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Use of Magnesium Sulphate for the Stabilisation of Black Cotton Soil

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ABSTRACT

Black cotton soils are present in larger amount all over the world. Black cotton soil can ingest large amount of water which possess swelling of soil and shrinkage when water is evaporated. Searching the best stabilizer to overcome the problems in expansive soil and reducing swell-shrink phenomenon is still main concern, because every construction is built with or upon the soil. If the subgrade is not having enough robustness to resist heaves, the whole structure has to face problems like base failure, cracks etc. So keeping the stability of whole structure in mind the subgrade is replaced with stronger soil, but it is not so economical in case of large construction. Problems identified with black cotton soils, are well known to engineers. During the last few decades damage due to swelling-shrinkage process has been observed clearly in many areas in the form of cracking and breakup of pavements, roadways, building foundations, reservoir linings, irrigation systems, water lines, and sewer lines. In this research paper, efforts had been made to decrease the plasticity of highly plastic black cotton soil, by the use of additives i.e. Magnesium sulphate. The main focus of this study is to reduce the swell-shrink property black cotton soil and increase its strength by the use of magnesium sulphate.

Keywords : Black Cotton Soil, Ingest, Robustness, Stabilization, Magnesium Sulphate.

I. INTRODUCTION

The natural cohesive soil is very bad as an engineering material as it is having very low bearing capacity it is highly spongy in nature. Soil is naturally occurring material which is stabilized to increase the robustness and imperishability of the soil. The soil in subgrade is normally overstretch to assured minimum level of pressure due to the traffic loads [2]. The index properties of soil are determined by tests such as sieve analysis, specific gravity, liquid limit and plastic limit [1,7] Since we are dealing with Cohesive soil, which include Black cotton soil, it is highly cohesive in nature and is having swelling and shrinkage characteristics in cold and hot weather due to the presence of the clay Montmorillonite. Bumping and shrinkage of Expansive soil cause differential settlement resulting in severe damage to the foundation, building, roads, retaining structures etc. It has been noted that many civil engineering structures failed because of the presence of weak underlaying soil strata [5]. This kind of soil possess behaviour like liquidity behaviour, plasticity behaviour, compaction behaviour and many more. The swelling pressure of Black cotton soil will be imposed on Infrastructures such as the Foundation slab, Tunnels and results in Extensive damages to the structure [2]. the basic objective of present study is to examine the possibility 0f using magnesium sulphate in, in the context of expansive soil [3].road pavements , buildings, dams, sewer linings experience huge damage due to heaving caused because of loss of

strength, bumping of soil in rainy season and shrinking of soil in winter season in the form of cracks. Foundation founded of black cotton soil experience uneven settlement, more on the central portion than on the edges [4]. This troublesome behaviour of expansive soil from Engineering consideration is due to the presence of kaolinite, illite, and mainly because of Montmorillonite.

Engineers are very careful about using black cotton soil as a construction material for building, embankment etc rather they replace soft soil with strong soil. Sometimes it is not possible to replace expansive soil in some sites because of non-availability of strong soil with good load bearing capacity. The stabilization of expansive soil in such location is not possible, therefore it is required to add additives in the soil to increase its robustness. By the use of certain Organic and Inorganic Additives, we are going to stabilize the soil by the improvement of its bearing capacity and by calculating the contents of additives to be added to enhance the strength of soil. In this project we are going to stabilize the soil by enhancing its bearing capacity by using certain Additives and to make a foundation bed strong and lasting.

II. LITERATURE REVIEW

Kola Srinivas (2016):
They had used CNS (Cohesive non swelling) layer for improvement of Expansive soil. They had also concluded that swelling pressure increases with increase in dry density and decreases with increase in water content. They had also proved that other than CNS soils the techniques for stabilizing soil are very expensive. They had also studied that in non-Expansive cohesive soil, the movement of heave is uniform and more tolerable. From this study they had enhanced the property of expansive soil thereby balancing the existing soil.

Srinivas Ganta (2017):
They had done the study on stabilizing the soil by the use of rise husk and lime sludge by adding rise husk ash alone they had reduced the plasticity of soil. By adding rise husk Ash they had decrease the value of maximum dry density (MDD) and increases the (OMC) optimum moisture content by adding lime and rice husk ash to the soil. They had also observed that with increase in percentage of lime and rise husk ash the value of specific gravity increases and permeability of clayey soil decreases.

Geethu Chandran (2016):
They had concluded a study on heave control and stabilizing the Expansive soil using lime mixed GGBS ground granulated blast furnace slag) column. they had also performed strength tests on three combinations of GGBS and lime. They had observed in the study that by adding only GGBS in expansive soil only 18% heave reduction is obtained but by mixing lime with GGBS column 24% heave value is obtained. By providing 2 GGBS column 30% heave reduction is obtained. They have also obtained maximum strength improvement from this study.

III. METHODS AND MATERIAL

The materials used in this project are magnesium sulphate.

A) Black cotton soil:
In India, near about 16 to 20% of land is covered by expansive soil deposits, which includes black cotton soil. This soil has low shear strength and compressibility and it is highly plastic in nature. The soil that we had used in this project is organic soil.

Fig A shows Black cotton soil.

Fig A) black cotton soil

B) Magnesium sulphate:

$MgSO_4$ is a white crystalline solid, odourless having a density of 2.66g/cm² {anhydrous} 2.445g/cm² {monohydrate}. It is commonly called as Epsom salt. its molecular weight is 120.36{anhydrous} 138.38{monohydrate} & 246.47{heptahydrate}. Organic formula of magnesium sulphate is $MgSO_4$ $\{H_2O\}$.It does not cause any skin irritation or harm to the environment .Historically, $MgSO_4$ has wide variety of uses in construction ,so we had used magnesium sulphate to increase the safe bearing capacity of soil as well as decreasing the plasticity of highly plastic soil. It is more economical in case of large construction. We had done certain tests like specific gravity to identify the type of soil whether it is Organic or Inorganic, Sieve Analysis to assess the particle size distribution of Granular Material, Water content test to find out the Natural Moisture content of soil, liquid limit and plastic limit to find out the plasticity Index, Proctor test to find out the maximum dry density and Optimum moisture Content and direct shear test. we are going to counter the heaves using certain Additives so that we can reduce Unification and desiccation of soil, to improve soils Robustness as well as its imperishability by the use of additive i.e. Magnesium sulphate. Fig B shows magnesium sulphate powder.

Fig B) magnesium sulphate powder

IV. RESULTS AND DISCUSSION

The following index and engineering properties are found out on standard field soil and then tests are conducted for the magnesium sulphate mixed in soil. The magnesium sulphate was taken in proportion as 5%, 10%, 20% by the weight of soil.

The following tests were performed on standard Black cotton soil:

A) Specific gravity:

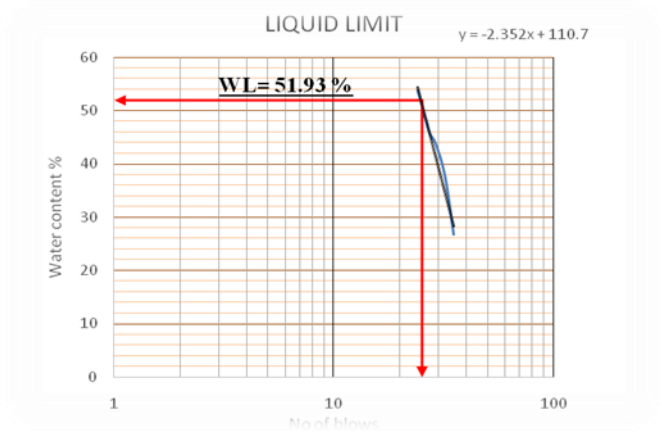
1)specific gravity is coming under the range of 2 to 2.5 i.e. the soil is organic soil in nature.

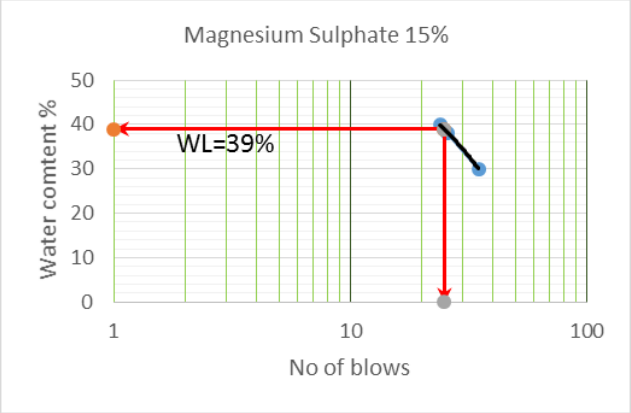
B) liquid limit:

1) The liquid limit of soil is found out to be 51% with standard field soil.

2) Whereas it was coming out to be 39% by adding 15% magnesium sulphate.

Graph:





C) plastic limit:

1) Plastic limit of standard soil or untreated soil is coming out to be 28.96%.

2)The plastic limit of soil is coming out to be 30.66% by adding 15% of magnesium sulphate.

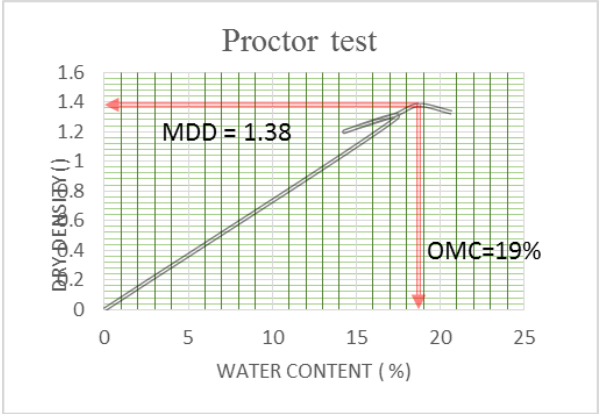
From liquid limit and plastic limit we found that the plasticity index of soil,

Plastic limit = liquid limit- plastic limit

= 22.04%

Therefore, the plastic limit of soil comes 22.04% which shows that the soil is highly plastic and cohesive in nature.

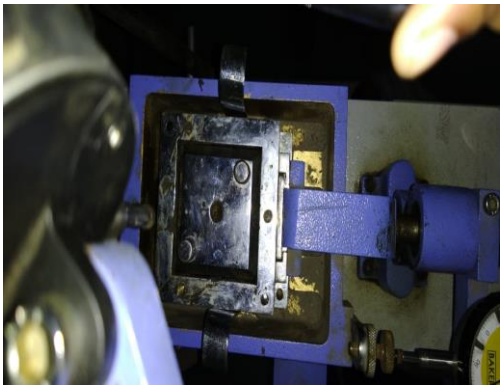
D) Proctor test:



RESULTS:

Optimum moisture content of untreated soil is coming out to be 19% at maximum dry density 1.38g/cc.

E) Direct shear Test:

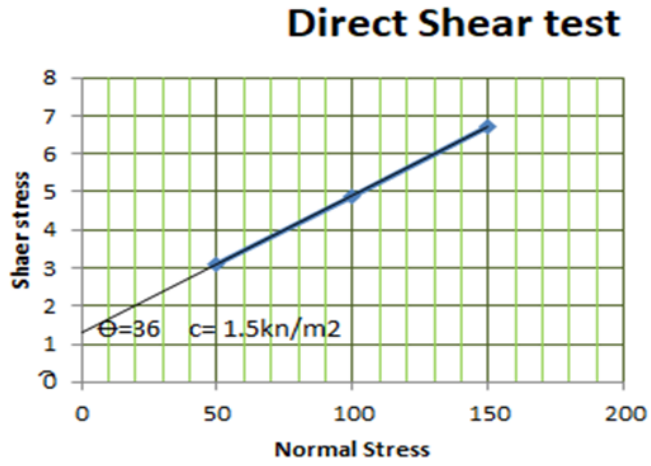


RESULTS:

1)Shear strength parameters for soil used in this test are

Cohesion, c=1.5kn/m ^{2}

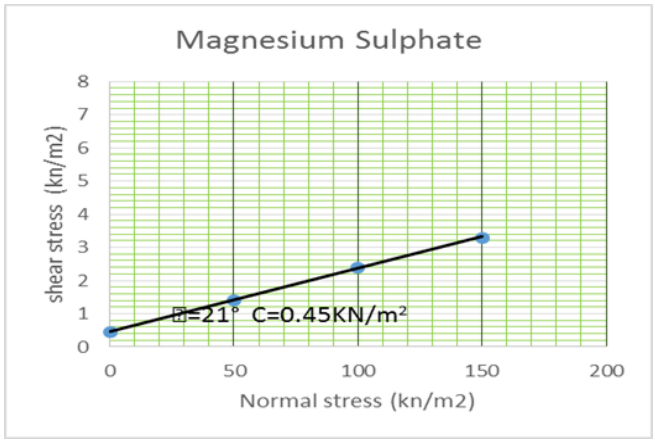
Shear Angle = 36˚



2)with treated soil with 15% Magnesium sulphate:

Cohesion(c) =0.45kn/m^2

Shear angle =21%



V. CONCLUSION:

The expansive soil was treated with magnesium sulphate to enhance its properties. From results based on the results of the tests conducted on black cotton soil, it is concluded that:

1) Expansive soil being problematic in nature is treated with magnesium sulphate to reduce its plasticity and improving the safe bearing capacity of soil.
2) Also, it is economical to add magnesium sulphate in soil to increase its strength because it is economical in case of large construction rather than replacing it with soft soil.

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