International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2015): 6.391

Review Paper on Stabilization of Clay Soil Using RBI Grade-81

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Abstract: ***Clay soil deposit occurs in the arid and semi-arid regions of the world and is problematic to the engineering structure because of their tendency to heave during the wet season. Clays exhibit generally undesirable engineering properties. Soil stabilization has become a process of improving engineering properties soil. There are various materials used as stabilizing material. In this paper, RBI GRADE -81 mixed with clay soil and its effect on the geotechnical characteristics of clay mixtures is investigated by conducting California Bearing Ratio test, Unconfined Compression Test and Proctor Test. The soil is stabilizing with different percentages of RBI Grade -81. Observations will be calculated for the changes in the properties of the soil such as Maximum dry density (MDD), Optimum moisture content (OMC), unconfined compressive strength (UCS) and California Bearing Ratio (CBR) values will determine on 0%, 2%, 4%, 6%, and 8% percentages of RBI.***

Keywords: Soil stabilization, RBI Grade-81, Compaction, CBR and UCS

1. Introduction

Soil is the basic construction material. It supports the sub structure of any structure and it is the sub-grade which supports the sub-base/base in the pavement. Soil is one of the most commonly encountered materials in civil engineering. Different damages in the form of cracking, undulation different settlements, etc are experienced by the roads, building, irrigation channels, water and sewer lines, etc. Clays exhibit generally undesirable engineering properties. It tends to have low shear strength further upon wetting or other physical disturbance. It can be plastic, compressible and expand when wetted and shrink when dried. There is a need to concentrate on improving properties of soils using cost-effective practices. Here an attempt is made in this paper to stabilize the clay soil using RBI Grade 81 as admixture. The variation in compaction characteristics, strength characteristics and CBR values of clay soil are compared in this paper.

2. Soil Stabilization

Soil Stabilization can be defined as any physical, chemical, biological or a combined method of changing the available natural soil in order to meet the engineering properties and fulfill the necessity. Soft Soils are characteristically known for their low strength, high compressibility and high groundwater table which cause large settlement. In addition, soft soil also exhibit high compressibility, reduced strength, low permeability which are unsuitable conditions for construction. Soft clay has low load bearing capacity and undergo large settlement when loaded. Hence, construction of highways embankment on normally consolidated soft soil deposit has suffered from extravagant settlement and lateral displacement without proper ground improvement before construction implemented. Therefore, ground improvement is needed to avoid these excessive settlements of structures constructed on soft ground.

3. Literature Review

Raju Sarkar, Ankur Mudgal, Sandeep Bhaskar, Varun Gupta and Ritesh Kurar (2016) study on Waste materials can be used as geotechnical admixtures to improve geotechnical properties of black cotton soils as well as curb environmental degradation. Methods: The aim of this paper is to provide a clear understanding of the effect of geotechnical admixtures on the properties of expansive soils through selective reference to some of the literature

B. Vishnuvardhan Kumar, M. Teja, G. Kalyan Kumar (2015) In this study a new Proprietary Cementitious Stabilizer (Road Building International Grade 81) and Ground granulated blast furnace slag(GGBS) is being used to study the improvement in engineering properties of Black Cotton (BC) soil. A pozzolanic reaction takes place which uses the excess SiO from the slag source, Ca(OH) produced by the hydration of the silicates, and water to produce more of the desirable CSH making slag a beneficial minerals admixture to attain Soil Stabilization.

Manisha Gunturi at. Al. (2014) carried out a study on CBR and swelling behavior of expansive soil when treated with RBI Grade-81. After the test investigation they were concluded that the UCS value was improved appreciably with the addition of RBI Grade-81 under the curing period of 3 days and 7 days with the increase in the percentage of RBI the rate of increase of UCS also increased.

Venugopal G, Chetan Fakkerappa Babji (2014) conducted a study Road infrastructure in India is developing at a very fast pace. A good pavement is needed for the safe, comfortable and economical movement of traffic. The thickness of road depends on geotechnical properties of subgrade soil and traffic intensity. The comparison of the strength results with or without RBI Grade-81 has been done. The subgrade soil can be improved by using RBI Grade-81 and cost of construction can be reduced to certain extent.

B.M. Patil and K.A. Patil, (2013) studied the effect of RBI Grade-81 and moorum to stabilize the soil. The RBI Grade-

81 and moorum were mixed with soil in different proportions and tested for OMC, MDD and soaked CBR. The conclusion made on the basis of test results was that the CBR value of soil can be improved by using moorum and RBI Grade-81 as stabilizer.

Tejinder Singh, Navjot Riar (2013) studied the effect of RBI Grade-81 to stabilize the soil with the help of Atterberg's limit test, Standard Proctor test and CBR test and analyze the cost difference between conventional method and cost of pavement constructed using 2%, 4%, 6% and 8% RBI Grade-81. They concluded that RBI Grade-81 is very effective in stabilizing the highly plastic soil. This soil can be considered as stabilized sub base. They also concluded that expense of pavement reduced with RBI Grade-81.

K.V. Madurwar (2013) rolled out a try to improve properties of black cotton soil with RBI-81 and sodium silicate. He concluded that the UCS & CBR quality increments with expansion in RBI 81. Expansion proposes its dependability as great stabilizer to enhance execution of delicate soil. They likewise arrived at the conclusion that free swell index diminishes as RBI - 81 expanded and its goes on expanded by expansion in sodium silicate.

B. M. Patil, K.A. Patil and L.K. Kokate (2012) conducted a study on use of Industrial Waste like Pond ash, Fly Ash, Stone dust, Foundry Sand and Steel Slag for Soil Stabilization. In the present investigation the different proportion of soil sample, Pond ash and RBI Grade-81 were prepared. This inferred that the industrial waste materials like fly ash and pond ash can be used as stabilizer with clayey soil.

A. B Oluyemi (2011) This study was primarily concerned with the use of geotextile, a geosynthetic membrane to strengthen the foundation of a flexible pavement. These moisture content results were compared with the natural moisture content values of the samples. The use of geotextiles should be incorporated into the construction of roads as they are economical in reducing the stress of 'borrowing to fill', enhance strength of the sub-grade and increase service life of the roadway.

B. M. Patil Manages the change in properties of sub grade soil by using soil stabilizer and provincially available poor materials. Where they completed standard proctor test on treated and untreated soil test and estimation of MDD and OMC were discover. This shows that the CBR value of sub grade soil can improved by using moorum along RBI 81and development expense can be reduced to definite limit.

Anitha.K.Ret. al. (2009) have performed test on "Effects of RBI- 81 on Different Types of Subgrade Soil". From the test results it is observed that substantial reduction in plasticity index for soil with RBI Grade 81. Soaked CBR value increased for all three soils with RBI. OMC increased and MDD decreased with addition of RBI Grade 81 for red soil and kaolinit

C.E.G.Justo and Krishnamurthy (2008) have conducted a study on laboratory studies on properties of soils treated with RBI-81 stabilizer. However there is an increase in the values of plastic limit and therefore a reduction in Plasticity Index (PI). The soaked CBR value of stabilized soils after 7-days curing showed significant increase in all the soils, even with 2% stabilizer content.

Feasibility Study on the Use of RBI Grade-81 Cementation Material in Road Construction, year (2007) by Central Road Research Institute (CRRI) New Delhi. The Clay and sand CBR improved from respective 4% and 22% to 129% and 79% at 12% RBI Grade-81. Gravel and silt soils sample also passed the durability test at 6 and 4% respectively; this dosage is recommended for construction of sub base and base.

4. Materials Used

4.1 Clay Soil

Soil is a natural aggregate of mineral particles. Soils are classified into coarse-grained and fine-grained soils. Majority of the Coarse-grained soils suit for the construction activities. Problems pose to the structure raised with fine-grained soil and few course-grained soils due to their water absorption characteristic. The variation in compaction characteristics, strength characteristics and CBR values are discussed in this paper.

4.2 RBI Grade-81

RBI Grade-81 (Road Building International Grade-81) is a major material which was created for altering the various types of soil through an inexpensive approach. It is an odour less powder, has pH of 12.5 in saturated paste, which is insoluble in water, non UV degradable and chemically stable. It forms dust free surface. It is durable, permanent and hardens fast. It is aesthetical and environmental friendly. It modifies the engineering properties of soil by providing rapid infrastructure development.

5. Research Methodology

The objective of my paper is to investigate the engineering properties of clay soil after improving with RBI Grade-81. The liquid limit, plastic limit and specific gravity of soil will be determined in the laboratory. The standard Proctor Test, Unconfined Compressive Strength Test, California Bearing Ratio test will be performed by adding at 0%, 2%, 4%, 6%, and 8% of RBI grade 81 in the clay soil.

5.1 Standard Proctor Compaction Test

Compaction test of soil also known as Proctor's test is done to understand compaction characteristics of different soils with change in moisture content.

5.1.1 Procedure for Compaction Test of Soil:-

Take about 20kg of air-dried soil. Sieve it through 20mm and 4.75 mm sieve. Calculate the percentage retained on 20mm sieve and 4.75mm sieve, and the percentage passing 4.75mm sieve. If the percentage retained on 4.75mm sieve is greater than 20, use the large mould of 150mm diameter. If it is less than 20%, the standard mould of 100mm diameter can be used. Weigh the mould with the base plate to the nearest 1 gram. Take about 16 – 18 kg of soil specimen. Add water to it to bring the water content to about 4% if the soil is sandy and to about 8% if the soil is clayey. Keep the soil in an air-tight container for about 18 to 20 hours for maturing. Mix the soil thoroughly. Divide the processed soil into 6 to 8 parts. Attach the collar to the mould. Place the mould on a solid base. Take about 2.5 kg the processed soil and hence place it in the mould in 3 equal layers. Take about one-third the quantity first, and compact it by giving 25 blows of the rammer. The blows should be uniformly distributed over the surface of each layer. The top surface of the first layer is scratched with spatula before placing the second layer. The second layer should also be compacted by 25 blows of rammer. Likewise, place the third layer and compact it. Remove the collar and trim off the excess soil projecting above the mould using a straight edge. Weigh it to the nearest gram. Take the soil samples for the water content determination. Determine the water content. Add about 3% of the water to a fresh portion of the processed soil, and repeat the steps.

The wet density and the moisture content are required to calculate the dry density as follows:

$$\gamma_d = \gamma / 1 + w$$

Where γ d = Dry density of soil
γ = Bulk density of soil
w = Water content expressed as fraction

5.2 Unconfined Compressive Strength Test

It is not always possible to conduct the bearing capacity test in the field. Sometimes it is cheaper to take the undisturbed soil sample and test its strength in the laboratory. Also, to choose the best material for the embankment, one should conduct strength tests on the samples selected. Under these conditions, it is easy to perform the UCS test on remolded soil sample. Now we will investigate experimentally the strength of a given soil sample. This test is performed on cohesive soils to determine the shear strength of soil.

5.2.1 Experimental Procedure:-

In this test, a cylinder of soil without lateral support is tested to failure in simple compression, at a constant rate of strain. The compressive load per unit area required to fail the specimen as called unconfined compressive strength of the soil.

5.2.2 Preparation of Specimen for Testing

5.2.2.1 Molded Sample

For the desired water content and the dry density, calculate the weight of the dry soil (Ws) required for preparing a specimen of 3.8 cm diameter and 7.5 cm long. Add required quantity of water (Ww) to this soil. Mix the soil thoroughly with water. Place the wet soil in a tight thick polythene bag in a humidity chamber and place the soil in a constant volume mould, having an internal height of 7.5 cm and internal diameter of 3.8 cm. After 24 hours take the soil from the humidity chamber and place the soil in a constant volume mould, having an internal height of 7.5 cm and internal diameter of 3.8 cm. Apply the compressive load till the specimen is compacted to a height of 7.5 cm. Eject the specimen from the constant volume mould. Record the correct height, weight and diameter of the specimen.

5.2.2.2 Test procedure

Take two frictionless bearing plates of 75 mm diameter. Place the specimen on the base plate of the load frame. Place a hardened steel ball on the bearing plate. Adjust the center line of the specimen such that the proving ring and the steel ball are in the same line. Fix a dial gauge to measure the vertical compression of the specimen. Adjust the gear position on the load frame to give suitable vertical displacement. Start applying the load and record the readings of the proving ring dial and compression dial for every 5-mm compression. Continue loading till failure is complete.

5.3 California Bearing Ratio Test

This is a penetration test developed by the California division of highways as a method for evaluating the stability of soil sub Grade and other flexible pavement materials.

5.3.1 Procedure for CBR Test of Soil:-

Take the soil samples by adding 0%, 2%, 4%, 6%, and 8% of RBI at their respective OMC and MDD and make the CBR samples in the CBR mould. Place the mould in the soaking tank for four days. Take other samples and apply different blows and repeat the whole process. Remove the mould from the tank and allow water to drain. Then place the specimen under the penetration piston and place surcharge load. Apply the load and note the penetration load values. Draw the graphs between the penetration (mm) and penetration load (mm) and find the value of CBR. Draw the graph between the %age CBR and Dry Density, and find CBR at required degree of compaction.

6. Conclusion

From last few years, many researches and advancements have taken place in this area. A thorough laboratory investigation was carried out to study the improvement in geotechnical properties of an expensive soil stabilized with RBI. The following conclusions are drawn from this study. Till now different soil stabilizing agents have been used to study the strength characteristics of clayey soil; however certain engineering problems are neglected while taking into consideration the stabilization and the techniques used.

- Majority of the researchers have discussed the effects of stabilization on index properties compaction properties, UCS, CBR and swelling properties of expansive soil.
- The effects of stabilization on, consolidation properties, shear strength, splitting tensile strength, stiffness and hydraulic conductivity of expansive soil have not been studied by most of the researchers.

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