IJFEAT
INTERNATIONAL JOURNAL FOR ENGINEERING APPLICATIONS AND TECHNOLOGY

SOIL STABILIZATION USING LIME

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Abstract
Soil stabilization can be explained as the alteration of the soil properties by chemical or physical means in order to improve the engineering quality of the soil . The long-term performance of any construction project depends on the soundness of the underlying soils. Unstable soils can create many significant problems for pavements or structures,The main objectives of the soil stabilization is to enhance the bearing capacity of the soil ,its resistance to weathering process and soil permeability, Therefore soil stabilization techniques are necessary to ensure the good stability of soil so that it can successfully sustain the load of the superstructure for the soil which is highly active, also it saves a lot of millions of money and time when compared to the method of cutting out and replacing the unstable soil. This paper deals with the complete analysis of the improvement of soil properties and its stabilization using lime.

Index Terms: *soil permeability, soundness, soil properties, stabilization, lime..*

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1. INTRODUCTION

1.1 General

The swelling and shrinkage characteristic of expansive soil depend upon the percentage of moisture content in it. So the expansive soil undergoes volumetric changes due to the water content changes. The percentage of moisture content inside the expansive soil depends upon the seasonal variation.The finer particles of the expansive soil more will be the water holding capacity. The swelling and shrinkage characteristics of the expansive soil causes the differential movement, resulting in severe damaged to the foundations, buildings, roads, retaining structures, canal linings, etc. The expansive soil losses its chemical strength during the expansion condition.

Lime stabilization is a method of chemically improving the unstable soil. Lime stabilization is particularly important in the construction of highway for modifying subgrade soils, subbase materials, and base materials.

Chemical stabilization introduced the use of technique to add a binder to the soil to improve the geotechnical performance of land such as mechanical and chemical characteristics of soil. Some studies are reported that, different additives such as cement, lime, fly ash, silica fume, and rice husk ash have been used for chemical stabilization of soft soils. It is also well known that stabilizing soil with local natural, industrial resources particularly lime and fly ash has a significant effect on improving the soil properties.Chemical stabilization is applied as a low cost, eco friendly and efficient method for soil treatment. In soil stabilization with lime and fly ash, additives combined by specific moisture content, then apply for improving the soil properties in engineering projects.

1.2 Objectives of Study

The prime aim of the present investigation is to assess the usefulness of lime as soil stabilizer. present investigation has been limited to the following. studies,

1.To study about the reaction of soil with lime.
2.To study the strengthening of soil of low bearing capacity.
3.To study the various test by adding lime as a stabilizer.
4.To study the influence to California bearing ratio.

2. SOIL STABILIZATION

Soil stabilization is the process of changing some soil properties by using different methodsTo increase the strength and durability or for preventing erosion and dust formation in soils,soils are generally stabilized. The main aim is the creation of a soil material or system that will hold under the designed conditions and for the designed life of the engineering project. The properties of soil vary a great deal at different places or in certain cases even at one place; the success of soil stabilization depends on testing of soil samples. Various methods are employed for soil stabilization and the method should be verified in the lab with the soil material before it applying on the field.

2.1 Principles of Soil Stabilization:

1. Evaluating the soil properties of the area under consideration.
2. Deciding the property of soil which needs to be change to get the design value and choose the effective and economical method for stabilization.
3. Designing the Stabilized soil mix sample and testing it in the lab for finding stability and durability values.

2.2 Needs & Advantages

Properties ofsoil vary a great deal and construction of structures depends upon the bearing capacity of the soil. Hence, we need to stabilize the soil which makes it easier to predict the load bearing capacity of the soil and

improve the load bearing capacity. The gradation of the soil is also a very important property that should keep in mind while working with soils. The soils may be well-graded which is desirable as it has less number of voids or uniformly graded which though sounds stable but has more voids. Thus, it is better to mix different types of soils together to improve the soil strength properties. It is very much expensive to replace the inferior soil by entirely different soil and so that, soil stabilization is the thing to look for in these cases.

1. By increasing the soil bearing capacityit improves the strength of the soil.
2. It is more economical both in terms of cost and energy to increase the bearing capacity of the soil rather than going for deep foundation..
3. It provides more stability to the soil in slopes or other such places.
4. Sometimes soil stabilization is also used to prevent soil formation of dust.
5. Stabilization is also done for soil water-proofing; this prevents the entry of water into the soil and hence helps the soil from losing its strength.
6. Due to change in temperature or moisture contentit helps in reducing the soil volume change.

3.LIME STABILIZATION

Lime stabilization is a more long-term effect, which results in more significant strength gain due to pozzolanic reaction. A pozzolan can be defined as "a siliceous or siliceous and aluminous material, which in itself possesses little or no cementitious value but will, in finely divided form and in the presences of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties"

As reactions continue to occur in a soil-lime mixture, silica and alumina found in soils reacts on the surfaces of the clay particles to produce calcium silicates and calcium aluminates. These chemical reactions that occur between clayey soils and lime are displayed below:

Initial dissociation of hydrated lime:

$Ca[OH]2 \square\square Ca^{++} + 2[OH^-]$

Reaction products of soil-lime interaction:

$Ca^{++} + 2[OH^-] + SiO2$ (clay silica) $\square\square$CSH (calcium silicate hydrates)

$Ca^{++} + 2[OH^-] + Al2O3$ (clay alumina) $\square\square$CAH (calcium aluminate hydrates)

To elaborate on the chemical reactions, the addition of a hydrated lime (Ca(OH)2) results in a separation of the calcium ion from the hydroxide ion leaving both ions free floating in this mixture. The silica and alumina that are naturally present in clayey soils then react with the free calcium ion to form calcium silicate hyrdrates or calcium aluminate hydrates. The silica and alumina can come from potential sources, such as clay minerals, quartz, feldspars, or micas (TRB 1987). These clay silicates and clay aluminates bond or gel to the clay particles together to further strengthen the soil. This reaction is dependent on time in the fact that the longer a specimen is allowed to cure, the more the clay reacts with the lime, and the higher the strength will be. This reaction may take place for weeks to months depending on the soil composition. Thompson claims that some field data show that this strength increase continues to occur for up to 10 years or even more.

4.TESTING RESULTS OF BLACK COTTON SOIL

4.1Atterberg Limits

The Liquid Limit (LL) of the samples were determined and plotted against the lime content. (See Fig. 1). The liquid limit of untreated soil was determined as 59.8% whereas it varied between 53.2% to 59.5% after lime was added. The liquid limit of the soil decreases with increase in lime content up to 4.5% after that it goes on increasing with increase in lime content. Thus the optimum lime content is between 4-4.5% for maximum effect on liquid limit.

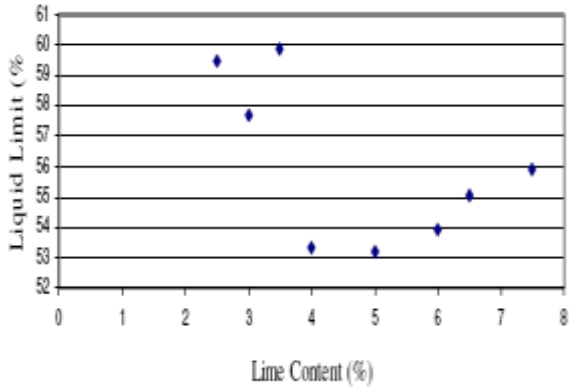

Fig. 1: Variations in Liquid Limit with Lime Content

4.2 PLASTIC LIMIT

Although the plastic limit did not change distinctly (range between 32% and 40%) with increase in lime content, the lowest value was reached at a lime content of about 4% as seen in Fig. 2. The plastic limit of untreated soil was determined to be 33%.

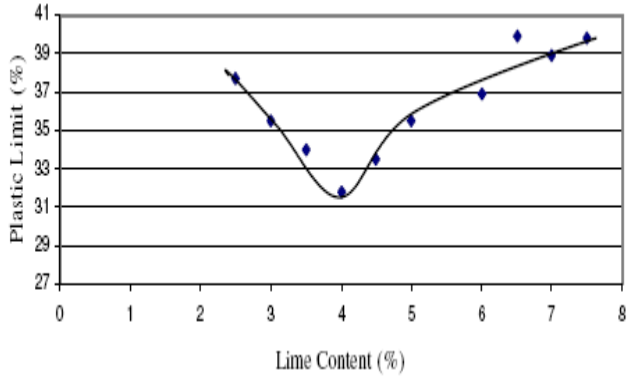

Fig. 2: Variations in Plastic Limit with Lime Content

4.3 PLASTICITY INDEX

The plasticity index decreased gradually with increase in lime content, see Fig. 3. The plasticity index varies from 25.9% to about15.1%. This shows that the plastic nature of the soil decreases and the stiffness of the soil increases as the lime content increases. Based on the sieve analysis and Atterberg Limit test results, the soil under consideration is classified as MH.

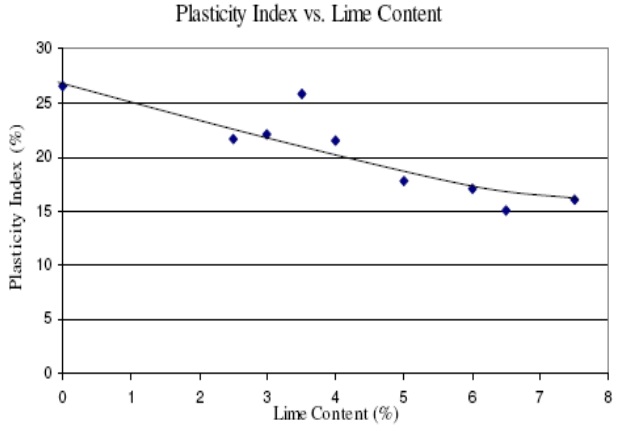

Fig. 3: Variations in Plasticity Index with Lime Content

4.4Standard Proctor Test

The Standard Proctor Test results show that the maximum dry density remains constant with variation in lime content (Fig. 4) whereas the optimum moisture content (OMC) lies

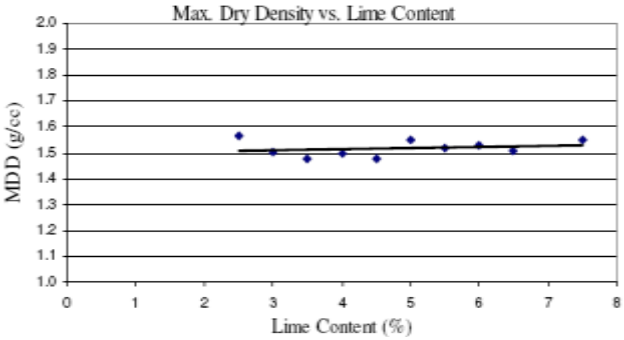

Fig. 4: Variations in Max. Dry Density with Lime Content

between 23-30% with a decreasing tendency as lime content increases (Fig. 5). So addition of lime did not improve the compaction characteristics of the soil under investigation (Prakesh, et. Al., 1989).

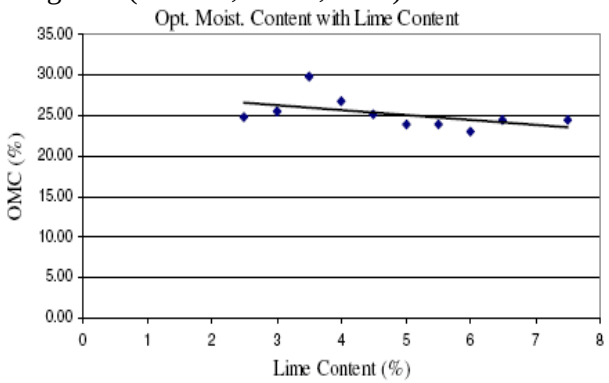

Fig. 5: Variations in OMC with Lime Content

4.5California Bearing Ratio Test

The CBR value of the soil decreases with increase in lime content up to 3.5% after which it goes on increasing. The optimum lime content is observed at about 3.5%. (Fig. 8)

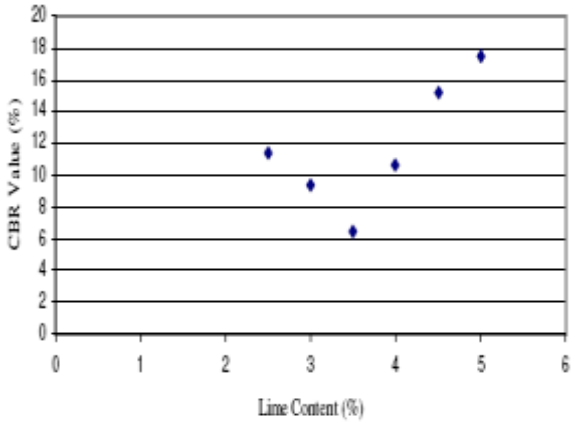

Fig. 6: Variations in CBR Value with Lime Content

5.Results

1. Addition of lime initially leads to decrease in liquid limit, this is due to depression in the diffused layer thickness associated with the clay particles. Subsequent addition of lime leads to increase in liquid limit of soil this is due to prolonged equilibrium of the lime soil mixture results in formation of coarser aggregate and more flocculated particle arrangement possibly, water entrapped in the large void spaces of the flocculated structure of the soil fabric there by increase in liquid limit.
2. Addition of lime initially leads to decrease in plastic limit, this is due to depression in the diffused layer thickness associated with the clay particles. Subsequent addition of lime leads to increase in plastic limit of soil this is due to prolonged equilibrium of the lime soil mixture results in formation of coarser aggregate and more flocculated particle arrangement possibly, water entrapped in the large void spaces of the flocculated structure of the soil fabric there by increase in plastic limit.
3.Addition of lime content, the plasticity index decreases gradually.
4.It is observed that, lime does not work on the compression properties of soil as the MDM and OMC do not change with the addition of lime content.
5.There is increase in the CBR ratio by addition of lime content.

6.CONCLUSION

1.Lime is used as an excellent soil stabilizing materials for highly active soils which undergo through frequent expansion and shrinkage.
2.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.

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

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