Soil Stabilization with Partial Addition of Lime, Location Phagwara Punjab.

[1]Saumyadeep Bhowmik, [2]Aviral Datta, [3]Shivam A. Patel

[1]*Civil Engineering Department, Lovely Professional University, (India)*

ABSTRACT

Soil Stabilization is the process in which improvementof the different types of engineering properties of the soil is done. It can be done by the use of controlled compaction, proportioning and the addition of suitable different types of admixtures and stabilizers. Stabilization of soil can be done using many different materials, mainly by-products so that it becomes economical. We have stabilized our soil sample by using locally available material, i.e. Lime. Stabilization is very necessary for various construction works like road pavement and foundation because it improves the engineering properties of soil. This research represents study of Lime as admixture or stabilizer in improving some engineering properties of soil. The research evaluates the effect of Lime on some basic engineering properties of soil i.e., Liquid limit, compaction of soil, Direct shear test and California Bearing Ratio (CBR) of soil. The percentage of Lime used varies from 2% to 8%. The geotechnical engineering properties like liquid limit, compressive strength, CBR values etc. have been studied in this research. The liquid limit and Optimum Moisture Content (OMC), California Bearing Ratio (CBR) increased with increase in Lime percentage while Maximum Dry Density (MDD) of soil decreased with increase in the percentage of Lime. The objective of this research is to estimate the effect of Lime on some geotechnical properties of black cotton soil, in order to determine the suitability of Lime for use as a modifier or stabilizer in the treatment of soil for further work.The aim of this research is to quantify the optimum quantity of Lime.

Keywords:Lime, California Bearing Ratio (CBR), Optimum Moisture Content (OMC), Maximum Dry Density (MDD), Direct Shear Test (DST), Standard Proctor Test (SPT)

I.INTRODUCTION

Soil is used as a construction material for roads, dams, canals, pavements, as a fill behind retaining walls etc. It would be ideal to find a soil at a particular site to be satisfactory for the intended use as it exists in nature but unfortunately, such a thing is of rare occurrence. So it is very important for the engineer to know about the extent to which soil properties may be improved or to think of other alternatives for the construction of intended structure at the available site.

Lime is an effective agent to be mixed with fine grained soils with high plasticity. There are two types of chemical reactions that occur when lime in added to wet soil. First is alteration of the nature of the adsorbed layer through iron exchange of calcium for the ion carried by the soil or a change in the double layer on colloids. The second is the cementing action or pozzolanic action which requires a much longer time. It is well known that lime improves certain properties of the soil due to its chemical action. The effect for lime on some of properties such as optimum moisture content, dry density, consistency limits and consolidation was studied on

samples collected from different places. An optimum value of percentage of lime to be added in order to improve the properties of the soil has been recommended.

1.1 Introduction to Materials Used

1.1.1 Natural Soil

The soil sample was collected from town market (Phagwara, Punjab) and it was air dried and pulverized manually. It was oven dried for 48 hours before conducting the tests on the soil.

1.1.2 Lime

The lime sample is taken from town market (Phagwara, Punjab) and has been dried and pulverized manually. Quick lime must be handled with care; it can burn the skin in the presence of moisture it also can cause corrosion of equipment. The main contribution of lime to the strength of soil is from its ability to create cementation between soil particles. The higher the surface area of the soil, the more effective this process of lime cementation is.

II. EXPERIMENTS

The lime & soil are mixed fully on dry weight basis in the suitable required proportions. The following tests were conducted:

- Sieve analysis
- Liquid limits
- Direct Shear Test
- Compaction
- California Bearing Ratio (CBR)

III. COMPOSITION OF MIXTURE

We took following three samples of mixtures,

- Simple soil + 2 % of lime
- Simple soil + 4 % of lime
- Simple soil + 8 % of lime

Soil preparation: Lime is mixed in varying percentage of 2%, 4% and 8% with natural soil. The soil sample thus obtained is kept in air tight polythene for 24 hours.

IV. RESULT AND ANALYSIS

4.1 Sieve Analysis

Based on the test results from the sieve analysis, the value of Cu obtained from the analysis is 3.8 whereas value of Cc is 0.59. It has also been noted that more than 50% of the soil is passing through 4.75 mm which means that the soil is fine-grained soil. Also the liquid limit of the soil 50% and less which means the soil is of low compressibility. If the plastic limit of the soil can be determined, Atterberg's line has an equation $I_p = 0.73(w_1 - 20)$. It has been noticed that the sand has properties of silty sand.

4.2 Liquid Limits

The liquid limit is defined as the minimum moisture content at which a soil will flow upon application of a very small shearing force. When a soil becomes a viscous fluid, the soil will begin to flow under its own weight and very small amount of energy input, as shown in picture on the right. The liquid limit is primarily used by civil and geotechnical engineers as a physical property of a soil. The
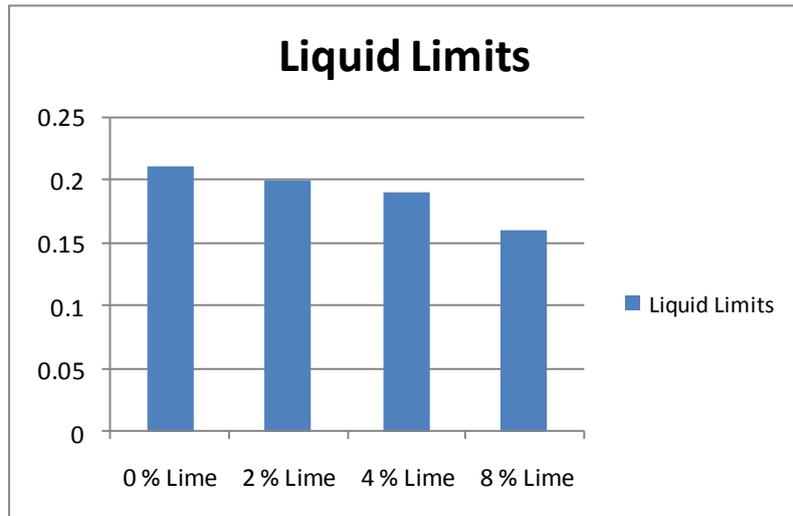

Figure 1: % Lime v/s Liquid Limit

liquid limit allows engineers to classify soils into their applications. For instance one soil may have applications in sub-bases of roads, where another soil may be better suited for foundations of buildings.It has been observed that with the increase in the content of lime, the liquid limit decreases.

4.3 Optimum Moisture Content

This test is done to determine the maximum dry density and the optimum moisture content of soil using heavy compaction as per IS: 2720 (Part 8) – 1983. By using different techniques of proctor test the value of optimum moisture content and maximum dry density is calculated. By calculating the maximum dry density after performing the test, a graph is
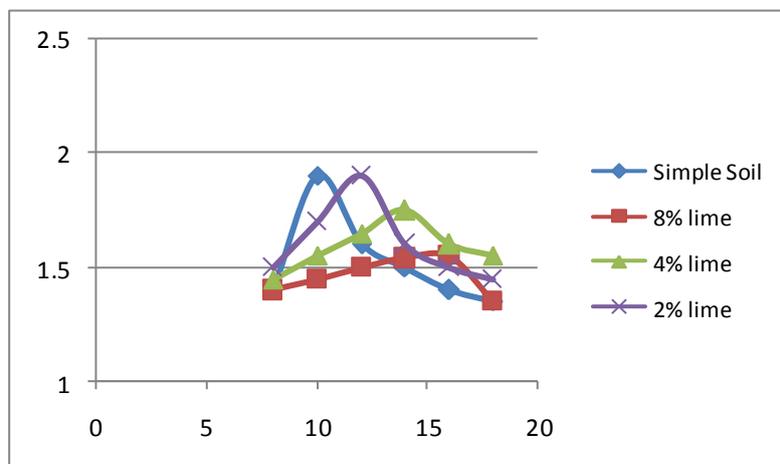

Figure 2: Water content % v/s Dry Density

plotted between maximum dry density and water content. The peak of the curve gives the optimum moisture content. Optimum moisture content is the content of water at which we get the maximum compaction. While conducting certain test we need the soil to be at optimum moisture content i.e., the soil should be fully compacted. While doing some tests optimum moisture content has to be added. Tests cannot be conducted without knowing the optimum moisture content of the soil.

When lime is added with soil following changes have been noticed.The Figureshows the effect of lime on dry density. The maximum dry density decreases with increase in lime %, while the optimum moisture content increases with increase in lime %.

4.4 California Bearing Ratio (CBR) Test

It is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard material.
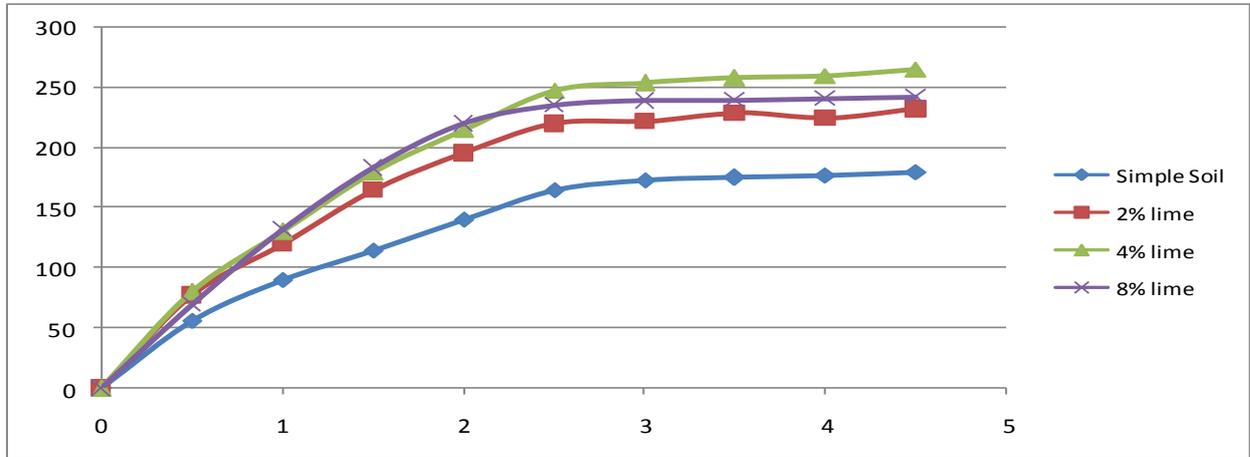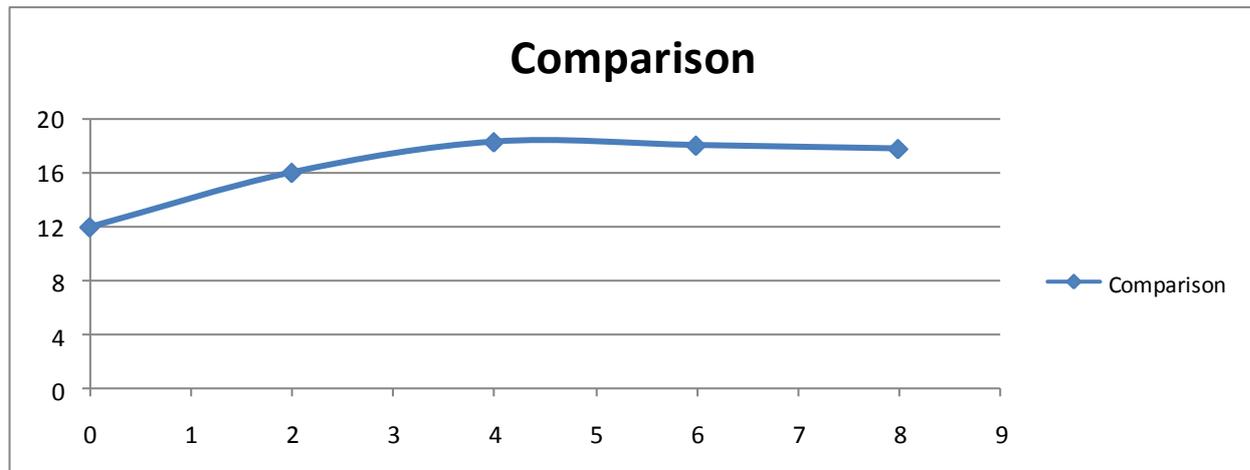

Figure 4: Lime % v/v CBR Value

Figure 3: Penetration (mm) v/s Standard Load (kg)

The California Bearing Ratio test is penetration test meant for the evaluation of subgrade strength of roads and pavements. The results obtained by these tests are used with the empirical curves to determine the thickness of pavement and its component layers. This is the most widely used method for the design of flexible pavement.

4.5 Direct Shear Test

Shear strength of a soil is the maximum resistance to shearing stress at failure on the failure plane Shear strength is composed of:

i. Internal friction which is the resistance due to friction between individual particles at their contact points and interlocking of particles. This interlocking strength is indicated through parameter φ.

ii.   Cohesion which resist due to inter-particle force which tend hold the particles together in a soil mass.

The indicative parameter is called Cohesion Intercept (c).

The purpose of direct shear test is to get the ultimate shear resistance, peak shear resistance, cohesion, angle of shearing resistance and stress-strain characteristics of the soils. Shear parameters are used in the design of earthen dams and embankments. These are used in calculating the bearing capacity of soil-foundation systems. These parameters help in estimating the earth pressures behind the retaining walls. The values of these parameters are also used in checking the stability to natural slopes, cuts and fills.
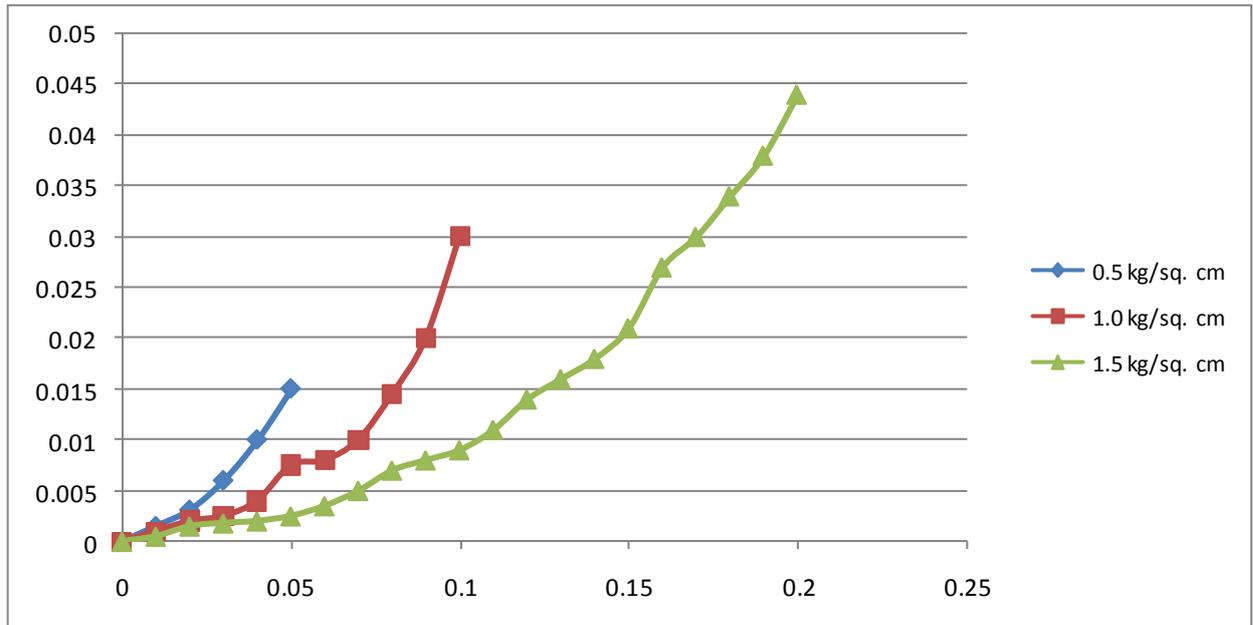

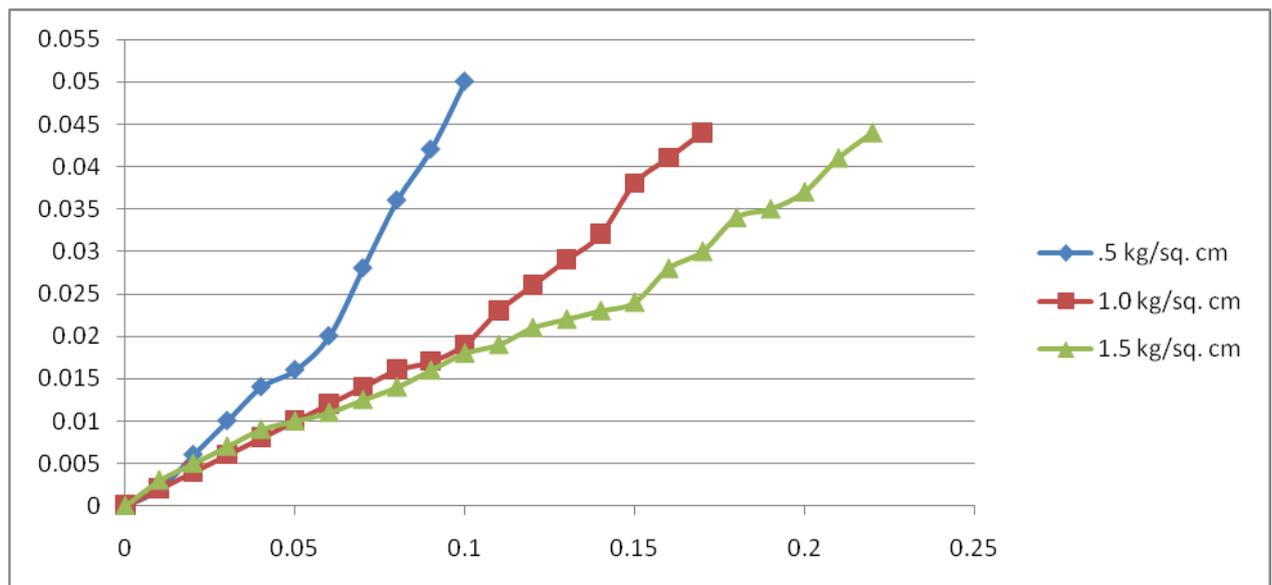**Figure 5: Shear Load v/s Shear Strength for Simple Soil**

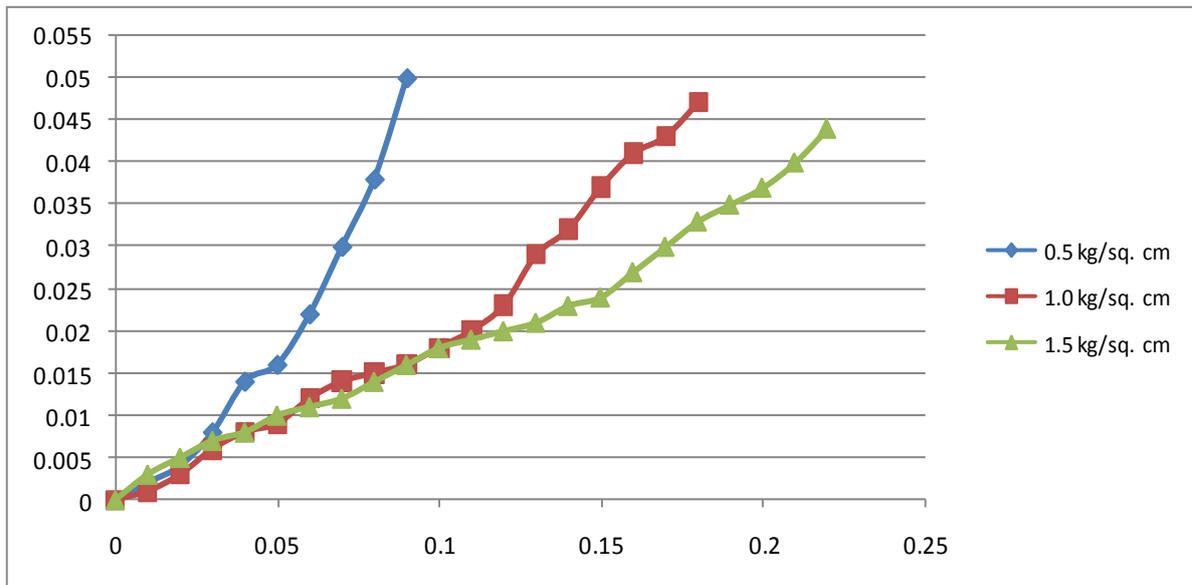**Figure 6: Shear Load v/s Shear Strength for (Soil + 2 % Lime)**

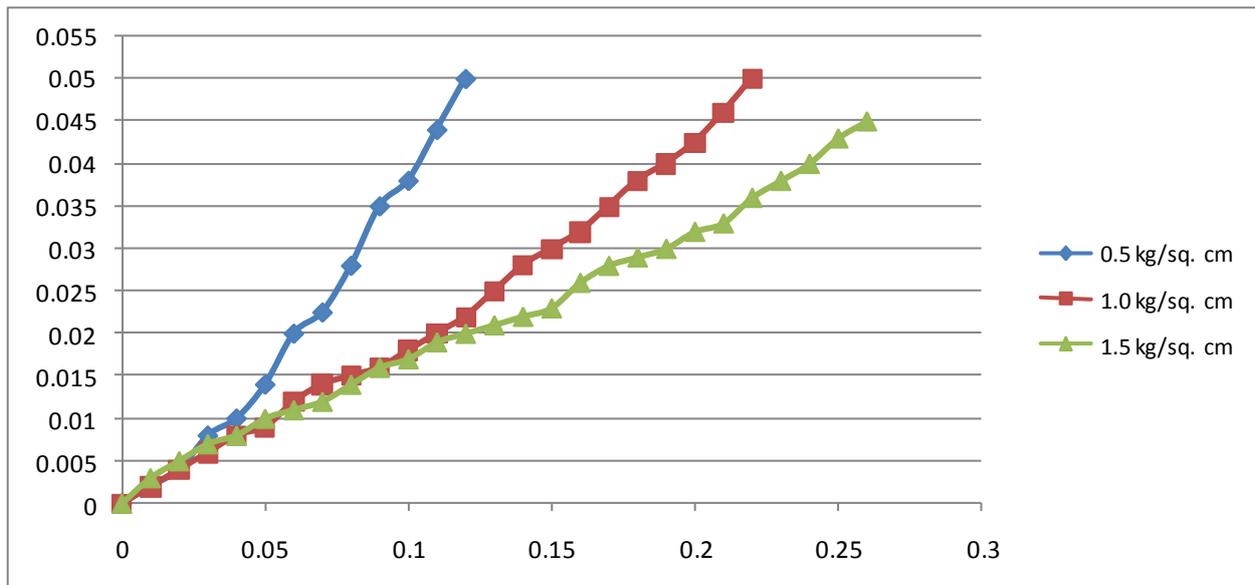**Figure 7: Shear Load v/s Shear Strength for (Soil + 4 % Lime)**

Figure 8: Shear Load v/s Shear Strength for (Soil + 8 % Lime)

V. CONCLUSION

Lime is used as an excellent soil stabilizing material for highly active soils which undergo through frequent expansion and shrinkage.

- Lime acts immediately and improves various property of soil such as carrying capacity of soil, resistance to shrinkage during moist conditions, reduction in plasticity index, increase in CBR value and subsequent increase in the compression resistance with the increase in time.

- The reaction is very quick and stabilization of soil starts within few hours.

- The graphs presented above gives a clear idea about the improvement in the properties of soil after adding lime.

REFERENCES

[1.] Chaddock, B. C. J., The Structural Performance of Stabilized Road Soil in road Foundations, Lime Stabilization, 1996.

[2.] Evans P., Lime Stabilization of Black Clay Soil in Queensland, Presentation to the National Lime Association Convention, San Diego, California, 1998.

[3.] Basma A., Tuncer E. R., Effect on lime on Volume Change and Compressibility of Expansive Clays, Transportation Research Record No. 1190, 1988.

[4.] Dawson R. F., McDowell C., A Study of an Old Lime Stabilized Gravel Base, Highway Research Board, Bulletin 304, 1961.

[5.] Doty R., Dumbleton M. J., Determination of Strength Equivalency for Design of Lime Stabilized Roadway, Technical Paper 64, Road Research Laboratory, England, 1968.