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EVALUATE THE STRENGTH OF SOIL USING SODIUM HYDROXIDE, ALUMINIUM OXIDE, LIME AND PHOSPHORUS PENTOXIDE.

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ABSTRACT:- Geotechnical engineers are mainly concerned with the soil that lies below 3m from the earth surface. As the soil below this contains hard strata composed of rocks and different minerals. So we will conduct a series of experiments on the soil. Our main aim was to use the locally available soil, as we live in Jammu and Kashmir, the soil is mainly of clayey origin, so the available soil is treated in such a manner so as to influence the engineering properties such as shear strength , permeability in a desired manner. In our experiments we have used Sodium hydroxide, Aluminium hydroxide, Lime and Phosphorus Pentoxide in different proportions to influence the engineering properties of soil. As these chemicals have no adverse or bad effect on the soil as well as environment. As all these chemicals react with the soil in a rapid manner also influence the properties of soil. The important tests which are performed are Standard Proctor Test (S.P.T) and Unconfined Compressive Strength Test (U.C.S test). The Standard Proctor Test (S.P.T) is performed so as to obtain a graph between Optimum Moisture Content (O.M.C) and Maximum Dry Density (M.D.D). After getting the Maximum Dry Density (M.D.D), Unconfined Compressive Strength (U.C.S) has been performed to get the Unconfined Compressive Strength (U.C.S) value which has been determined as peak strength value and respective strain has been calculated from different observations.

Key Words: Clayey soil, Sodium Hydroxide, Aluminium Hydroxide, Lime, Phosphorus Pentoxide.

I. INTRODUCTION

Soil stabilization is a very primitive technique that has been implied or used from very beginning with one major requirement, to develop, change or alter the properties of soil in useful manner so that the soil can be used for various engineering purposes. Several additives which have been used for ground improvement such as cement, lime and mineral additives such as fly ash, silica fume, rice husk and ash have been used under various contexts. So in this study we have used Sodium hydroxide, Aluminium hydroxide, Lime and Phosphorus pentoxide for the locally available clayey soil. The chemical reaction which takes place between clayey soil and chemicals used can be categorized in two different forms of improvement techniques i.e. short term effect (modification) and long term effect (stabilization).In short term modification the process of ion changes makes the clay minerals flocculates and agglomerate leading to change in plasticity, swelling and change in moisture content. The second reaction (pozzolonic reaction) completes over a long period of time creating binding properties that increases the strength of soil for long term. The amount of tbese chemicals which are used depends upon the mineralogical composition of the clayey soil.

II. EXPERIMENTAL INVESTIGATIONS

2.1 Materials used

2.1.1 Soil

The soil used to study was the locally available clayey soil. Various tests have been performed to determine the index as well as the engineering properties of the parent soil by IS specifications.

2.1.2 Sodium Hydroxide

Sodium hydroxide is a white crystalline odorless solid that absorbs moisture from air at room temperature, It is also known by names as caustic soda or dye.

TABLE 1 PHYSICAL PROPERTIES OF SODIUM HYDROXIDE

S.NO	PROPERTIES	VALUES
1.	Specific gravity	1.50
2.	Colour	White

2.1.3 Aluminium Oxide

Aluminium oxide is white in colour and is avaliable in powdered form. It reacts vigorously with soil to form a different sample which is little bit cool than its original one.

TABLE 2 VARIOUS PROPERTIES OF ALUMINIUM OXIDE.

S.NO	PROPERTIES	%BY WEIGHT
1.	Aluminium Oxide	Minimum 99%
2.	Silicon oxide	Maxi mum 0.01%
3.	Iron oxide	Maximum 0.1%
4.	Sodium oxide	Maximum 0.5%
5.	Particle size	96%

2.1.4 Lime

Lime (CaO) which is very effective in improving the engineering properties of soil especially heavy clays or granular soil , due to their high affinity towards water.Table

TABLE 3 VARIOUS PROPERTIES OF LIME

S.NO	PROPERTIES	%BY WEIGHT
1.	Calcium Hydroxide	Minimum 94%
2.	Chloride(Cl)	Maximum 0.01%
3.	Sulphate(SO4)	Maximum 0.2%
4.	Aluminium and insoluble water	Maximum 1.0%

2.1.5PHOSPHORUS PENTOXIDE

Phosphorus pentoxide is available in white colour and in sticky powdered form. It is highly reactive with clayey soils and water.

Table 4: Various properties of Phosphorus Pentoxide

S.NO	PROPERTIES	% BY WEIGHT
1.	P_2O_3	Minimum 0.5%
2.	Iron	Maximum 0.02%
3.	Arsenic	Maximum 0.03%
4.	Lead	Maximum 0.01%

III. **METHODOLOGY**

The following main tests were conducted as per their codal provisions

1. *Standard Proctor Test*
   Specimens of the soil is mixed with 3%, 6%, 9% of lime and 9%, 13% and15% of sodium hydroxide, aluminium oxide and phosphorus oxide. All these samples are mixed at optimum moisture content and maximum dry density as per IS: 20 (Part7)1974. Appropriate amount of potable water is also added to get desired consistency. Then all the ingredients are thoroughly mixed with a spatula thoroughly.
2. *Unconfined Compressive Strength Test*
   The unconfined compressive strength test has been performed for a number of times to check the shear strength characteristics of soil in its natural state and then after adding the soil with different chemicals in different proportions. Soil is treated with 2.5%, 6.5%, 9% lime, then with 9%, 13%, 15% sodium hydroxide, aluminium hydroxide and phosphorus pentoxide to find the shear strength of the soil.The different characteristics of the soil and the chemicals involved have been shown by drawing a relationship between the strain applied in strain controlled and the axial stress. The unconfined strength has been determined as the peak value and the failure strain has been calculated from the different observations that have been taken during the test.

IV. RESULTS AND DISCUSSIONS

Standard Proctor Test

In this chapter we will study the results of the test which have been conducted on locally available clayey soil(CI) stabilized by using different chemicals such as sodium hydroxide, aluminium oxide, lime, phosphorus pentoxide in geotechnical lab.

Comparision curve for standard proctor test

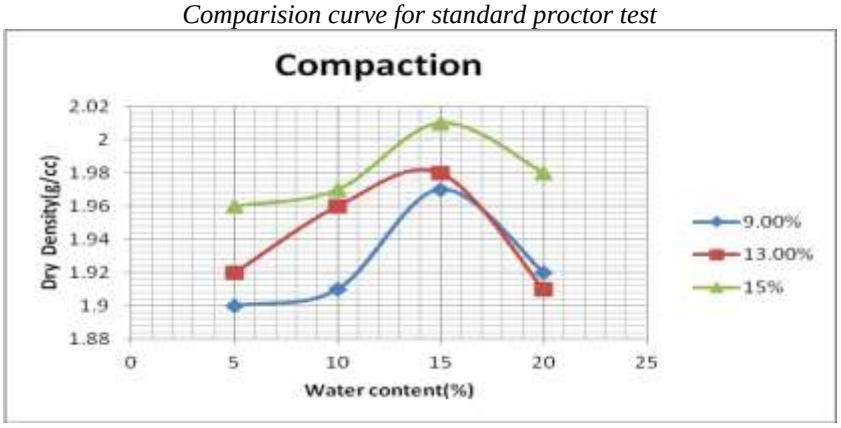

Fig -1: Clayey soil with9%,13% and 15% Sodium Hydroxide

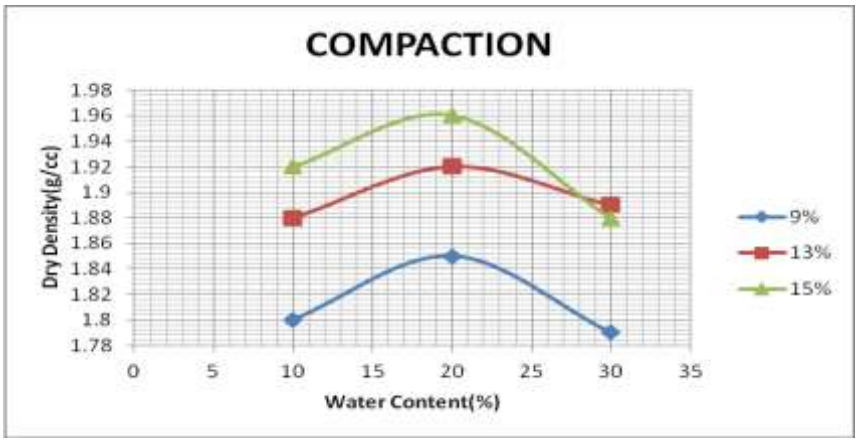

Fig-2: Clayey soil with 9%,13% and 15% Aluminium Oxide

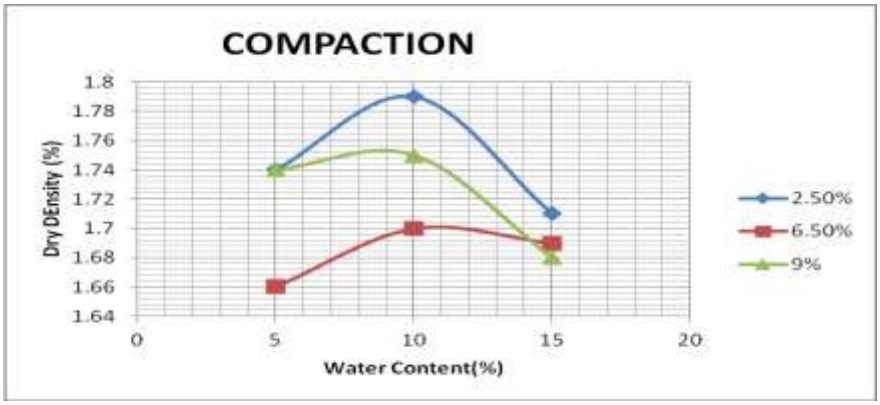

Fig-3: Clayey soil with 3%,6% and 9% Lime

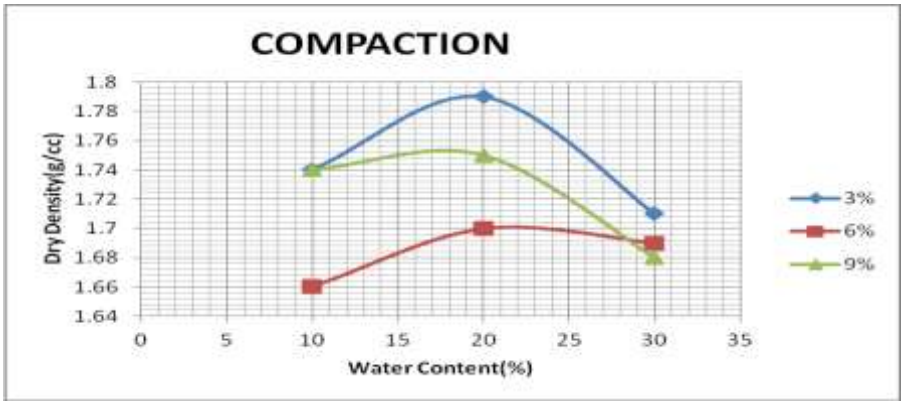

Fig-4: Clayey soil with 9%,13% and 15% Phosphorus Pentoxide

Unconfined Compressive Strength Test

Unconfined compressive strength of clayey soil is shown below in the graph. The sample of the soil is tested after 14 days from the day of casting the sample so that it can gain some strength to sustain the load on it while testing it in Tri-Axial test.

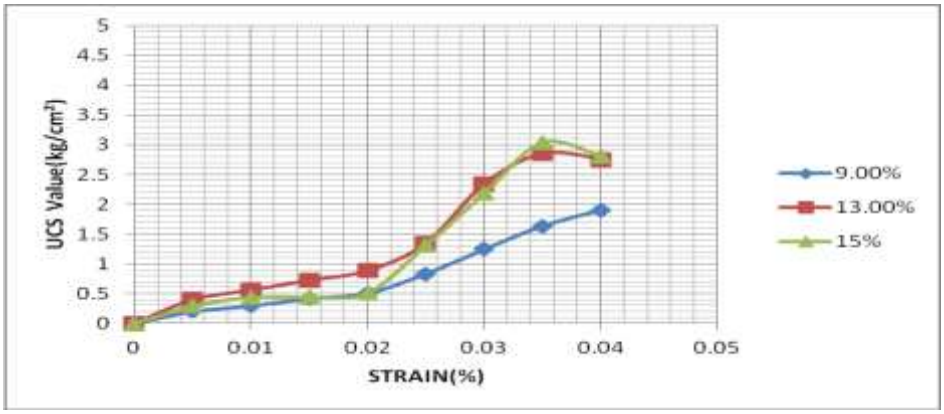

Fig-5: UCS value of Clayey soil with9%,13% and 15% Sodium Hydroxide

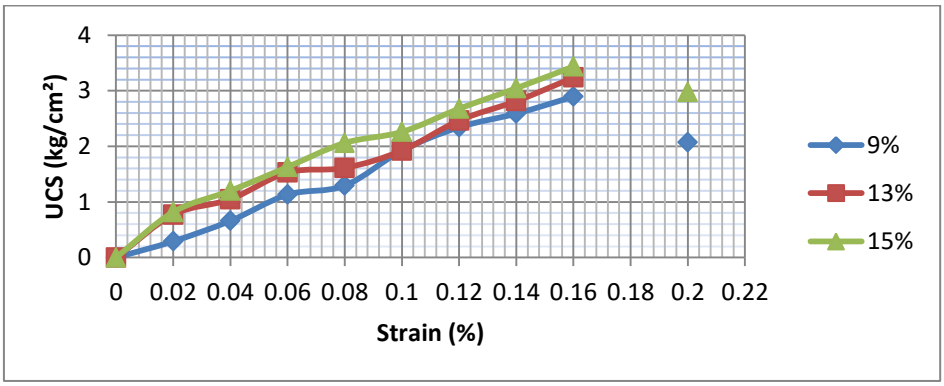

Fig-6: UCS value of Clayey soil with 9%,13% and 15% Aluminium Oxide

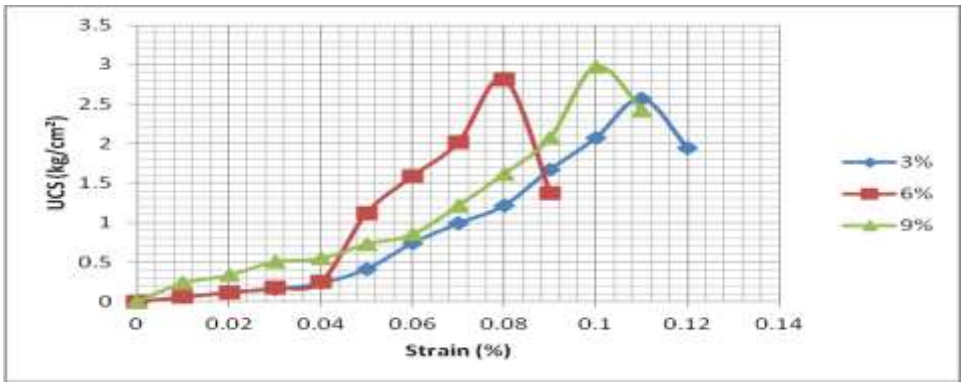

Fig-7: UCS value of Clayey soil with 3%,6% and 9% Lime

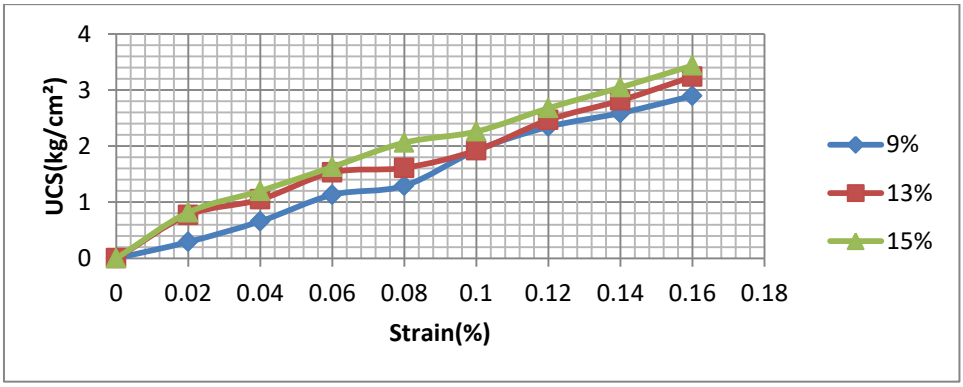

Fig-8: UCS value of Clayey soil with 9%,13% and 15% Phosphorus Pentoxide

V. CONCLUSION

- In this research work of mine, Sodium hydroxide, Aluminium oxide, Lime and Phosphorus Pentoxide were used to treat the locally available clayey soil , which results in the improvement of engineering properties of soil.

- The effect of lime on soil is to increase in optimum moisture content of soil and also to reduce in maximum dry density. On addition of 3% Lime O.M.C value increases to 21.30% from the parent soil which is 16.67%. On increasing the content of Lime to 6% and 9% the value of O.M.C changes to 23.63 and 24.51 and the dry density decreases i.e on 3% is 1.79 g/cc, 6% is 1.70 g/cc and on 9% is 1.69 as compared to parent soil i.e. 1.81 g/cc. The unconfined compressive strength of soil also increases i.e. on 3% is 2.57 kg/cm^2, on 6% 2.81 kg/ cm^2 and on 9% is 2.97 kg/cm^2 as compared to parent soil i.e. 2.33 kg/cm^2.

- On addition of Sodium Hydroxide to the clayey soil the maximum dry density increases i.e. on 9% is 1.97 g/cc, on 13% is 1.98 g/cc and on 15% is 2.01 g/cc with the reduction in O.M.C i.e. on 9% is 15.93, on 13% is 17.8 and on 15% is 15.99. the U.C.S value of soil also gets increased i.e. on 9% is 2.46 kg/cm^2 , on 13% is 2.85 kg/cm^2 and on 15% is 3.04 kg/cm^2 as compared to the parent soil.

- The addition of aluminium oxide in research work is to stabilize the clayey soil, which results in increasing compaction. The M.D.D of soil i.e. on 9% is 1.85 g/cc, on 13% is 1.92 g/cc and on 15% is 1.96 g/cc which has been increased as compared to parent soil and O.M.C decreases i.e. on 9% is 17.20%, 13% is 17.71% and on 15% is 18.19% . The addition of this chemical shows a strong bonding effect with soil. The U.C.S value also increases as on 9% is 2.87 kg/cm^2 , 13% is 2.88 kg/cm^2 and 15% is 3.37 kg/cm^2.

- Phosphorus pentoxide used increases the M.D.D of the soil i.e. on 9% is 1.89 g/cc, on 13% is 1.98g/cc and on 15% is 2.00 g/cc and the reduction in O.M.C i.e. on 9% is 16.52%, on 12% is 15.97% and on 16% is 16.49%. U.C.S value of the soil increases i.e. on 9% is 2.90 kg/cm^2 , on 12% is 3.23 kg/cm^2 and on 15% is 3.32 kg/cm^2.

- As, from above discussions a calculation can be drawn that sodium hydroxide is the best material among all the other type of chemicals that has been used in these calculations, as it changes the the properties of soil with every bit of it. Another conclusion can be drawn that sodium hydroxide gives the best of the results on using its higher percentage with soil.

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