentonite is a highly colloidal clay mineral, formed by the decomposition of volcanic ash, that swells as it absorbs water.It consists of smectite minerals, mainly montmorillonite and also include hectorite, saponite, beidelite and nontronite. Smectites are clay minerals, i.e. they consist of individual crystallites the majority of which are <2μm in largest dimension. Bentonite presents strong colloidal properties and its volume increases several times when coming into contact with water, creating a gelatinous and viscous fluid.. A fundamental property of bentonite is to absorb water and expand. Its level of hydration and swelling depends on the type of exchangeable ions contained, with different hydrophilic and solvating power. Swelling is mainly due to two factors: 1) water absorption at platelet surface level, and 2) osmotic repulsive forces, forcing platelets to detach and open up like a "stack of cards". The special properties of bentonite (hydration, swelling, water absorption, viscosity, thixotropy) make it a valuable material for a wide range of uses and applications.

3.METHODOLOGY

Expansive soil, found in South India was collected. Various laboratory tests such as standard proctor test, California Bearing Ratio test, Unconfined Compression test, Consolidation test, particle size determination, Consistency tests were conducted on the collected sample in order to determine engineering properties of soil. Free Swell Index test was conducted in addition to the above mentioned tests to quantify the swelling behavior. Tests were conducted on the same sample as well as on soil mixed with varying percentages of fly ash and properly cured. .Properties so evaluated was compared with the observations previously obtained and the results obtained were used to determine an optimum percentage of fly ash.

4. EXPERIMENTS

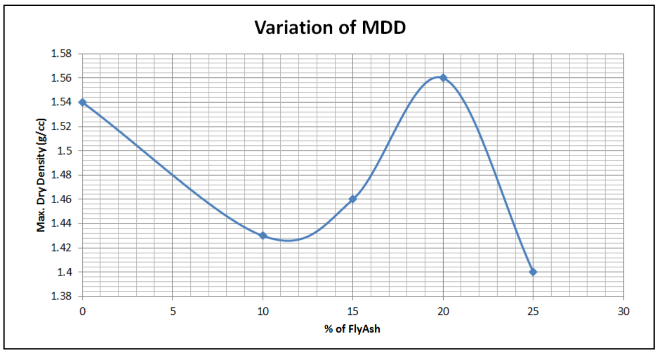
4.1. PROPERTIES OF EXPANSIVE SOIL

Table 4.1.1.Test Results for Soil

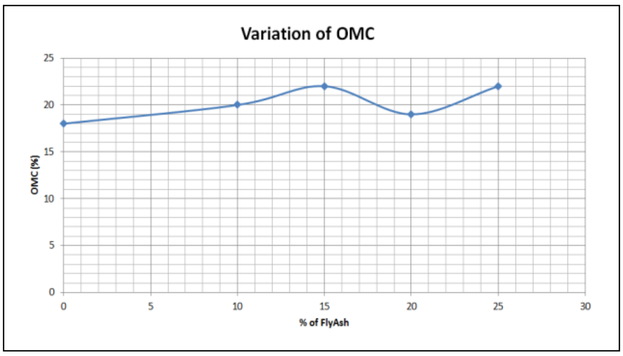
PROPERTY	VALUE
OMC	18%
Max. dry density	1.54g/cc
Plasticity Index	20%
Compressive Stress	0.2153kg/cm^2
Free Swell Index	72.73%
Coefficient Of Consolidation	8.953 x 10^{-5} cm^2/sec

4.2. COMPARISON OF TEST RESULTS

4.2.1.Standard Proctor Test

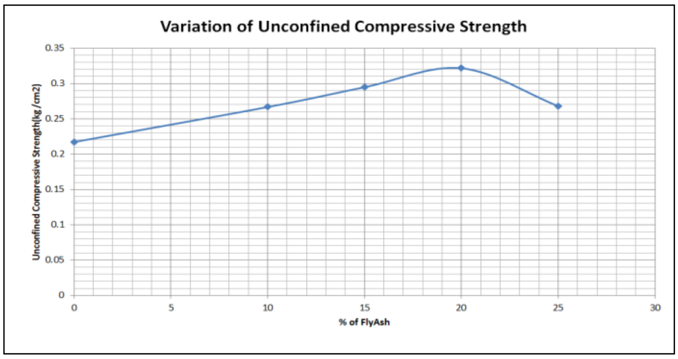


From the compaction test data it is identified that with increasing the percentage of fly ash, MDD values are varying abruptly. Low dry densities are due to nature and low specific gravity of fly ash particles compared to clay particles. As the percentage of fly ash is increased, soil particles get oriented and hence dry density increases.



From the compaction test data it is identified that with increasing the percentage of fly ash, OMC values are fluctuating. Increase in OMC values are due to the development of flocculated structure which resist the compaction effort and the particles in the soil-fly ash matrix requires more water to mobilize. The cause for the reduction in the optimum water content is due to the cation exchange between additives and expansive soil which decreases the thickness of electric double layer and promotes the flocculation.

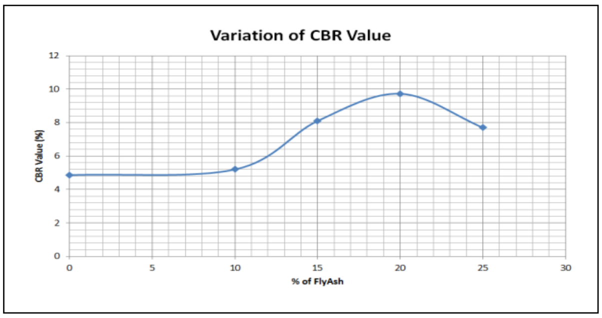
4.2.2. Unconfined Compression Test



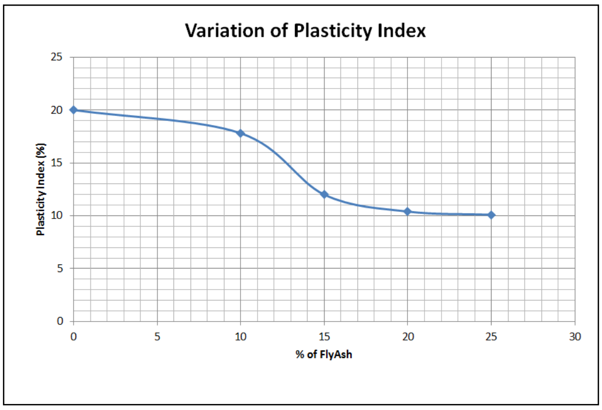
From UCC test, it is observed that unconfined compressive strength increases with increase in fly ash content .As the clay particles are replaced by fly ash, strength increased and it can take more load. Beyond the optimum percentage of fly ash, UCS decreased.

4.2.3. CBR Test

From test results of CBR it is observed that as the percentage of fly ash is increasing, CBR values are also increasing.

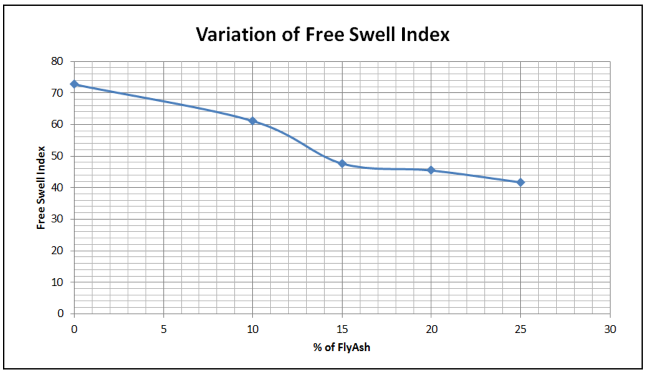


4.2.4. Consistency Limits



From the consistency test data, it is identified that as the percentage of fly ash is increasing plasticity index values are decreasing. This is due to the decrease in diffused double layer by replacement of clay particles by fly ash particles and also due to the development of shear resistance at the inter particle level.

4.2.5. Free Swell Index Test



It is observed that with the increase in percentage of fly ash free swell values are decreasing. This is due to decrease of the amount of repulsion between clay particles due to replacement of clay by fly ash particles.

5. CONCLUSIONS

As the percentage of fly ash increases, maximum dry density decreases initially, then increases and again decreases. . It is observed that maximum increase in optimum moisture content is corresponding to 15% of fly ash. An increase in fly ash content is found to decrease plasticity index. Free swell index reached permissible limit on addition of 20% of fly ash, signaling the reduction in expansive nature of soil. Unconfined compressive strength and CBR value attain maximum value at 20% of fly ash and then decreases. Hence within the framework of present investigation, it may be concluded that 20% is the optimum amount of Class F fly ash to be added to stabilize expansive soil.

6. REFERENCES

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