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STABILIZATION OF CLAYEY SOIL WITH FLY ASH AND DIFFERENT CHEMICAL ADMIXTURES

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ABSTRACT: Soil stabilization is defined as the change in geotechnical properties of soil by chemical or physical means in order to enhance the engineering quality of the soil. The main objectives of the soil stabilization is to increase the bearing capacity of the soil, its resistance to weathering process and soil permeability. Infrastructure projects such as highways, railways, water reservoirs, reclamation etc. requires earth material in very large quantity. In urban areas, borrow earth is not easily available which has to be hauled from a long distance. Quite often, large areas are covered with highly plastic and expansive soil, which is not suitable for such purpose. Extensive laboratory / field trials have been carried out by various researchers and have shown promising results for application of such expansive soil after stabilization with additives such as sand, silt, lime, fly ash, etc. As fly ash is freely available, for projects in the vicinity of a Thermal Power Plants, it can be used for stabilization of expansive soils for various uses. The present paper describes a study carried out to check the improvements in the properties of expansive soil with fly ash in varying percentages. Both laboratory trials and field tests have been carried out and results are reported in this paper. One of the major difficulties in field application is thorough mixing of the two materials (expansive soil and fly ash) in required proportion to form a homogeneous mass. The long-term performance of any construction project depends on the soundness of the underlying soils. Unstable soils can create significant problems for pavements or structures. Stabilization of soil through different chemicals can enhance the strength and behavior of soil. The focus on this research is on the improvement of engineering properties of clayey soil by mixing with different proportions of liquid chemical.

Key words: Soil stabilization, expansive soil, fly ash

1. INTRODUCTION

Clayey soil were having undesirable engineering properties. They tend to low shear strength on wetting or other physical disturbances. Clayey soil are normally associated with volumetric changes when subjected to change in water content because of seasonal water fluctuations. Furthermore, problems of high compressibility can cause severe damage to civil engineering construction. Therefore, these soil must be treated before commencing the construction operation to achieved desired properties. Different methods were available to improve the engineering properties of such soil are densification, chemical stabilization,

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reinforcement and techniques of pore water pressure reduction. The chemical reaction between clayey soil and chemicals can be categorised in two forms of improvement i.e. short term reaction (modification) and long term (stabilization). In the first reaction the process of ion exchanges makes the clay minerals flocculates and agglomerate leading to reduction in plasticity, swell and moisture content. The second reaction (pozzolonic reaction) accomplishes over a period of time creating cementing products that cause long term strength gain. Clayey soil also develop large lateral pressures and they tend to have low resilient modulus values. For these reason, clayey soil were generally poor materials for foundations. But, the engineering properties of clayey soil can be improved by using different stabilization techniques. Soil stabilization has been practiced by mixing additives such as cement, lime and other chemicals, fly ash, rice husk, to the soil to increase the strength of soil.

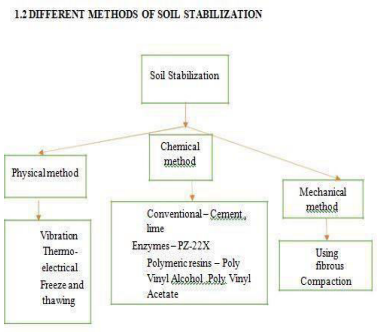

Fig:1 CHEMICALS FOR STABILIZATION OF SOIL

1.1 FLYASH: The major constituents of most of the fly ashes are Silica (SiO), alumina ((Al O), ferric oxide (Fe O) and calcium oxide (CaO). The other minor constituent of the fly ash are MgO, Na O, K O, SO , MnO, TiO and unburnt carbon. There is wide range of variation in the principal constituents - Silica (25- 60%), Alumina (10-30%) and ferric oxide (5-25%). When the sum of these three principal constituents is 70% or more and reactive calcium oxide is less than 10% - technically the fly ash is considered as or class F fly ash. Such type of fly ash is produced by burning of anthracite or bituminous coal and possess pozzolanicproperties.

Figure 2: Fly Ash

1.2 SODIUM HYDROXIDE

Sodium hydroxide is a white, odourless, non –volatile solution. It does not burn but highly reactive. It reacts violently with water and numerous commonly encountered materials generating enough heat to ignite nearby combustible materials. Its principal advantage is that itcan easily react with water which results into a powerful compaction and giving higher density for same compaction effort.

Figure 3: Sodium Hydroxide

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1.3 ALUMINIUM OXIDE

Aluminium oxide is white coloured shining powder form which reacts with soil to form a sample little bit cool due to its affinity with water. It improves the properties of soil such as dry density and optimum moisture content.

Figure 4 Aluminium Oxide

1.4 PHOSPHORUS PENTOXIDE

Phosphorus Pentoxide is white coloured sticky powder form which is highly reactive with water and clay particles of soil. It improves the index properties, dry density, and optimum moisture content of soil.

Figure 5: Phosphorus Pentoxide

2. PROPERTIES OFMATERIALUSED

CHEMICALS

Chemicals purchased from local market wereused throughout the study. distributor of chemicals in market railway crossing. Cost of all chemicals was Rs 1500. Physical and chemical properties of all chemicals are as follows:

1. FLYASH
2. SODIUMHYDROXIDE
3. ALUMINIUMOXIDE
4. PHOSPHORUSPENTOXIDE

Study was planned to investigate the index properties, compaction and compressive strength of soil with chemicals on different percentages. The aim of the study is to investigate the effects of various proportions of **Fly Ash** i.e. 4%, 8% and 12%,**Sodium Hydroxide** 6%, 12% and18%,**Aluminium Oxide** 6%, 12% and 18% and **Phosphorus** Pentoxide is 6%, 12% and 18% on the following parameters.

3. EXPERIMENTAL STUDIES:

3.1 PROCEDURE FORSOILSAMPLES:

The soil collected from the site **Kakinda near port** which is of marine clay. the break the lumps with wooden hammer and then dried in air under covered area. Then it was sieved through 2.35mm IS sieve and mixed thoroughly. The properly mixed soil was stored in polythene bags. For each test required quantity of soil was taken from polythene bags and dried in an oven at 105˚C + 5˚ C or 105˚C - 5˚ C for 24 hours. The soil was allowed to cool at room temperature.

3.2 METHODOLOGY: The following test were conducted as per codal provisions

4. RESULT:

This chapter presents the results of the test conducted on locally available clayey soil (CI) stabilized with chemicals such as Fly Ash, sodium hydroxide, aluminium oxide, phosphorus pentoxide .

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UCS OF CLAYEYSOIL with fly ash at different percentages

Unconfined compressive strength of clayey soil shows in graph. The sample of parent soil is tested after 14 days from the day of casting the sample so that it gain some strength to sustain the load on it while testing in Tri-Axial equipment. Fly Ash used in experiments taken in different percentage as 4%, 8% and 12%. The graph shows the effect of UCS on different percentage of Fly Ash with clayey soil. On 3% value of UCS was 2.56kg/cm^2, on 7% value was 2.81kg/cm^2 and on10% value was 2.98kg/cm^2.

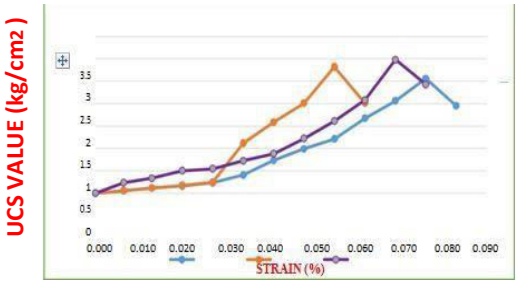

Figure 6: Comparison Graph of Clayey Soil with Fly ASH

CLAYEY SOIL WITH SODIUM HYDROXIDE IN DIFFERENT PERCENTAGES

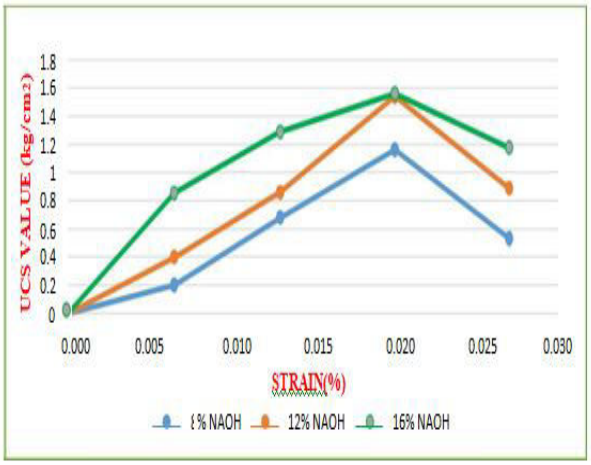

Figure 7: Graph of Clayey Soil with Sodium Hydroxide

CLAYEY SOIL WITH ALUMINIUM OXIDE IN DIFFERENT PERCENTAGES

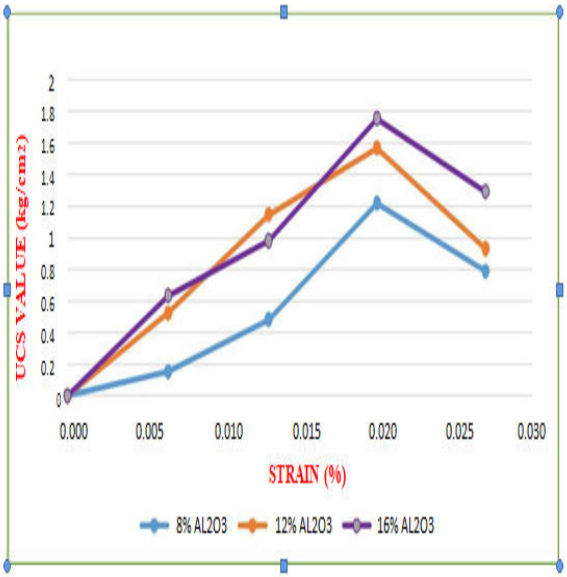

Figure 8: Comparison Graph of Clayey Soil with Aluminium Oxide

CLAYEY SOIL WITH PHOSPHORUS PENTOXIDE IN DIFFERENT PERCENTAGES

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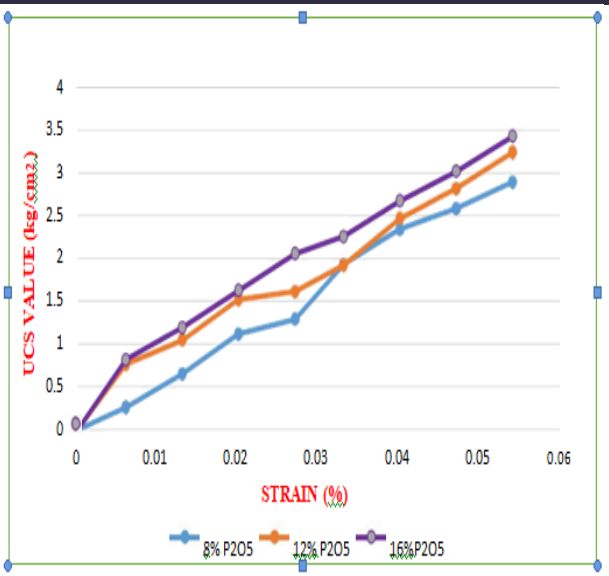

Figure 9: Comparison Graph of Clayey Soil with Phosphorus Pentoxide

5.CONCLUSION

1. In this research work, Fly Ash, Sodium Hydroxide, Aluminium Oxide and Phosphorus Pentoxide were used to stabilize the clayey soil resulting in improvement of geotechnical properties of the soil.
2. The Fly Ash effect on soil leads to increase in optimum moisture content of soil and reduction in maximum dry density. On 4% Fly ash concentration, OMC value increases to 21.40% from parent soil value i.e. 17.71% on other percentage i.e. 7% and 10% the value are 23.61% and 24.48% and reduction in maximum dry density i.e. on 3% is 1.80 g/cc, 7% is 1.71 g/cc and on 10% is 1.74 g/cc as compared to parent soil i.e. 1.81g/cc.
3. Clayey soil interaction with sodium hydroxide results in increasing maximum drydensity
   i.e. on 8% is 1.98 g/cc, on 12% is 2.01 g/cc and on 18% is 2.02 g/cc with reduction in optimum moisture content i.e. on 8% is 16.03%, on 12% is 17.26% and on 18% is 16.09%.
4. Unconfined compressive strength of soil also increasesi.e. on 6% is 2.63 kg/cm^2 , on 12% is 2.85 kg/cm^{2}and on 18% is 3.04 kg/cm^2 as compared to parentsoil.
5. Aluminium oxide used in research work to stabilize the clayey soil, results in increasing compaction. The maximum dry density of soil i.e. on 6% is 1.86 g/cc, on 12% is 1.93 g/cc and on 18 % is 1.96 g/cc increases as compared to parent soil and optimum moisture content decreases i.e. on 8% is 17.41%, 12% is 17.13% and on 12% is 17.52%, but this material is suitable for stabilization of soil as the effect of chemical with soil show strong bonding withsoil.
6. The compressive strength of soil also increases with each percentage of aluminium oxide i.e. 8% is2.48 kg/cm^2,12% is 2.88 kg/cm^2 and 16% is 3.19 kg/cm^2. Phosphorus Pentoxide used in research work to stabilize the clayey soil results in increasing maximum dry density i.e. on 8% is 1.92 g/cc, on 12% is 1.96 g/cc andon 16% is 2.01 g/cc and reduced optimum moisture content i.e. on 8% is 16.36%, on 12% is 16.75% and on16% is 16.52%. Unconfined Compressive strength of soil also increases i.e. on 8% is 2.89 kg/cm^2, on 12% is 3.24 kg/cm^2 and on 16% is 3.42 kg/cm^2.
7. Hence, it can be concluded that Sodium hydroxide is the best material among all the chemicals used in research work, as the properties of soil get increased on every percentage of soil. This experiment also

indicates that sodium hydroxide gives best result always on higher percentage with soil i.e. 6%, 12% and18%.

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