STUDY ON THE BEHAVIOR OF SOIL STABILIZATION BY PROTEKTA RGS 300

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Abstract: Soil Stabilization is only one of the abundant techniques existing to the geotechnical engineer and preference for any condition should be made only after an evaluation with other techniques which indicates it to be the most brilliant result to the problem implies the increase in strength properties of soil. Between ranges of forms of soil stabilization such as mechanical stabilization, bitumen stabilization etc. chemical stabilization is gaining significance due to the financial system associated with it. Usually chemicals such as Calcium Chloride, Sodium Chloride, Sodium Silicate, etc were used as stabilizers. Various modern chemicals in the form of fluids are being used in developing countries. As developing countries are having the target on infrastructure development so modern chemicals are in advance in countries like India. In this experimental study Protekta RGS-300, a chemical certified by IRC, is taken as a chemical stabilizer on CI (Clay with Intermediate Plasticity) soil. The Chemical taken in the experimental study was obtained from Advance Inorganics, Dehli. Protekta RGS-300 is supplied as a gluey liquid based on a mix of silicates and courtesy chemicals that can be applied by spraying. Its purposeful use is as a piercing sealer and surface hardener for soil. In this study, the influence properties of CI soil with PROTEKTA RGS 300 and without using of PROTEKTA RGS 300 was studied. Protekta RGS-300 was used in different dosage by mixing it with water and making 4 proportions of chemical by part to the water namely 1:30, 1:40, 1:50, and 1:60.Maximum Dry Density (MDD) and Unconfined Compressive Strength (UCS), which are the essential geotechnical properties of soil, were determined during the tests in the laboratory. The unconfined compressive strength tests were done after a curing period of 7, 14 and 28 days. Due to the chemical reaction taken place in-between soil and PROTEKTA RGS 300, the soil mass gets compacted probably due to the decrease of the voids between soil solids. It was experimented that PROTEKTA RGS 300 has negligible consequence on maximum dry density and optimum moisture content of the soil as time required to perform Proctor Test was not adequate for chemical reactions to take place. The Unconfined compressive strength intended after a curing phase of 7, 14 and 28 days showed a highest growth of 252 percent after a period of 28 days of air curing. The rate of strain at crumple showed an unimportant raise as the PROTEKTA RGS 300 content in the treated soil goes on rising from Dosage 1 to Dosage4.

1.1 Introduction: Soil Stabilization implies the various process or methods which improve the load carrying capacity of soil. Soil Stabilization also includes the changes in properties like increase in stability, change or improvement in density and swelling behavior, change in chemical properties and water proofing properties.

By means of Soil Stabilization techniques the strength of locally available material, which otherwise is low, can be improved to the desired level. More over by means of these techniques locally available material can be used in various construction processes like sub grade material. Such utilization of locally available material will help to reduce the transportation cost, which affects the overall cost of a project.

Soil Stabilization or in other words the bearing capacity improvement of soil can be carried out by using compaction techniques, proportioning of sub grade material and addition of suitable chemical agent. Depending on this basic definition various forms of traditional soil stabilization techniques are popular around world in geotechnical fraternity.

In the present effort, potency characteristics have been considered nearby existing extremely plastic clay treated with unusual dosages of a chemical RGS- protekta 300. A sequence of unconfined compression tests be conceded out to ascertain the effect of chemical on strength of the soil at various dosages and after curing period of 7, 14, 28 days. The most favorable dosage of chemical viewing a marked development in the strength properties of soil is obtained.

Stabilization of the base layer with Fly Ash, Lime, cement etc. has made traditional designed roads very strong with good longevity, notwithstanding, the good properties of traditional designed roads, very little progress has been made during the last 100 years to utilize technology in reducing costs associated with bringing in borrow-pit or quarry materials for road construction. Researcher around the world has optimized these traditional for most of the soils. Traditional stabilizers have various advantages and disadvantages associated with them. Various patented chemicals like polymer stabilizer are gaining popularity these days due to so many advantages associated with them.

2.1 Literature: Majority of the patented chemicals are environmental friendly and green products. Use of these chemicals stabilizer decreases the construction time substantially. Such patented chemicals reduced the requirement of quarry material in road construction which further reduce the cost of construction. Experimental study has shown that soil after treatment with these chemicals, exceeds all strength parameters of standard code of practices. In India researcher has studied the effect of various such chemicals on strength properties of soil.

S. Jayalekshmi et al. (2012) studied the effect of Renolith on clayey soil mixed with Portland cement. Keeping the content of cement at a fixed percentage, the amount of Renolith by percentage to the cement weight was increased. An increase in the unconfined compressive strength was seen with increasing the percentage of Renolith. Marginal increase was also seen in the CBR value of the soil with increasing percentage of the chemical. Authors also provided the list of projects in which chemical was used as stabilizer in Indian states of Arunachal and Rajasthan.

Dr. S. Chandrakaran et al. (2014) studied the effect of Teradyne on Loam soil and concluded that chemical alters the hydrophilic nature of clay materials to hydrophobic and rendered the clay minerals inert to the water. The chemical has a significant effect on atterberg limits of soil and plastic limit and liquid limit showed an appreciable reduction. A significant improvement in unconfined strength of soil was also observed.

Nima Latifi et al. (2014) studied the effect of tx-85 and sX-85, the non-traditional stabilizer, on the lateritic soil. Kaolinite, quartz goethite and gibbsite were the main minerals present the lateritic soil. X-Ray spectrometer study on tx-85 and SH-85 shows that sh-85 is a calcium based stabilizer. It also indicates that the Na, Al, Si and Fe are main elements present in the tx-85.It was observed that the addition of these stabilizers to the lateritic soil increase the optimum moisture content and reduce the maximum dry density of the soil. The possible reason behind the decrease in dry density of soil is the flocculation and agglomeration of soil particles. The 7 day compressive strength of lateritic soil treated with tx-85 showed an increase of about 4 times to that of the parent soil. 7 day compressive strength in case of sh-85 showed an increase of 5 times to that of the parent soil. The increase in optimum moisture content can be favorably used at sites with high natural water content.

PuneetAgarwal et al. (2016), investigated the effect of Teradyne, a Bio-enzymatic soil Stabilizer, on UCS of black cotton soil. UCS value of soil showed an increment of up to 200 percent when treated with Teradyne. Chemical gave best result after a curing period of seven days.

Er.Tejinder Singh et al. (2013) studied the effect of RBI Grade 81 on strength parameters of a locally available with 62.5 percent of silt and clay and found that the chemical reduces the plasticity Index of soil and has a marked effect on the CBR value of the soil. The dosage of the chemical which is economic for that soil sample was also suggested.

Mamta Mallikarjun, Honna. **et al. (2014)** compared the effect of RBI Grade 81 on Black Cotton soil and Lateritic soil. Curing of samples was done for zero and three days. The engineering properties which were analyzed in this study are Atterberg’s limits, unconfined compressive strength and CBR value. The consistency limits of both the soil showed a decrease with varying percentage of RBI Grade 81. Unconfined compressive strength and CBR value of both the soil showed a marked increase as comparison to that of the parent soil

B.M. Lekha et al. (2013), reported the effect of Zycosoil on engineering properties of Lateritic soil. The effect of different dosage of chemical on strength parameter of soil was studied at different curing period. Consistency limits of soil and permeability of soil showed a downward trend with increase in chemical dosage of the chemical. Unconfined compressive strength of soil increases with increase in dosage of the chemical. The optimum dosage of chemical giving the best result on UCS value of a soil was also reported. While the UCS value of the soil showed a decrease after curing period of 4 weeks, the CBR value showed a continuous increase with curing time. A significant improvement in fatigue life of the soil was also reported. It was also concluded that in low volume roads the WBM material can be replaced with the soil stabilized by Zycosoil with minimum curing period of 4 weeks.

3.1 Methodology

3.2 Soil used

Soil used in the experiments has been collected from a village Nepra, near Rajpura. The soil is classified as intermediate compressible clay, CI, as per IS: 1498(1970). The liquid limit of the soil is determined by reading the water content corresponding to 25 blows on the flow curve. The specific gravity of soil was calculated using Pycnometer as per IS: 2720-(1970). Various index properties of the soil under investigation are reported in Table 3.1

3.3 Chemical stabilizer: Rgs protekta 300

Protekta RGS 300 has been procured from Advance inorganics (India) Pvt. Ltd., Dehli. It is a chemical, soil stabilizer and strengthener product. It is supplied as a viscous liquid based on a blend of silicates and proprietary chemical that can be spray applied. Its intended use is as a penetrating sealer and surface hardener for soil. It is an odorless chemical and it is completely soluble in water. Solid content in the chemical is about 63 percent.

The following properties of chemical stabilizer is shown below.

Properties	**Description**
Appearance	Viscous liquid
Color	Clear to cloudy
Odor	Odorless
Solubility	Complete
Solid content	63 %
Specific gravity	1.4 kg/ltr

TESTING SCHEDULE

(March-June 2018)

phase 1
March

Phase 11
May

Phase 111
June

3.4 Dosage of chemical

Protekta RGS 300 was applied in the diluted form to the soil. The ratio of the chemical to that of the water is chosen as 1:60, 1:50, 1:40 and 1:30 and three different dosages of the chemical were made. The solution of chemical and water was then used in Proctor Test.

3.5 Standard proctor test

Standard proctor tests have been conducted to determine optimum moisture content and maximum dry density of parent soil and soil treated with Protekta RGS #)) applied various dilutions (chemical dilution=1:60, 1:50, 1:40, 1:30) on to the parent soil. These tests were conducted so as to prepare specimens at maximum dry density by adding desired optimum moisture content as per specifications of IS: 2720 (Part7)(1974). The results of Standard Proctor Test have been reported in Table 3.4 and Figure 3.1 to 3.5 Dry densities is computed from the bulk density and water content.

Dry density, $\rho\ d = p/1 + w$

Where "ρ" is Bulk mass density and "w" is the water content.

3.6 Sample preparation

3.6.1 Composition of specimens

Specimens of parent soil and soil treated with Dosage 1,2,3 and 4 of RGS Protekta 300 were prepared at maximum dry density and optimum moisture content as per IS:2720 Part 7 1974

3.6.2 Mixing

Soil was dried in the oven. Chemical RGS Protekta 300 was mixed in water at appropriate proportion to prepare Dosage 1, 2, 3 and 4 of chemical. Sufficient quantities of these Dosages were added in to the oven dry soil to bring the optimum moisture content to the desired level. The mixture was then mixed thoroughly with a spatula. All the specimens were kept in polythene bags for maturing for three days.

3.6.3 Compaction

3.6.4 for unconfined compression test

Cylindrical specimens will be compacted by static compaction in 3.81 cm diameter and 7.62 cm high mould. The inner surface of the mould will be smeared with mobile oil (of low velocity which does not affect the property of sample) so as to extrude the sample from mould with minimum disturbance. The wet homogeneous mixture will be placed inside the specimen mould in seven layers using spoon, leveled and gently tap-compacted by 1 cm diameter ram. Pressure pad will be inserted into the mould and the whole assembly will be statically compacted in loading frame to the desired density. The sample will be kept under static load for not less than 10 minutes in order to account for any subsequent increase in height of sample due to swelling. The sample will then be removed from the mould with the help of sample extruder.

3.7 Testing program :A series of unconfined compressive strength tests after a curing period of 7, 14 and 28 days will be conducted to determine the shear strength characteristics of untreated soil and soil treated with different dosage of RGS Protekta 300 to evaluate the effect of RGS Protekta 300 on shear strength of the soil at different curing period. These characteristics will be illustrated by establishing the relationships between resulting axial stress and applied axial strain in strain controlled tests. Unconfined compressive strength determined as peak strength value and respective failure strain will be calculated from the observations taken during the tests

3.8 Unconfined compressive strength test

3.8.1 Apparatus used

Strain controlled tri-axial apparatus will be used to conduct unconfined compressive strength tests to determine the shear strength and deformation characteristics of untreated soil and soil treated with different dosage of RGS Protekta 300. For conducting Unconfined Compressive Strength Test, tri axial cell is not filled with water so that there is no confining pressure, and axial stress is applied to fail the specimen.

Strain controlled tri-axial test apparatus.

Strain controlled mechanism consisting of strain setting lever and turret level for inducing axial strains in the sample at rates varying from 0.02 mm/minute to 1.00 mm/minute.

For measurement of compressive stress taken by the sample, 250 kg capacity proving ring with ring constant of 0.176 kg/division. Load gauge installed in proving ring with a least count of 0.002 mm.

For measurement of vertical deformation in the sample, deformations dial gauge with a least count of 0.01 mm.

3.8.2 Procedure

The Remolded sample will be placed on the pedestal of the tri axial cell with non-previous disc at the top and bottom. A loading platen will be placed at the top which is connected through loading piston to the proving ring. The axial strain rate is chosen as 1.0 mm/minute by appropriate setting of turret lever and train setting lever. The compressive stress taken by the sample will be recorded at various strain levels. At failure, peak compressive stress will be noted as unconfined compressive strength and failure strain will also be recorded.

3.8.3 Precautions

- The specimens should be handled carefully to prevent disturbances, change in density loss of moisture.
- Two ends of the specimen should be perpendicular to the long axis of the specimen.
- The seating of the sample should be proper on the upper and lower plates.
- The strain should be induced in the specimen at a constant rate and perpendicular to cross-sectional area of the sample.

4.1 Result And Discussions

The objective of the present study is to investigate the strength characteristic of locally available clay treated with different dosage of RGS Protekta 300. This has been done to make the soil suitable for construction of sub grade over it. Shear strength of soil treated with chemical is analyzed by unconfined compressive strength tests A series of unconfined compressive strength test is carried out after an air curing of 7,14 and 28 days of sample preparation to study the effect of chemical on strength properties with passage of time.

The Results of these tests have been analyzed under the following headings.

4.2 Moisture density relationship

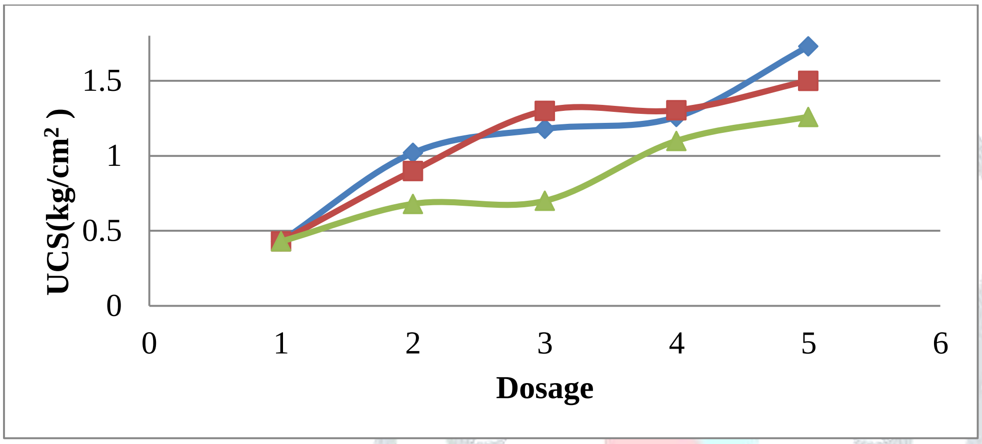
Standard Proctor Test have been conducted to determine the optimum moisture content(OMC) and maximum dry density (MDD) of soil under investigation, stabilized with various dosages of chemical stabilizer RGS Protekta-300. Figure 4.1 and Figure 4.2 shows the comparison of MDD and OMC for soil under investigation stabilized with various dosages of chemical stabilizer.

The Optimum Moisture content (OMC) of soil treated with various dosages of chemical stabilizer first increases from 24.5% of parent soil to 25.5% at Dosage 1. On further increment of chemical dosage the OMC of treated dosage the OMC of treated soil decreases up to 24.76%. It has been observed that OMC of treated soil varies slightly as compared to the OMC of parent soil. Moreover a general specific trend is not seen in the variation of OMC of treated soil. It can be said that as the time taken to complete the standard proctor test is very less and this time is not sufficient for chemical reactions to complete so OMC of treated soil remain more or less similar to that of the parent soil.

Maximum Dry Density of parent soil is 15.65 KN/m^3. The MDD of soil decreases with increase in Dosage of chemical up to Dosage 2.At Dosage 3, MDD increases slightly and it further decreases slightly at Dosage 4. In general it can be said that MDD of treated soil decreases slightly with the increase in the chemical content in the dosage. The possible reason of this decrease in the value of MDD is the formation of some new chemical product after reaction between lay mineral and chemical.

4.3 Unconfined compressive strength

The stress strain relationship of chemically treated soil (Treated with RGS Protekta 300) has been determined from unconfined compression tests as shown in Figure



For Parent soil, the unconfined compressive strength value has been determined as 0.43 kg/cm^2 at a peak failure strain of 0.036.It has been observed that 7 day unconfined compressive strength of soil treated with RGS Protekta 300 vary from 0.68 kg/cm^2 to 1.26 kg/cm^2 with increase in the chemical content from dosage 1 to dosage 4. The value of strain at failure varies from0.036 to 0.051 with increase in chemical content from dosage 1 to dosage 4.It has been observed that 14 days unconfined compressive strength of soil treated with RGS Protekta 300 vary from 0.90 kg/cm^2 to 1.50 kg/cm^2 with increase in the chemical content from dosage 1 to dosage 4. The value of strain at failure varies from 0.039 to 0.08 with increase in chemical content from dosage 1 to dosage 4.It has been observed that 28 days unconfined compressive strength of soil treated with RGS Protekta 300 vary from 1.02 kg/cm^2 to 1.73 kg/cm^2 with increase in the chemical content

dosage 1 to dosage4. The value of strain at failure varies from 0.038 to 0.091 with increase in chemical content from dosage 1 to dosage 4.It has been observed that unconfined compressive showed a general increase as the chemical content in the treated soil increases from dosage 1to dosage 4 indicating the improvement in the strength properties of treated soil. The value of unconfined compressive strength treated with RGS Protekta 300 is greater to that of the parent sol at every dosage of chemical. Highest value of unconfined compressive strength has been observed as 1.73kg/cm^{2}after 28 days of sample preparation. The value of strain at failure increases marginally as the chemical content in the treated soil increases from dosage1 to dosage4.

In general it can be summed up that greater unconfined compressive is obtained in soil treated with RGS Protekta 300 at a marginally higher failure strain. This trend confirms that the addition of Protekta 300 as a stabilizer improves the strength properties of soil

5.1 Conclusions

- The study demonstrates the influence of RGS Protekta 300 on strength properties of locally available clay with intermediate plasticity. The following conclusions can be drawn based on the investigations carried out during the study:

- The chemicals used in soil stabilization are turning out a boon for developing countries as they help in expediting the process of road construction. Many of the chemicals discussed above are Bio-Enzyme and organic in nature. Such organic chemical poses no threats to environment.
- The use of these chemicals can decrease the quantity of aggregates required in road construction. In some projects, like rural roads even aggregate free roads are possible by using the appropriate amount of such chemical stabilizer. Other than the main function of strength improvement, some of these chemicals are also effective in improving the subsidiary properties of the soil. For example chemicals are also being used as dust controller.
- In general it can be said that Maximum Dry Density (MDD) of treated soil decreases slightly with increase in the chemical content in the dosage. It has been observed that Optimum Moisture Content (OMC) of treated soil varies slightly as compared to the OMC of the parent soil. Moreover a general specific trend is not seen in the variation of OMC of treated soil. It can be said that as the time taken to complete the Standard Proctor test is very less and hence not sufficient for chemical reactions(between clay minerals and stabilizer) to complete so OMC and MDD of treated soil remain more or less similar to that of the parent soil.
- The unconfined compressive strength of soil treated with RGS Protekta 300 increases significantly with increase in chemical content from dosage 1 to dosage 4. The value of unconfined compressive strength treated with RGS Protekta 300 is greater to that of the parent soil at every dosage of chemical. Highest value of unconfined compressive strength has been observed as 1.73 kg/cm^2 at Dosage 4, after 28 days of sample preparation.
- The value of strain at failure showed a marginal increase as the chemical content in the treated soil increases from Dosage 1 to Dosage 4.

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