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OVERVIEW STUDY ON BEHAVIOUR OF EXPANSIVE SOIL WITH LIME

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Abstract: ***This study is review on lime stabilisation (quick and hydrated) lime. A lime is cheapest and traditional stabilizer for expansive soil. The stabilisation of expansive soil by lime is depend upon cation exchange mechanism, which leads to the flocculation and agglomeration of expansive soil. Lime-treated soil effectively increases the shear strength, bearing capacity, durability and workability, improves compressibility of soil and chances of failure is reduced. A fluctuation behaviour was observed on the influence of lime on soil permeability. However, the factors affecting the permeability of the soil-lime mixture should be extensively studied. But there has a number of internal disadvantages, such as carbonation, sulphate attack and environment impact. Magnesium oxide/hydroxide are thus proposed as a suitable alternative stabilizer to overcome at least some of the disadvantages of using lime in soil stabilization.***

Keywords: Quick lime, hydrated lime, MgO, bearing capacity, carbonation.

I. INTRODUCTION

Soil stabilization is the process of the alternative solution to improve the geotechnical properties of soil to satisfy the engineering requirements or purpose. A number of stabilizers are used for stabilisation, such as lime, cement and industrial waste like fly ash, kota stone slurry, marble slurry and wooden saw dust this all kind of material's behaviur depend on their chemical reactions with the soil elements in the presence of water. Other additives, such as geofiber and geogrid, depend on their physical effects to improve soil engineering properties). Combination of both of chemical and physical stabilizers is also used for the improvement of soil for example, by using lime and geofiber or geotextile together.

Lime is the oldest traditional chemical stabilizer used for soil stabilization. However, soil stabilization using lime involves advantages and disadvantages. This study provides details of advantages and disadvantages of using lime as soil stabilizer. In addition, to control the disadvantages inherent to lime treated soil, proposing an alternative material for stabilisation.

II. LITERATURE REVIEW

1. Eades and Grim (1960)- lime-soil chemical reaction has two stages. The first stage, which is known as immediate or short-term treatment, occurs within a few hours or days after lime is added. Three main chemical reactions, namely, cation exchange, flocculation-agglomeration and carbonation occur at this stage. The second stage requires several months or years to complete the long-term treatment. Pozzolanic reaction is the mainly occur at this stage. The drying of wet soil and the increase in soil workability is attributed to the immediate treatment, whereas the increase in soil strength, compressibility, durability is associated with the long- term treatment.

2. A. A. Amadi, A. Okeiyi(2017)- The tests were performed to evaluate and compare the quick lime and hydrated lime for stabilization effectiveness on different percentages (0, 2.5, 5, 7.5, 10%) of soil when mixed separately to locally available lateritic soil, a major soil group in the tropical and sub-tropical regions. The following tests were conduct in this research work: Atterberg's limits, compaction, unconfined compression tests, California bearing ratio (CBR), Swelling potential using CBR instrument.

III.EFFECT OF LIME STABILISATION ON THE ENGINEERING PROPERTIES OF SOIL

The drying of wet soil and the increase in soil workability are attributed to the immediate treatment, whereas the increase in the strength, durability and compressibility of the soil are associated with the long -term treatment. The following relationship are showing lime-soil treatment chemical phenomenon.

1. Dry density-Water content relationship

Chemical reaction and soil-lime mechanism shows that the optimum moisture content of soil is increases by the increasing the percentage of quick lime due to the addition of lime to the soil water system produces (Ca^{+2}) and (OH^{-}). In negative charged ions exchange, bivalent calcium ions (Ca^{+2}) are replaced by monovalent cations. The Ca^{+2} ions tie with the soil minerals (having negative charge). Thereby lowering the repulsion forces and the thickness of the diffused moisture layer. This layer enclose the soil particles together, strengthening the bond between the soil particles rest of the anions (OH^{-}) are responsible for the increased alkalinity After the reduction in water layer thickness, the soil particles become closer to each other, causing the soil texture to change. Results the floc formation occurs and the enlarged

particle size causes the void ratio to increase. This increase in void ratio reflects the decrease in maximum dry density and increases optimum moisture content.
The silica and alumina that exist in the soil minerals become soluble and free from the soil when pH exceeds 12.4. The reaction between the released soluble silica and alumina and the calcium ions from lime hydration creates cementitious materials such as Calcium Silicate Hydrates (C-S-H) and Calcium Aluminate Hydrates (C-A-H). These are the following chemical reaction takes place:

$$Ca(OH)_2 + SiO_2 \rightarrow CaO\text{-}SiO_2\text{-}H_2O \qquad (1)$$

$$Ca(OH)_2 + Al_2O_3 \rightarrow CaO\text{-}Al_2O_3\text{-}H_2O \qquad (2)$$

Recently some studies have not only showed the maximum percentage of lime is 12% for highly swell soil but also shows, the maximum dry density is decreases and optimum moisture content is increases as above mentioned reason.

2. Effect on Atterberg's limits

Most of the studies have shown on increment of lime percentage in expansive soil (montmorillonite mineral) liquid limit and plastic limit decreased, hence plasticity index is decreases. Even some times it has been convert into non-plastic soil. Whereas we found in the presence of kaolinite and quartzite mineral the liquid limit is increases. These changes are depend upon two things first is lime percentage and another is type of mineral and this changes are occurs due to hydroxyl ions.

3. Effect on Bearing and Shearing Strength of Soil

Several researchers have used various methodologies and conditions to evaluate the effect of lime on uncured and cured soil strength (determined in the laboratory) with different percentage of lime content and Unconfined Compressive Strength (UCS), California Bearing Ratio (CBR) tests were conducted, also used triaxial test and indirect or flexural tensile strength to evaluate the shear strength of treated soil.
The UCS value of treated soil is increases in both conditions (cured and uncured) even the value of UCS were observed for cured condition increases upto 60% for 28days only for 6-8% lime and further increment of lime percentage in the expansive soil the value of compressive strength is decreased due to rearrangement of soil crystalline structure after 8% it replace soil particles and reduce the shear strength this phenomena is called dilatancy. After sometimes it regain its shear strength but less than 8% this phenomena is called thixotropy.
The value of CBR is also increases with increment of lime percentage upto 12% after further increment of lime percentage the value of CBR is decreased. The fatigue strength is also increases it mean it can bear number of cyclic loading, it can also preserve from freezing and thawing it means the capability of treated soil to adverse effect of environment like cycle of dryness and wetness.

4. Effect on swell pressure value and volume change

Expansive soils are known as problematic soil because of their swell pressure value and volume change, which apply uplift pressure and cause substantial damage to the structures (particularly for the light-weight structure). The percent of swell as the volume change that the soil has endured when the moisture content approaches saturation level. Stated that a significant reduction in swell potential and swell pressure can be achieved in lime treated expansive soil. This reduction in swell pressure is associated with the decrease in plasticity index caused by lime treatment. Furthermore, the reduction in swell pressure and volume change are attributed to the reduction in the thickness of the diffused double layer. Such characteristic, along with the immediate water absorption and the immediate reduction in plasticity index, indicates that the yields from lime-treated soil have a significant role in reducing the swell pressure instantaneously. In addition, curing and pozzolanic reaction provide additional reduction in the swelling during the long-term treatment.

5. Effect on Durability: Durability means the capability of lime-stabilized soil to resist the unfavourable effects of the wet-dry and freeze-thaw cycles resulting from the changes in environmental conditions during a year. This is the assurance of the keep up a strength gain achieved by soil stabilization. Durability can be carried out in numerous ways, such as combination of soaked and unsoaked test conditions. Other studies have analysed the effects of freeze-thaw cycles on lime-stabilized soil. In that actual durability is dependent on the immediate strength, that is, a higher immediate strength corresponds to a greater number of freeze-thaw cycles bound to failure. Therefore, the researchers recommended the use of a low strength before the first freeze-thaw cycle to accommodate strength loss. According to litreture and laboratory test performance

IV. CONCLUSION

Lime-treated soil was studied extensively in the literature. Numerous field and laboratory studies were conducted to evaluate the improvement of geotechnical properties by lime. We observed on the basis of above discussion the mechanism of treatment comprised hydration, cation exchange, flocculation-sagglomeration of soil particles and pozzolanic reaction to form Calcium Silicate Hydrate (C-S-H) and Calcium Aluminate Hydrate (C-A-H) as cementitious materials. Soil-lime mixtures have its advantages comprise significantly increase soil strength, reduce plasticity (increase workability) and increases soil durability. In addition, a considerable reduction in consolidation settlement and improve compressibility characteristics were observed. Unclear behavior was noted for the permeability of soil-lime mixture when compared with the original soil.

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