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Some Studies on Clayey Soils Using Lime as Stabilising Agent

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ABSTRACT: In this study an effort has been made to obtain the optimum dosage of lime for stabilization of locally available Karewa soil (Wudur Soil) in Jammu and Kashmir. These clayey soils with medium plasticity in nature are compressible, swell when wetted and shrink when dried thereby exhibiting some undesirable characteristics, which need to be stabilized before using for any construction purposes. The study incorporates investigations on basic properties of soil. Then the investigations are carried out to study the effect of addition of the different lime contents to evaluate the extent of modification on Liquid Limit, Plastic Limit, Maximum Dry Density, Optimum Moisture Content and California Bearing Resistance values of the soil. The experimental investigations show liquid limit decreases with an increase in lime content while as plastic limit of Karewa soil increases with increased lime contents. The maximum dry density increases with increased lime content that is up to 7% and thereafter with the addition of more lime it starts decreasing, hence the optimum lime content as observed was taken as 7%. The CBR value of the subgrade increases from 1.88 to 7.03 when the lime content is gradually increased from 0% to 7%, the increased strength of the Subgrade makes an allowance for the subsequent decrease in the base and sub-base courses, even up to the extent of 50%.

Key Words: Karewa soils, Soil Stabilisation, Lime, MDD, OMC, CBR.

I. INTRODUCTION

The soil used in this study is Karewa Soil brought from Pampore which is extensively being used as a sub-grade material in Kashmir valley, especially in South Kashmir [10]. Pavement sub-grade over there is composed of clayey soil whose bearing capacity is extremely low. Due to this reason, the roads do not last and require periodic maintenance to take up repeated application of wheel loads. The cold and harsh winter of the valley with its snowfall adds salt to the injuries. Many immediate benefits are obtained from subgrade stabilization, especially chemical admixture stabilization. For example, by improving the bearing strength and stiffness of the subgrade, a good working platform is established for supporting construction traffic and for compacting paving materials. Subgrade soils that have poor engineering properties may be used effectively when chemical stabilization is used. Additionally, a better subgrade will result in thinner base and sub-base layers leading to financial as well as material savings. A number of chemical admixtures can be used like lime, fly ash, cement etc. In this paper lime as a chemical admixture for subgrade modification has been used [2-3]. For stabilization with lime, soil conditions and mineralogical properties have a significant effect on the long term strength gain. A pozzolanic reaction between silica and alumina in the clay particles and calcium from the lime can form a cemented structure that increases the strength of the stabilized soil. Residual calcium must remain in the system to combine with the available silica or alumina to keep the pH high enough to maintain the pozzolanic reaction. The natural soil slope composed of Kerewa soil undergoing shear or sliding failure during heavy rainfall seasons. They tend to have low shear strength which soils tend to react rapidly with lime, losing plasticity immediately, because expansive clay minerals such as montmorillonite exhibit a high cation exchange capacity. The short-term effect of the addition of lime to a clay soil is to cause flocculation and agglomeration of the clay particles, for cation exchange takes place between the metallic ions of the clay particles and the calcium ions of the lime. It is this process which is primarily responsible for the modification of the engineering properties of clay soils when they are treated with lime (Bell, 1996). The long-term reactions are the pozzolanic reactions. The addition of lime to soil produces a highly alkaline environment, due to the OH anions from the hydration of lime, which gives rise to a slow solution of silica and alumina from clay particles (Kinuthia et al. 1999).

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II. MATERIALS AND EXPERIMENTAL PROGRAMME

The Karewa soil on which the project work is to be done is collected from National Highway NH-1A at Lethpora near irrigation canal. Upon visual inspection, the soil sample is collected at a depth of 2m from the natural ground surface and where classified as CI that is clay of medium plastic nature known for saffron cultivation. Various tests and analysis are carried out to examine the effect of lime on the Karewa Soil namely Atterbergs limits test, Optimum Moisture Content, Maximum Dry Density and California Bearing Ratio test. Based on these tests, the optimum quantity of lime required for effective stabilization of Karewa Soil was determined. The experimental work of the project was done in two phases. In the initial phase, the basic tests of plain soil sample were done as per relevant IS Codal provisions (IS-2720-1983, Part 1-5). In the 2nd phase, the same tests will be repeated upon the addition of different concentrations of lime and the deviations from the initial phase will be noted very carefully. In the initial phase, liquid limit tests are done using a mechanical liquid limit device, whereas the plastic limit is obtained by the thread rolling method as per IS:2720 (V)-1985. The optimum moisture content and dry density of soils were determined by performing the Standard Proctor Test as per IS: 2720(VII)-1980. The CBR Tests were performed as per IS-2727-1987 Part-16. In the 2nd phase, the soil is mixed with 3%, 5%, 7%, and 9% of lime by dry weight of soil. The geotechnical properties of these lime treated soil samples were evaluated and compared with that of soil before stabilization.

III. RESULTS AND DISCUSSIONS

The liquid limit of simple Karewa soil changed from 28.30 to 31.10 when 3% of lime was added by dry weight. The liquid limit then showed a reduction when the concentration of lime was gradually increased to 7%, this reduction occurs as the lime is added to the Karewa soil, Ca+ ions are released into the pore fluid and results in increase in electrolyte concentration which reduces the thickness of diffuse double layer by cat ion exchange (replacement of monovalent ions of soil by divalent ions Ca2+ of lime) held around soil particle leading to a lower liquid limit. On further increase in the concentration of lime, the liquid limit starts to increase again. It is observed that plastic limit increases with lime content. The influence of lime on plastic limit is more at 3% lime content. It was also seen that beyond 5% lime content, the plastic limit does not show major deviation. The plasticity index of the Karewa soil was found to be 6.05 at liquid limit 28.3 %. The addition of lime results in increased dry density up to 7% lime content. As evident from figure 3, the dry density increases from 1.74g/ml to 1.82g/ml when the concentration of lime is increased from 0% to 7%, respectively. Upon further addition of lime, the dry density showed a slight decrease to 1.80g/ml. When lime is added in excess of 7%, the clay particles get flocculated and agglomerated to structure, resulting increase in pore space with the soil matrix or larger void ratio which leads to decrease in maximum dry density (MDD) as the flocculated structure counteracts the compactive effort. It was found that the CBR value of the Karewa soil gradually increases as the lime content increases from 0% to 7% as shown in figure 4. There is a sharp increase in the CBR value up to 7% lime addition and after that the effect is less or constant. Therefore 7% lime content is regarded as optimum value and should not be exceeded.

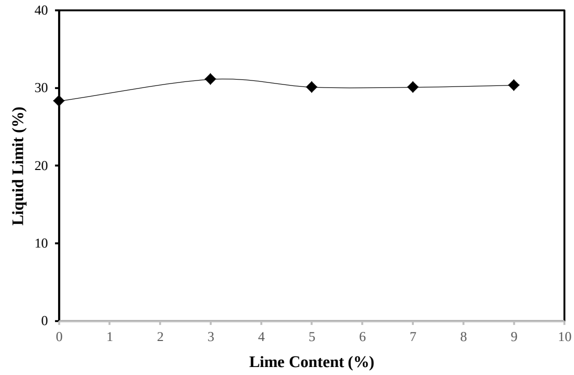

Figure 1. Variation of Liquid Limit with Lime Content

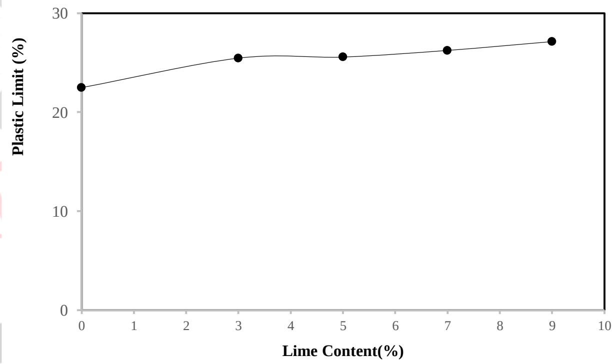

Figure 2. Variation of Plastic Limit with Lime Content

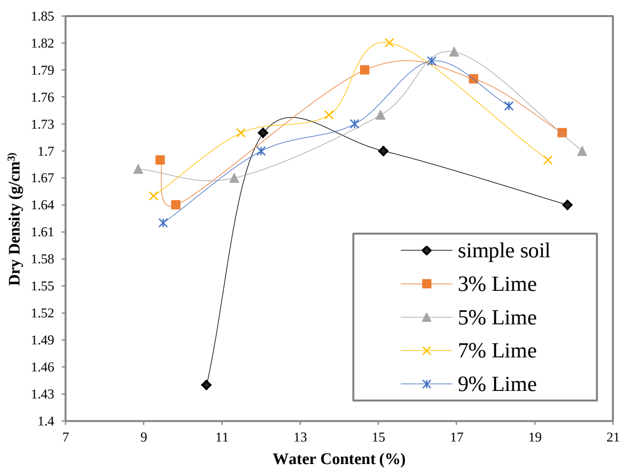

Fig 3: Variation of Dry Density with Water Content at different Lime percentages

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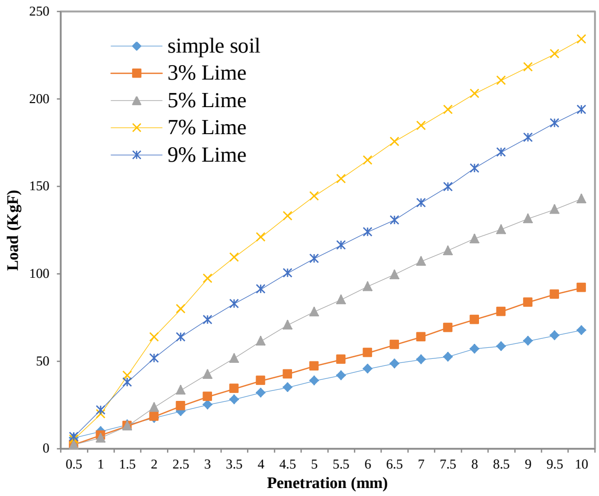

Fig. 4: Load vs Penetration at different percentages of lime.

IV. CONCLUSION

Many of the engineering properties of soils can be enhanced by addition of lime. The properties of such soil-lime mixtures vary and depend upon the type of soil as well as the concentration of lime. In this study, a series of experiments were performed on Karewa soils through variation of parameters, based upon which the following conclusions were drawn:

1. The liquid limit of Karewa soil decreases with an increase in lime content. This result is obtained due to reduction in thickness of double layer as the electrolyte concentration increases in the pore fluid.

2. The plastic limit of Karewa soil increases with increased lime contents as the charge concentration of pore water increases, the viscosity increases and offers high resistance against inter-particle movement.

3. The Karewa soil is of CL-ML character as evident from the results of liquid limit and plastic

Limit tests in association with plasticity index Curves.

4. The compaction characteristics of Karewa soils vary significantly at low lime content. The maximum dry density increases with increased lime content.

5. The resistance or strength to penetration of the soils is determined by CBR test. As the concentration of lime is increased from 0% to 7%, the value of CBR of Karewa soil increases from 1.88 to 7.03.

6. After going through the detailed experimentation of the Karewa soil under this study, the tabulated data and corresponding plots reveal one point of inflexion named to be optimum lime content and is decided as 7% lime content to dry weight of the soil.

7. As the CBR value of the subgrade increases from 1.88 to 7.03 when the lime content is gradually increased from 0% to 7%, the increased strength of the Subgrade makes an allowance for the subsequent decrease in the base and sub-base courses, even up to the extent of 50%.

REFERENCES

[1] Herrin, M. & Mitchell, H. (1961),"Lime-soil Mixtures", Highway Research Board, Bulletin.

[2] Kennedy, T.W et al (1987)" An Evaluation of Lime and Cement Stabilization", Transportation Research Record.

[3] Bell, G. & Coulthard, J.M. (1996) "Stabilization of clay soils with lime". Engineering Geology Volume 42, Issue 4, July 1996, Pages 223-23.

[4] Kinuthia et al. (1999), "Effects of Some Metal Sulfates on the Strength and Swelling Properties of Lime-Stabilised Kaolinite" International Journal of Pavement Engineering 2(2):103-120.

[5] Rogers et al (2000), "Lime Requirement for Stabilization. Journal of the Transportation Research Board.

[6] Todres, H.A. et al (2003), "Stabilization of Clay Soils by Portland Cement or Lime" – A Critical Review of Literature. PCA R&D Serial No 2066. Portland cement Association, Skokie.

[7] Trucer B et al, "Stabilizing Soft Fine-Grained Soils with Fly Ash,"Journal of Materials in Civil Engineering" April 2006.

[8] Consoli N.C, et al. (2009) "Key parameters for the control of lime stabilized soils", Journal of Materials in Civil Engineering.

[9] C.A.B. Carvalho et al, "Modification of a Lateritic Soil with Lime and Cement", An Economical Alternative for Flexible Pavement Layers" Soils and Rocks, January-April, 2012.

[10] Majid et al, ENVIS Newsletter April–June (2015), "Soils of Jammu & Kashmir". Department of Ecology, Environment & Remote Sensing, Jammu & Kashmir

[11] G. Venkata Rao et al "Experimental Studies on Laterite Soil Stabilized with Cement and Aggregate" IJRET: International Journal of Research in Engineering and Technology Volume: 04 Issue: 08 | August-2015.

 DOI : 10.18231/2454-9150.2018.1417