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Stabilization of Black Cotton Soil Using Lime and Rice Husk Ash

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Abstract

Expansive soils are basically susceptible to detrimental volume changes with the changes in moisture content. The behavior of soils is attributed to the presence of montmorillonite mineral with in expanding lattice. Understanding the behavior of expansive soil and adopting appropriate control measures have been a great task for geo-technical engineers. Researchers into new and innovative uses of waste materials are continuously advancing. Many highway agencies, private organizations are in the process of a wide variety of studies and research projects concerning the environmental suitability and performance of using recycled products in highway construction. The amount of wastes has increased year by year and the disposal becomes a serious problem. By product of rice milling. its use as a soil stabilizer is a alternative to the final deposition with the environmental benefit. It is necessary to utilize the wastes effectively with technical development in each field. The swell and shrink movements are due to changes in soil moisture. Providing uniform soil moisture next to and under your foundation is the only best thing to reduce or minimize the damaging effects of Expansive soil. The present study is an attempt to utilize the Rice husk ash and the lime to stabilize the expansive soils for the foundation beds and sub-grades.

A well proportion mix of soil, rice husk ash, lime forms a material of improved quality having a higher value of strength in bearing. This have been proved by performing tests for compaction properties, Atterberg limits, shear parameters and CBR values, which is showed a considerable increase in the bearing capacity.

Keywords: Stabilization, Black Cotton Soil, Lime and Rice husk ash,

1. INTRODUCTION

Expansive soils are found in semi arid regions of the world and, hot climate and poor drainage conditions are usually associated with the formation of these soils. In INDIA, these soils are generally called as a black cotton soils and cover about 20% of the total land area. They are found in the states of Andhra Pradesh, Gujarat, Karnataka, MadyaPradesh, Maharashtra and Tamilnadu. Expansive soil is one among the problematic soils that has a high potential for shrinking or swelling due to change of moisture content. Expansive soils can be found on almost all the continents on the Earth. Destructive results caused by this type of soils have been reported in many countries. In India, large tracts are covered by expansive soils known as black cotton soils. The major area of their occurrence is the south Vindhayachal range covering almost the entire Deccan Plateau. These soils cover an area of about 200,000 square miles and thus form about 20% of the total area of India.

World over, problem of expansive soils has appeared as cracking and break-up of pavements , railway and highway embankments, roadways, building foundations ,irrigation systems, water line, sewer lines, canal and reservoir linings. The losses due to extensive damage to highways running over expensive soil sub grades and estimated to be in billions of dollars all over the world.

The primary problem that arises with regard to expensive soils is that deformations are significantly greater than the elastic deformations and they cannot be predicted by the classical elastic or plastic theory. Various remedial measures like soil replacement, moisture control, pre-wetting, lime stabilization have been practiced with varying degrees of success. however, these techniques suffer from certain limitations with respect to their adaptability, like longer time periods required for pre-wetting the highly plastic clays, difficulty in constructing the barriers, pulverization and mixing problems in case of lime stabilization and high cost for hauling suitable refill materials for soil replacement etc.
Many researches, all over the World are working, to evolve more effective and practical treatment methods, to alleviate the problems caused to pavements laid on expansive soils. Investigations on chemical stabilization, (Desai and Oza, 1977; Sivapullaiah et al., 1994; PrasadRaju, 2001) revealed that electrolytes like potassium chloride, calcium chloride and ferric chloride may be effectively used in place of the conventionally used lime, because of their ready dissolvability in water and supply of adequate cations for ready cation exchange.

Mitchell and Radd (1973) also felt CaCl2 might be effective in soils with expanding lattice clays. Katti et al, made (1996) made an attempt to stabilize the in-situ soil using deal moisture KOH solution and revealed that the properties of black cotton soils in place can be altered by treating them with aqueous solution of KOH. Ho (1968) conducted the laboratory tests and observed that the swelling characteristics of expansive soils can be improved by means of flooding at a given site with proper choice of electrolyte solution more so using chloride of divalent or multivalent cations. Sivanna et al. (1976) studied that influence of CaCL2 and KOH on strength and consolidation characteristics of black cotton soil and found an increase in the strength and reduction in the settlement and swelling. Rao and SubbaRao (1994) recommended 5%FeCl3 solution to treat the caustic soda contaminated ground of an industrial building in Bangalore.

Moreover, they can be applied to ground in the form of electrolyte solution either by ponding for shallow depths or ponding-cum-boreholes for reasonable depths. Petry and Amstrong (1989) recommended the use of calcium chloride in place of lime, as calcium chloride is more easily made into calcium chloride supernatant than lime.

The amount of wastes has increased year by year and the disposal becomes a serious problem. Particularly, recycling ratio of the waste materials in life and industry is low and many of them have been reclaimed for the reason of unsuitable ones for incineration. It is necessary to utilize the wastes effectively with technical development in each field. The simple way of recycling waste in the field of civil engineering as reinforcement material. Reinforced soil construction is an efficient and reliable technique for improving the strength and stability of soils. It is necessary to utilize the wastes effectively with technical development in each field. In this work it is attempted to study the effect of lime and rice husk ash on the engineering properties of expansive soil through laboratory experimentation.

2. LITERATURE REVIEW:

Soils are typical tropical formations, generally found in poorly drained localities where there are marked dry and wet seasons. The clay minerals are formed through extensive physical and chemical weathering of parent material. Donaldson (1973) classified the parent material into two groups; the first group comprises the basic igneous rocks and the second group comprises the sedimentary rocks, which contain montmorillonite as a constituent. The basic igneous rocks, poor in silica and rich in feldspar, pyroxenes and amphiboles, weather to clay minerals.

Sedimentary rocks such as shale's and clay stone, which contain varying amounts of volcanic ash and limestone and marls rich in magnesium, can also weather to clay minerals. An alkaline environment and the absence of leaching, the presence of Ferro magnesium minerals in parent materials and presence of bases favor the formation of montomorillonite. The basic igneous rocks, volcanic ash and their derivatives serve as the parent materials for the formation of montomorillonite clay minerals.

The other important clay minerals are kaolinite and ilite. Kaolinite formation is favored by prolonged leaching under acidic environment and high temperatures with parent rocks containing ferric iron. The conditions for the formation of ilite material are similar to those leading to the formation of montmorillonite and in addition, the presence of potassium in the parent material is essential.

Black Cotton soils found in INDIA are formed by weathering of basalt and traps Deccan plateau. However, their occurrences on granite, gneiss, shales, Sandstone, slates and limestone is also recognized (Uppal, 1965; katti, 1979; Mohanand Jaisingh, 1985).

3. MATERIALS:

3.1EXPANSIVE SOIL:

The soil used was a typical Black Cotton Soil collected from JAGGAMPETA, in East Godavari District, Andhra Pradesh, India. The properties of soil are presented in the Table. All the tests are carried out on the soil as per IS specifications. RICE HUSK ASH (RHA) the rice husk ash was collected from sri lalitha rice mill valuthimmapuram road near peddapuram. In the form of ash which is a solid wasted which is disposed in the empty barren land as a solid waste. Rice Husk Ash is by-product material produced from the process of manufacturing puffed rice, contains large amount of iron oxide and silicate. It has higher density, stay in the top layer and then transported to a water basin with a low temperature for solidification. The end product is a solid, hard material that goes to the crusher for further processing. Annually 60,000 tons of rice husks are produced in India. It is chemically stable and its physical properties are similar to that of natural sand. The high angularity and friction angle (up to 530) of rice husk contribute to excellent stability and load bearing capacity. With specific gravities ranging from 2.8 to 3.8, rice husk aggregates are decidedly heavier than conventional granular material. Rice husk aggregate tend to free drying and are not frost susceptible. The constituents of Rice Hush Ash are listed.

3.2 LIME:

Lime, chemically known as, calcium oxide (cao),commonly known as quick lime or

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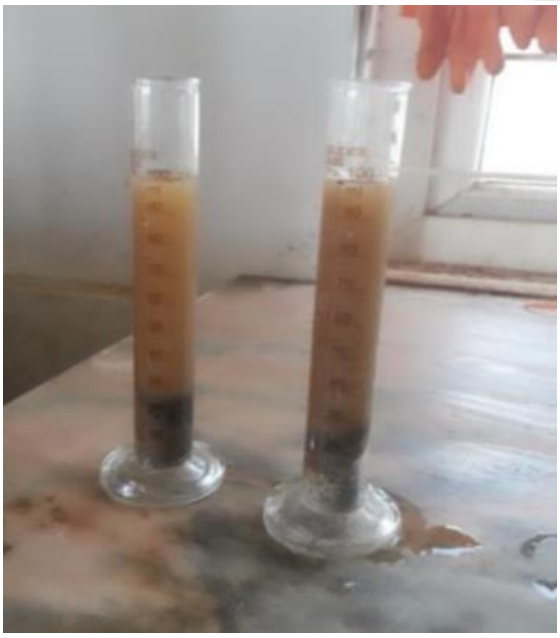
burnt lime, is a widely used chemical compound. It is white ,caustic, alkaline crystal solid at rooms temperature. The broadly used term c lime contains of calcium, silica, magnesium, aluminium, and iron predominate such as lime stone . By contrast, quick lime specifically applies to a single chemical compound.

Calcium oxide is usually made by the thermal decomposition of materials such as lime stone ,that contain calcium carbonate caco3;(mineral calcite) in lime kiln. This is accomplished by heating the minerals to above 8250c(1,5170f) a(co2);leaving quick lime. The quick lime is not stable and when cooled, will spontaneously react with co2 form the air until ,after enough time , it is completely converted back to calcium carbonate.

4. Experimental Programme:

Tests are conducted in the laboratory on the expansive soil to study the behavior of expansive soil, when it is treated with Rice husk ash and lime. The following tests were conducted as per IS code of practices.

DIFFERENTIAL FREE SWELL (DFS)
To determine the free swell index of soil as per IS: 2720 (Part XL) – 1977. Free swell or differential free swell, also termed as free swell index, and is the increase in volume of soil without any external constraint when subjected to submergence in water.
Free swell index = [Vd - Vk] / Vk x 100%
Where,
Vd = volume of soil specimen read from the graduated cylinder containing distiled water.
Vk = volume of soil specimen read from the graduated cylinder containing kerosene.
Free swell index test of soil (is-2720-part-40-1970)



Sieve analysis was carried out using a set of standard I.S Sieves. The sample was oven dried and placed on the top of the sieve set and shaken by hand. The fine fraction that passed through 75 micron sieve was taken and hydrometer analysis was carried out in 1000 ml for using the required quantity of sodium Hexameta phosphate as dispersing agent. The test was carried out according to IS: 2720- part 4, 1985.
known quantity of oven dried sample has taken in a set of sieves i.e., 4.75mm, 2.36, 1.18 mm, 600 μ, 425μ, 300μ, 150μ, 75μ arranged in an ascending order and shake for 10 minutes to 15 minutes on a sieve shaker. The weight retained on each sieve has obtained and their corresponding percentage finer has determined. Therefore from the graph plotted between percentage finer as Ordinate and Particle size (D in mm) as abscissa, mean particle size D10, D15, D30 ,D50, D60, D85, D90 are determined similarly the Coefficient of Uniformity (Cu) and Coefficient of Curvature (Cc) also be determined.

The water content is defined as the ratio of the mass of water to the mass of solids.

The water content is also known as the moisture content. It is expressed as percentage and used as decimal in computation. The water content of a soil is an important parameter that controls its behavior. It is a quantitative measure of the wetness of a soil mass. The water content of a soil can be determined by many methods of which oven drying method has been adopted. In this method the soil sample in the container is dried in an oven at a temperature of 110°±5°C for 24 hours.

Water content, w= Mw/ Ms = (M2-M3)/ (M3-M1)
Where M1 = mass of container, with
M2 = mass of container, lid and wet soil
M3 = mass of container, lid and dry soil

The Atterberg limits are a basic measure of the critical water contents of a fine-grained soil: its shrinkage limit, plastic limit, and liquid limit.

As a dry, clayey soil takes on increasing amounts of water, it undergoes distinct changes in behavior and consistency. Depending on the water content of the soil, it may appear in four states: solid, semi-solid, plastic and liquid. In each state, the consistency and behavior of a soil are different and consequently so are its engineering properties. Thus, the boundary between each state can be defined based on a change in the soil's behavior. The Atterberg limits can be used to distinguish between silt and clay, and to distinguish between different types of silts and clays.
These limits were created by Albert Atterberg, a Swedish agriculturist. They were later refined by Arthur Casagrande.
Distinctions in soil are used in assessing the soils that are to have structures built on them. Soils when wet retain water, and some expand in volume. The amount of expansion is related to the ability of the soil to take in water and its structural make-up (the type of atoms present). These tests are mainly used on clayey or Silty soils since these are the soils that expand and shrink due to moisture content. Clays and silts react with the water and thus change sizes and have varying shear strengths. Thus these tests are used widely in the preliminary stages of designing any structure to ensure that the soil will have the correct amount of shear strength and not too much change in volume as it expands and shrinks with different moisture contents.

5. TEST RESULTS & DISCUSSION:

Details of the laboratory experimentation carried out with different combinations of materials have been discussed in the previous chapter. In this chapter a detailed discussion on the results obtained from various laboratory tests are presented.
To find the optimum percentage of Lime and Rice husk ash with expansive clay, compaction tests are conducted by using different proportions of soil, Lime and Rice husk ash.
Compaction tests were conducted to get the Optimum Moisture Content and Maximum Dry Density of the mix of different proportions of soil, Lime and Rice husk ash by using Modified proctor compaction apparatus.

6. CONCLUSIONS:

The following conclusions are drawn based on the laboratory studies carried out in this investigation
1. I.S heavy compaction, CBR tests were conducted by using different percentages of Lime and Rice Husk Ash were mixed for finding the optimum moisture content and max dry density.
2. From the compaction test results it is observed that Expansive soil reinforced with Lime and Rice Husk Ash, the OMC increases continuously whereas the MDD for Llime and Rice Husk Ash increases

from 13.1 kN/m3 to 13.6kN/m3 up to 3% beyond it decreases respectively as shown in Figures

3. From the test results it is observed that Expansive soil reinforced with optimum Rice Husk Ash has given better performance when mixed with optimum Lime

4. Addition of Lime and Rice Husk Ash inclusions in the Expansive soil results in an appreciable increase in the strength characteristics and CBR values.

5. From the result of compaction, CBR, Expansive soil reinforced with Rice Husk Ash has shown better performance when mixed with Lime.

6. Shear strength and bearing capacity of soil increase with optimum use of lime and admixture.

The investigation is further carried out by constructing laboratory model flexible pavements for Expansive Soil sub grade unreinforced and reinforcing with optimum percentages of wastes. Cyclic plate load tests and heave measurements are carried out on the pavement system at OMC and saturation state to find out load bearing capacity and performance of reinforcement materials.

The laboratory model tests are further extended with using different combinations of randomly distributed waste plastics and Bagasse waste fibre material and other alternatives. The short and long-term performance of Expansive Soil reinforced with waste plastics and Rice husk ash could be further extended by extensive field studies during both dry and wet season.

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