An Experimental Study on Stabilization of Expansive Soil with Barites Powder And Calcium Chloride

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Abstract- *Infrastructure projects such as highways, railways, water reservoirs, reclamation etc. requires earth material in very large quantity. For centuries mankind was wondering at the instability of earth materials, especially expansive soil. Quite often, large areas are covered with highly plastic and expansive soil, which is not suitable for such purpose. One day they are dry and hard, and the next day wet and soft. Swelling soil always create problem for lightly loaded structure, by consolidating under load and by changing volumetrically along with seasonal moisture variation. As a result the superstructures usually counter excessive settlement and differential movements, resulting in damage to foundation systems, structural elements and architectural features. Extensive laboratory / field trials have been carried out by various researchers and had shown promising results for application of such expansive soil after stabilization with additives such as sand, silt, lime, fly ash, etc. A relatively new solid waste, Barytes Powder, Barite often occurs as concretions and void-filling crystals in sediments and sedimentary rocks. It is especially common as concretions and vein fillings in limestone and dolostone, can be used for stabilization of expansive soils for various uses. In combination with Calcium Chloride. The present study was planned to access the role of Calcium Chloride inclusions in improving the weak expansive soil besides stabilizing it with Barites Powder in different proportions.*

Keywords- Expansive Soil, Barites Powder, CaCl2, Soil Stabilization, Compaction tests, Triaxial Tests, CBR Tests, Engineering properties, Expansive soil, Stabilization, Coir Fibre, Calcium Chloride.

I. INTRODUCTION

In India, the area covered by expansive soils is nearly 35% of the total area. They normally spread over a depth of 2 to 20m. In Rainy season, structures on this soils experience large-scale damage due to heaving accompanied by long strength, where as in summer season, they shrink and gain density and become hard. Their alternative swelling & shrinkage damages structure severely. This is severe for lightly loaded structures.

The deformations produced as a result of swelling or shrinkage is significantly greater than elastic deformation and classical elastic or plastic theory cannot predict them. During summer, POLYGONAL SHRINKAGE CRACKS appear at surface, which may extend to a depth of about 2m indicating the active zone in which volume change occurs.

Because of the swelling of black cotton soils during rainy season & their shrinkage during summer, extensive damages have been carved such as “Building Cracks”, canal LANDSLIDES, beds of canal heave, healing &rutting of pavements, damage to conduits etc.

Soil is a natural body consisting of layers (soil horizons) that are primarily composed of minerals which differ from their parent materials in their texture, structure, consistency, and colour, chemical, biological and other characteristics. It is the unconsolidated or loose covering of fine rock particles that covers the surface of the earth. Soil is the end product of the influence of the climate (temperature, precipitation), relief (slope), organisms (flora and fauna), parent materials (original minerals), and time. In engineering terms, soil is referred to as regolith, or loose rock material that lies above the 'solid geology'. In horticulture, the terms 'soil' is defined as the layer that contains organic material that influences and has been influenced by plant roots and may range in depth from centimetres to many metres.

1.2Scope of the Study

The experimental study is concerned with the selection of approximate type of soils to achieve a very high degree of compaction and to expose the compaction properties of clay. The clayey soils are difficult to compact in the initial stages of compaction, but as the moisture content increases the compaction becomes quite easy. The results of the study can provide thoughts for applying clay soil in various applications of soil stabilization process.

1.3Objectives of the study

The following are the main objectives of our project work.

- To increase the load bearing capacity of the soil.
- To increase resistance against the temperature and moisture changes.
- To increase the shear strength and therefore bearing capacity.
- To increase the stiffness and therefore reduce future settlement.
- To decrease void ratio and so permeability, thus reducing potential frost heave.

II. LITERATURE RIEVIEW

The history of the study of soil is intimately tied to our urgent need to provide food for ourselves and forage for our animals. Throughout history, civilizations have prospered or declined as a function of the availability and productivity of their soils. The scientists who studied the soil in connection with agricultural practices had considered it mainly as a static substrate. However, soil is the result of evolution from more ancient geological materials. Other scientists later began to study soil genesis and as a result also soil types and classifications.

Extensive studies have been carried out on the stabilization of problematic soil (such as marine clay and swelling soil, etc.) using various additives such as lime, fly ash, and Fiber P. R.

1. **T Yamini Devi et al (2016**) have studied the stabilization of expansive soil using AlCl3 and fly ash .the expansive soils mixed with AlCl3 in varying percentages of 0.5%, 1.0%, 1.5%, 2.0% of the expansive soil and at each percentage of chemical, addition of fly ash in percentage of 5%, 10%, 15%, and 20%. They concludes optimum percentage i.e., 1.0% AlCl3 and 10% fly ash, there is marked improvement in the results.
2. **G D N Santhoshi et al (2017)** their works reveals Black Cotton Soils combining with different proportion of Barite powder and AlCl3, increases the geotechnical properties and the optimum percentage are 1.5% and 20% of AlCl3 and fly ash.
3. **S.Satya Priya and Dr.P.D.Arumairaj "Micro Fabric and Mineralogical studies on Stabilization of expansive soils using cement industry waste".**

In the present research the unconfined compressive strength of stabilized clayey soil by compacting to different densities at particular moisture content, at different curing period and varying copper slag and cement content. Cylindrical specimens stabilized with copper slag and cement was subjected to determination of unconfined compressive strength method. The low strength and high compressible soft clay soils were found to improve to various degrees by addition of copper slag and cement. The overall test results indicate that copper slag and cement is effective in stabilizing the soil, where significant improvement in unconfined compressive strength. A relatively good strength prediction can be derived from a compilation of the strength and , on condition a reliable number of data are made available. From the test results of unconfined compressive strength method could be easily established for quality control and assurance of stabilization work.

III. METHODOLOGY

** **Expansive Soil**

The Clay that has been used in this study was a typical BC soil collected from Rampachodavarm, East Godavari District. The soil used for the investigation was dried, pulverized and then sieved through 4.75mm size sieve. The properties of black cotton soil experimented, based on relevant I.S. code provisions are given in the Table 1 below.

Table 1 Physical properties of Black Cotton Soil

Laboratory Experimentation	Value
Specific gravity	2.068
Compaction Parameters	
Maximum Dry Density(g/cc)	1.575
O.M.C. (%)	16
Atterberg's limits	
Liquid limit (%)	80.4
Plastic limit (%)	30.6
Plasticity index(%)	49.8
IS classification	CH
Differential Free Swell (%)	40
CBR- Unsoaked	3.425
Soaked	1.959

Barite Powder (BP)

Barite is a mineral composed of barium sulfate (BaSO4). It receives its name from the Greek word "barys" which means "heavy." This name is in response to barite's high specific gravity of 4.5, which is exceptional for a nonmetallic mineral. The high specific gravity of barite makes it suitable for a wide range of industrial, medical and manufacturing uses. Barite also serves as the principal ore of barium.

Barite often occurs as concretions and void-filling crystals in sediments and sedimentary rocks. It is especially

common as concretions and vein fillings in limestone and dolostone. Barite is also found as concretions in sand and sandstone. These concretions grow as barite crystallizes within the interstitial spaces between sand grains. Sometimes crystals of barite grow into interesting shapes within the sand.

The largest single deposit is the Mangampet deposit in Andhra Pradesh, India where two Stratiform lenses up to 1.2 km long and 20 m thick contain over 74 million tones of barytes. The APMDC is one of the major producers of the mineral.

Table 2 Physical properties of barites

Physical properties of barites	
Chemical classifications	Sulfate
Color	Colorless, white, light blue, light yellow, light red, light green
Mohs hardness	2.5 to 3.5
Specific gravity	4.5
Diagnostic properties	High specific gravity, three cleavage, directions at right angles
Chemical composition	Barium sulphate, $BaSO_4$
Crystal system	Orthorhombic
Uses	Drilling mud, high density filler for paper, rubber, plastics

Properties of Calcium Chloride:

- Calcium chloride can serve as a source of calcium ions in an aqueous solution, as calcium chloride is soluble in water. This property can be useful for displacing ions from solution. For example, phosphate is displaced from solution by calcium:
  3 $CaCl_2(aq)$ + 2 $K_3PO_4(aq)$ → $Ca3(PO_4)_2(s)$ + 6 KCl(aq)
- Molten calcium chloride can be electrolysed to give calcium metal and chlorine gas: $CaCl_2(l)$ → $Ca(s)$ + $Cl_2(g)$
- Calcium chloride has a very high enthalpy change of solution. A considerable temperature rise accompanies its dissolution in water.

IV. RESULTS AND DISCUSSION

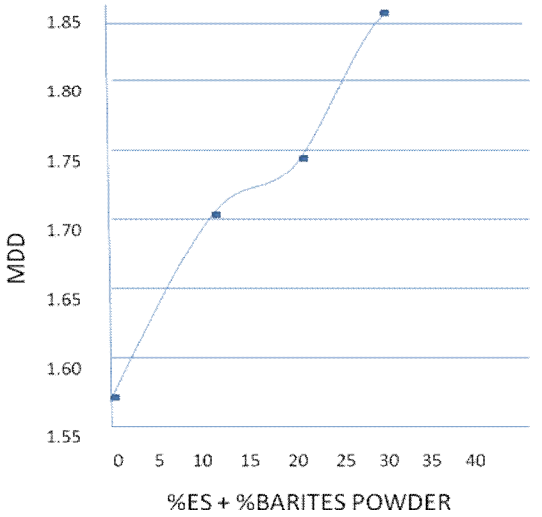
In the laboratory, various experiments were conducted by adding different percentages of Barites Powder(BP) in the expansive soil and also further stabilizing it with Calcium Chloride as a binder. Compaction, Strength and CBR tests were conducted with a view to determine the optimum combination of Barites Powder as replacement in expansive soil and Calcium Chloride as a binder.

EFFECT OF % BARITES POWDER(BP) AS ADDITIVE ON THE STRENGTH CHARACTERISTICS OF EXPANSIVE SOIL

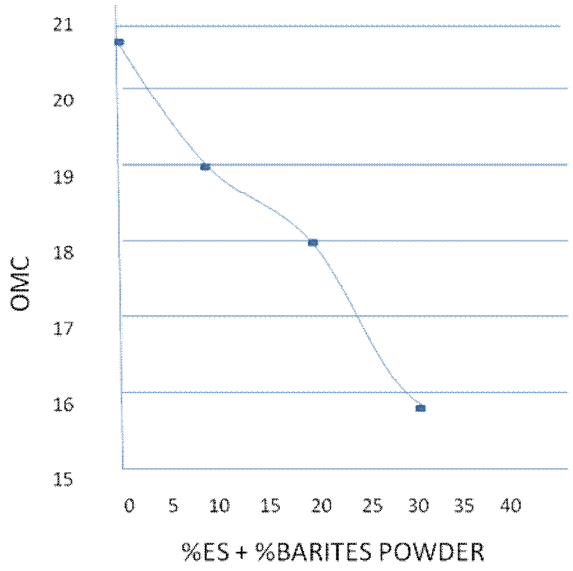
The individual influence of Barites Powder(BP) on the Compaction and Strength characteristics of expansive soil are clearly presented in Figures below. The percentage of Barites Powder (BP) was varied from 0%, to 30% with an increment of 10%. From the below graphs, it was observed that the treatment as individually with 20% BP has moderately improved the expansive soil. It can be inferred from the graphs, that there is a gradual increase in maximum dry density with an increment in the % replacement of BP up to 30% for strength characteristics. The addition of BP had mobilized little amount of friction to the pure Clayey soil without friction

Properties of Expansive Soil with Coir Fibre

ES+BP	MDD	0MC	Unsoaked CBR	Soaked CBR
100+0	1.557	20.8	2.269	1.959
90+10	1.705	19.0	3.781	1.570
80+20	1.734	18.0	5.810	3.092
70+30	1.872	15.8	3.512	0.669



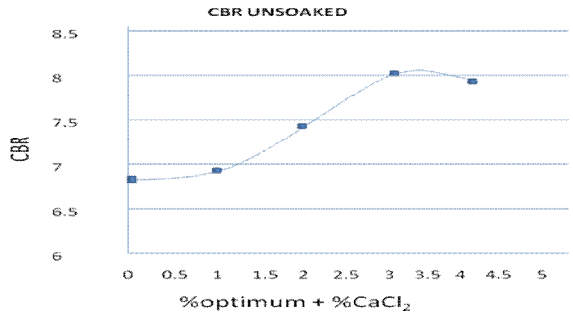
Plot showing the variation of Maximum Dry Density with % replacement in Expansive soil with Barites Powder.



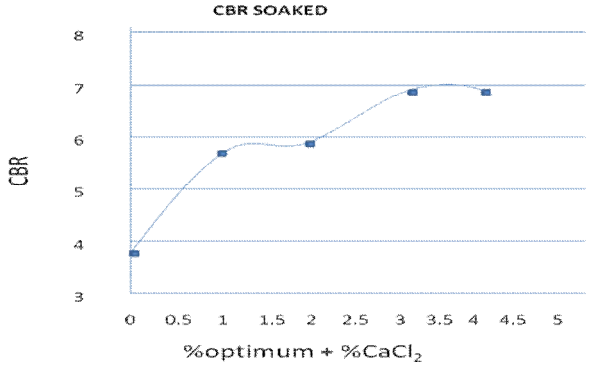
Plot showing the variation of Optimum Moisture Content with % replacement in Expansive soil with Barites Powder.

Properties of Optimum Mix with Calcium Chloride

ES+BP+$CaCl_2$	MDD	OMC	Unsoaked CBR	Soaked CBR
80+20+0	1.680	30.5	6.810	3.724
80+20+1	1.687	30.4	6.891	5.771
80+20+2	1.699	29.6	7.432	5.893
80+20+3	1.736	29.3	8.081	6.935
80+20+4	1.728	29.1	7.901	6.81



Plot showing the variation of Unsoaked CBR values with % Calcium Chloride inclusions in Optimum Content of BP with Expansive Soil



Plot showing the variation of Soaked CBR values with % Calcium Chloride inclusions in Optimum Content of CF with Expansive Soil

V. CONCLUSION

The following conclusions are made based on the laboratory experiments carried out in this investigation.

1. Stabilization of expansive soil using Barites powder improves the geotechnical properties of expansive soil.
2. The free swell index of the expansive soil used has 40%.
3. The dry density of the soil has increased when barites powder was added to the soil and Optimum moisture content was decreased.
4. The C.B.R value has increased when barites powder was added upto 20% after that further addition of barites powder CBR value start decreasing.
5. To increase the CBR value of the expansive soil we added Calcium Chloride as a binder, the treatment of Calcium Chloride has increased the CBR value

From the above laboratory investigation it can be concluded that the barites powder has a potential to modify the engineering behavior of Expansive soil with that calcium chloride is acts as a binder and brings that soil to make it suitable in many geotechnical application

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