INFLUENCE OF FLYASH ON THE STRENGTH AND SWELLING CHARACTERISTICS OF BENTONITE

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Abstract: Swelling soil like Bentonite causes many problems more for lightly loaded structures than moderately loaded structures. Through consolidation under load and changing volumetrically along with seasonal moisture variation, these problems are proved through swelling, shrinkage and unequal settlement. It leads to damage of foundations, structural elements and architectural aspects which defeats the purpose for which the structures are erected. So, to avoid these types of failures research is done and some methods have been proposed. Pre-stabilization is very effective method in tackling expansive soil. Therefore, a many laboratory experiments are conducted to ascertain host of soil engineering properties of a naturally available expansive soil before and after stabilization. Pre stabilized and post stabilized results are compared to arrive at conclusion that can thwart expansive soil problems. Such structures are requiring renovation of foundation by under pinning. New structural shall need special techniques for control of swelling and shrinkage. Index properties of expansive soil like Atterberg limits and shrinkage limit with and without fly-ash have been compared. Grain size distribution has also been determined by experiments. The swelling potential of this soil has been determined for various percentage of fly-ash. Maximum dry density (MDD) and optimum moisture contents (OPC) have been found out by the proctor compaction test and the graphs are drawn. The strength of swelling soil is determined for soil specimens with different fly-ash concentrations through Unconfined Compression Test and the results are compared through the graphs.
The above results of experiments are compared among them to obtain a percentage concentration of fly-ash with swelling soil which gives best results for lower value of swelling potential and higher strength.

I. INTRODUCTION

For a long time, we are facing problems like failures of small and big structures. The biggest problem behind this is swelling soil. This is very unstable soil. Its property varies from hard to soft and dry to wet. It exhibits swelling and shrinkage with different water content. As a result, the many structures usually face excessive settlement and differential movements, which results in damage to foundation systems and structural elements. We are aware about this situation for a long time, but unable to make improvements due to absence of technologies till now. So now our main aim is to improve the properties of swelling soil like Bentonite. The purpose was to check the scope of improving bearing capacity value and reduce expansiveness by adding additives like fly ash, lime fly ash, ordinary Portland cement etc.

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Expansive soils are found in many parts of the world like Burma, south Africa, Western USA, Cuba, Spain, Russia and Indonesia etc... In India it found in Madhya Pradesh, Maharashtra, Gujarat and Orissa. In many countries, coal is the primary fuel in thermal power plant and other industry. The fine residue collected from field is known as fly ash and considered as a waste material. The fly ash is tossed out of either in the dry form or mixed with water and discharged in slurry into locations known as ash ponds. Production of flyash worldwide is huge and increasing day by day. Four countries, namely, China, India, United State and Poland are producing more than 270 million tons of fly ash every year. It is causing hazards to our environment. Therefore, it is used as admixture for expansive soil like Bentonite, to stabilize it which is easy, ideal and cheap technique.

Bentonite is naturally occurring industrial rock, characterized by the property of absorbing water and by capacity for base exchange; both properties are significantly greater than that of plastic clays and kaolin; in certain bentonites water absorption is accompanied by a considerable increase in volume and formation of gelatinous mass (Johnstone and Johnstone, 1961). Bentonite is processed to give sodium and calcium montmorillonite, activated clays and organo-clays all of which have different properties that can be

applied in wide range of uses and application. Foundry, pelletizing, construction – civil engineering, environmental markets, drilling, oils and food markets, agriculture, pharmacy, cosmetic and medical markets, detergents, paints, dyes and polishes, cat litter, paper, ceramics, catalyst are uses and applications reported by European Bentonite Association.

Special use of bentonite, where its absorbing properties are employed to provide water-tight sealing is for an underground repository in granites (Chegbeleh et al., 2008). In repository, compacted bentonite is used in buffer zone which is designed for containment of radioactive materials over long time period, as protection against minor rock displacements, impermeable barrier to the mass transport by ground water, protection of chemical bufferingand retardation capacity, conduction of heat from the radioactive canister to the surrounding rock. In mixtures with other materials, bentonite is used as backfill that is low in permeability and its purpose is to maintain mechanical stability of underground constructions (tunnel, buffer). Aim of this paper is to describe the bentonite beneficiation process.

A new geo-environmental approach was proposed to use waste materials in certain engineering applications and thereby reduce the potential impact on the environment. This paper presents a laboratory study on eject of waste materials like fly ash on the physical and chemical properties of soil. Fly ash are mixed with bentonite with varying percentage of waste materials. Index properties and engineering properties are known by conducting laboratory tests on bentonite to study on the effect of fly ash on bentonite.

Swelling behaviour of bentonite is reduced by adding fly ash up to some extant later increasing of fly ash to the bentonite again increases the swelling behaviour of bentointe. The addition of fly ash improved some engineering properties of bentonite.

An attempt made to check the advantage application of additives into soil, which may result in permanent physical and chemical alterations. The focus of the experimental test plan was to investigate the effect of fly ashon strength improvement expansive soil. The laboratory test matrix in each test plan included variations additive content, curing period, and moisture condition. A study made to know fly ash addition to expansive soils, its effect on the Index and Engineering properties. The main advantage of chemical stabilization is that setting time and curing time can be controlled. In this stabilization method, setting time and curing time can be controlled.The compacted density of the soil is increased. Chemical stabilization improves the permeability of soil.

Index properties of expansive soil like Atterberg limits and shrinkage limit with and without flyash have been compared. Grain size distribution has also been determined by experiments. The swelling potential of this soil has been determined for various percentage of fly-ash. Maximum dry density (MDD) and optimum moisture contents (OPC) have been found out by the proctor compaction test and the graphs are drawn. The strength of swelling soil is determined for soil specimens with different fly-ash concentrations through Unconfined Compression Test and the results are compared through the graphs. The above results of experiments are compared among them to obtain a percentage concentration of fly-ash with swelling soil which gives best results for lower value of swelling potential and higher strength.

From the above data, bentotine having high swelling property. So, to increase the strength of soil fly ash is taken as additive. Fly ash is added to bentonite with different percentages from 0 to 100% by weight of bentonite through unconfined compression test. The maximum dry density and optimum moisture content are found by compaction proctor test. Finally,results comparison is done through the graphs.

II. LITERATURE SURVEY

The emerging problem obliges contemporary material usage to balance the ecology. In this essence, the abundant availability of waste fly ash can be utilized as a stabilizer which is very effective natural stabilizer which will be beneficial for both circumstances. Hence this research project investigates the use fly ash in bentointe. There have been a few numbers of bentonite-based projects developed in all the corners of Civil Engineering. A critical review of the existing literature on the bentonite is presented in the following areas:

Clay mineral is the key element which passes on swelling characteristics to any ordinary non swelling soil. Montomorillonite has the maximum swelling potential among several types of clay minerals. The origin of such soil is sub

aqueous decomposition of blast rocks, or weathering in situ formation of important clay mineral takes place under alkaline environments. If there is sufficient supply of magnesium of ferric or ferrous oxides and alkaline environments along with sufficient silica and aluminium due to weathering condition, it will favor the formation of Montomorillonite. The depth is shallow at the place of formation for Bentonite with the parent rock underneath. The alluvium deposits can be much deeper in low lying areas, where these soils are transported and deposited.

III. MATERIALSAND METHODOLOGY

In this chapter, the characterization of materials used in this study were explained; for details of the experimental investigations such as specific gravity, liquid limit, plastic limit, plasticity index, free swell index, optimum moisture content and maximum dry density value of bentonite, selecting the additives of fly ash are discussed.

The bentonite utilized for the project work was Sodium bentonite which is normally happening hydrated aluminum silicate clay. It exhibits extremely high swelling and water absorbency properties. Sodium bentonite has been effectively utilized as a sealant for earthen darn structures in areas abundant with exceedingly permeable soil. This is mainly because of its efficient water absorbency resulting in swelling, thereby filling the existing air and water voids with a thick plastic mass. Montmorillonite kind of clay has less pore space, moderately little pore spaces occupied by water and which leads to decrease of hydraulic conductivity of Montmorillonite. Bentonite can also increase the plasticity index of clayey soil in mm. Hence, it was favoured as blended soil.

Sodium bentonite expands when wet, absorbing as much as several times its dry mass in water. Because of its excellent colloidal properties, it is often used in drilling mud for oil and gas wells and boreholes for geotechnical and environmental investigations.The property of swelling also makes sodium bentonite useful as a sealant, since it provides a self-sealing, low permeability barrier. It is used to line the base of landfills, for example. Various surface modifications to sodium bentonite improve some rheological or sealing performance in geoenvironmental applications, for example, the addition of polymers.

Fly ash is the solid waste residue produced from coal, oil, and biomass combustion. It is known that major components of fly ashare SiO2 and Al2O3. After high-temperature combustion, these oxides are formed with highly thermal stability, which results in fly ashhaving good catalyst support. In addition, minor components of other metal oxides, such as Fe2O3, TiO2, CaO, MgO, K2O, and Na2O, could also be used as effective catalyst components. The fly ash could be employed as a catalyst and as catalyst support for many catalytic reactions. However, fly ash has not been used for biomassconversion. It should be noted that fly ash also contains some trace elements, such as Hg, which may be released during fly ashutilization and cause secondary pollution.

Fly ash can be mixed with soil to improve the density, water content, plasticity, strength, and other engineering properties of soil that would otherwise be unsuitable for construction applications, such as road base or structural fills. Class C-Fly ash alone or Class-F fly ashblended with lime or other cementing material are mixed with soil and water with grading equipment. This methodology is used to stabilize road base, stabilize embankments, control expansive soils, and reduce moisture content to permit compaction of soil. The use of fly ash in soil stabilization and modification may be subject to local environmental requirements. One of the primaries uses of fly ash in soil stabilization is to improve the compressive and shear strength of soils. Using fly ash for soil stabilization reduces environmental impacts by reducing the need to remove unsuitable soil and replacing it with engineered fill, thus eliminating the expense and environmental burden of transportation.

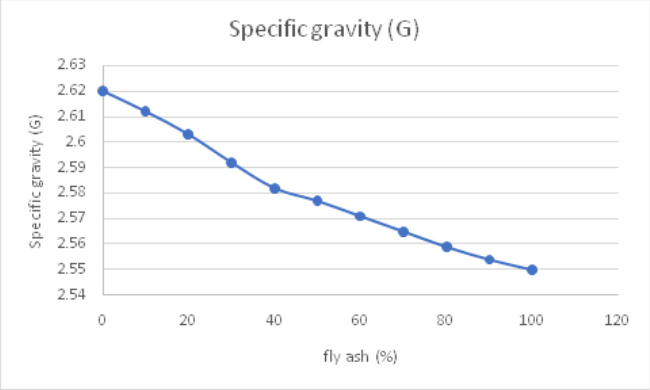
IV. RESULTS&DISCUSSIONS

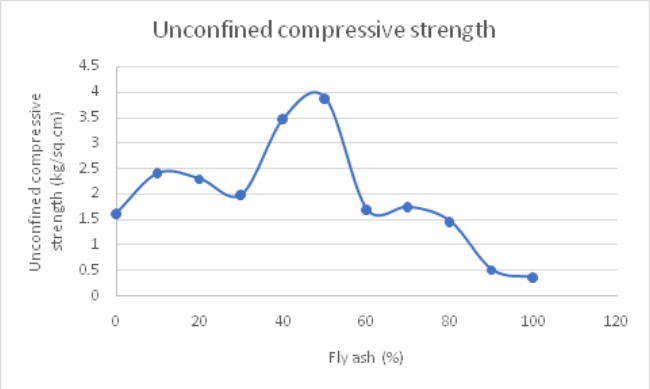
To satisfy the goals, the learning of the tests to be directed is fundamental. This chapter deals with the different type of tests are conducted on bentonite, the brief explanation on the different type of tests and methods to be adopted during the laboratory experiments.

This chapter includes the bentonite characterization in which all the tests are performed for physical, chemical

and geotechnical properties of bentonite are given in detailed. Every one of the tests are executed according to the IS details and in view of code reference are specified this part. In present investigation an endeavour has been made for stabilizing bentonite. It was understood that based on laboratory tests even though the bentonite contains significant quantity of fines and high swelling behaviour so, requirement was not satisfied. The bentonite was mixed with class F fly ash with different percentages from 0 to 100%. Hence bentonite clay was mixed in various extent and their outcomes were analysed to study the criteria satisfied by the mixture.

Examination and discussion of the test outcomes have been done in this chapter. The experimental examination of the soil includes its characterization which covers the fundamental examination, physical, chemical and engineering properties of the soil.





V.CONCLUSION

Fly ash will act as best stabilizer to bentonite which increases the strength and decreases the swelling behaviour of bentonite which is the most important problem in bentonite.Bentonite have plasticity index drastically decline from 0 to 10% and then 20%. The bentonite was blended with various proportions of fly ash and an appropriate mix was found at which the desired strength was achieved. It was observed to be addition of 50% of fly ash shows high strength. A broad Laboratory testing was completed on bentonitebased on the experimental investigation the following are some of the important conclusions. 1. Till 60% of flyash addition, free swell index value decreases more than half than that of its value of only Bentonite. 2. Specific gravity decreases as straight line in a gentle manner and minimum at maximum content of flyash. 3. Liquid Limit value is decreasing with addition of flyash content like in free swell index, but decreases drastically from 0 to 10%. 4. Plastic limit value also decreases with addition of flyash. 5. Plasticity index also decreases with addition of flyash but abruptly from 0 to 10%. 6. Value of maximum dry density (MDD) is near about same but at 20% flyash content we are getting maximum MDD. 7. The Optimum moisture content increases slightly from 0 to 10% and then it decreases up to 70% and again get increases up to 100% of flyash content.

8. Unconfined compression strength of flyash Bentonite mixes shows peaks at 10%, 50% and 70%. But at 50% we are getting very high value of strength.

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