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A Review on Stabilization of Expensive Soil

Bisrat Hailu[1], Shamshad Alam[2]

[1]*Department of Civil Engineering, Sharda University,*
[2]*Department of Civil Engineering, Sharda University,*

Abstract— Expansive soil is considered as problematic soil through the world and is inappropriate for foundation. It covers large area of the land in the world and covering about 45% of the total area in Ethiopia. This soil is highly affected by the change in the water content with large variation in the volume. The common practice to encounter the volume change behaviour of expensive soil is the stabilization using additives. This paper presents the summarised results of previous work in this direction using different additives like lime and brick powder and a conclusion has been drawn based on the result.

Keywords— Expansive soils, stabilization, geotechnical property

I. INTRODUCTION

Expansive soils are soil observe significant volume change when comes in contact with water depending on the mineralogical composition and considered as problematic for geotechnical engineers (Negawo et al. 2017). Soils that contain montmorillonite minerals exhibit the largest swell shrink behaviour (S. K. Dash and M. Hussain 2016). The volume change characteristic of the expensive soil causes large pressures on the structures over it (Bhuvaneshwari and Sowbi 2017). The changes in volume of expensive soils result in differential settlement of structures which leads to cracking of structures and subsidence of pavements (Negawo et al. 2017). This type of problem is mostly connected to the top few meters of the soil stratum which is mostly influenced by the environmental agents. The annual destruction due to expensive soils is estimated more than the combined hazards due to floods, hurricanes, earthquakes, and tornadoes (Jones and Jefferson 2012). To eliminate damages from expansive soils, several techniques are being used and the removal, replacement, and in place stabilization are very common (Negawo et al. 2017). However, in place stabilization using chemical stabilizer contained the mixing or injecting of chemical materials into the soil. Such as Portland cement, lime, asphalt, calcium chloride, hypo sludge, brick powder and paper wastes are collective chemical stabilization factors. The efficiency of these admixtures can be influenced the soil conditions, stabilizer behaviour and type of construction undergoing (Bhuvaneshwari and Sowbi 2017). The chemical soil stabilization helps in altering the Atterberg's limits, particle size distribution, swelling properties and the mechanical strength (unconfined compressive strength, California bearing ratio) (Moses and Osinubi, 2013; Negawo et al. 2017). The plastic limit of lime stabilized expensive soil showed an increasing trend whereas the liquid limit decreases with increasing lime content (Dash et al. 2016). Recently, few researchers presented their work lime stabilization of black cotton soil with brick (Reddy et al. 2018). So, this paper presenting the previous research in the direction of stabilization and characterization of expensive soils.

II. LITERATURE REVIEW

Ikeagwuani and Nwonu (2019) made an attempt to alter expensive soil properties using chemical stabilization. The main object of the chemical stabilisation was to improve the stability of soil as construction materials. This accomplished by increasing the particle size of soil through a reducing of plasticity index and decreasing the shrinking-swelling potential of problematic soils. The chemical stabilisation was achieved by introducing a specific amount of chemical compound to the expansive soil.

Reddy et al. (2018) carried out a research on black cotton soils and observed the property of high swelling due to exposer to water and shrinkage due to evaporation of water. This swelling and shrinkage was observed due to existence of high expansive mineral. They used lime to lower down the high plasticity of black cotton soils. Lime along with the brick powders was found to improve the strength. Brick dust along with fly ash in black cotton soil improved the unconfined compressive strength significantly.

Emarah and Seleem (2018) studied the effect of lime on physical and mechanical properties of expensive soil as subgrade material. The result showed that the combination of salt water and lime improve the unconfined compressive strength and CBR value along with the decrease in plasticity index and void ratio.

Negawo et al. (2017) carried out a research on lime-stabilisation of highly plastic swelling soils to study the mechanical properties of road subgrades in Ethiopia. It was observed that the soils treated with lime with different proportion and cured for seven days gives better result as compared to uncured samples. A considerable improvement was observed in unconfined compressive strength and the California bearing ratio.

Mousavi (2017) carried out a research on stabilization of compacted clay containing peat ash with cement and lime for road materials. The stabilized soil showed higher maximum dry unit weight with higher unconfined compression strength.

Akshatha (2016) presented a result on the stabilization of black cotton soil by brick powder and lime. An increase in maximum dry unit weight was observed with the decrease in optimum moisture content. The unconfined compressive strength and CBR was also observed to increase which is may be due to increase in density.
Mousavi (2016) investigated the effect of cement and lime on the geotechnical property of expansive soil and observed that the swelling potential can be controlled. It was also observed that the lime reduce the swelling potential whereas, pozzolan increases the swelling potential.
Mishra (2016) carried out a research on lime stabilization to enhancing the strength, durability and minimizes the moisture variations of expansive soil. In the work, lime was well compacted for gaining adequate strength and durability by maintaining OMC and the same hypothesis is made in the investigational determination of the vital lime proportion. Demonstrated quality of lime was mixed based on the amount of soil and it was more for fine grained soils up to 12 to 15 % by weight of soil. The crucial advantage of using lime to become stable clays showed improved strength, workability and volume stability that dangerous soil. The result showed that stabilization using lime increases the strength of soil, improve the durability, and resistance towards water seepage.
Dash and Kumar (2016) conducted a study on lime treatment of expansive soil and found that the addition of lime increases the unconfined compressive strength up to3000 kPa with 8% lime and 28 days curing. However, a decreasing trend was observed in liquid limit with the increase in lime content.
Hasan (2016) carried out a review on stabilisation techniques of expansive soil. Different conventional procedures were used to improve the soil texture, plasticity and strength. Chemical stabilisation was performed through introducing specific fractions of admixtures like lime, gypsum, slag, cement and fly ash.
Zumrawi (2015) conducted several experiments like Atterrberg's limit test, swell index, Proctor compaction values and UCS on lime treated and untreated soils. The percentage of lime was varying from 5% to 30% with an increment of 5%. It was observed that an increase in lime content increases the dry density and unconfined compressive strength.
Lopez et al. (2014) conducted the research on stabilization of clay soil by using slag and observed that the slag was observed effective in controlling the swelling potential of soil.
Negussie and Dinku (2014) investigated the effect of lime along with sodium silicate on expansive soil for subgrade stabilization in Ethiopia. It was observed that the sodium silicate make a physical bonding among the soil particles thereby improve the geotechnical property.
Wubshet and Tadesse (2014) conducted a research on the stabilization of expansive soil using bagasse ash (14%) and lime (4%). From test, an increase in CBR was observed whereas, the maximum dry density and plasticity of the soil for both additives together. From all test concluded that admixture of lime and bagasse improved swelling soil challenge was observed to decrease. It was also observed that the lime along with bagasse ash shows higher value of CBR as compared to lime and bagasse ash alone. The increase is may be due to formation of cementitious compounds such as calcium-silicate-hydrates and calcium-aluminate-hydrates.
Roohbakhshan and Kalantari (2013) conducted research on stabilization of clayey soil with lime and waste stone powder (WSP). It was observed that the increase in WSP increases the MDD value whereas the increase in lime decreases the MDD value. However, increasing percentage of lime along with WSP increases the OMC and UCS with decrease in plasticity index.
Jones and Jefferson (2012) conducted a study on the swelling clay and found the plasticity index above 30%, liquid limit more than 50% and have high swelling capacity.
Robert (2009) conducted a study on swelling soil and found that the addition of fly ash decreases the swelling potential of the soil due to replacement of sodium ion in soil by calcium ion in fly ash. The test showed an optimum moisture content and the maximum dry unit weight of soil as 20% and 15.5 kN/m^3, respectively. Whereas, the addition of 12% RHA changes the OMC (15%) and MDD (17.5 kN/m^3). On the other hand unconfined compressive strength increased from 660 to 1300 kPa due to addition of RHA.
Teferra and Yohannes (1986) investigated the expansive soils to study the significant engineering properties. To evaluate the damages on structures as a result of heaving and shrinkage of the soil on which the foundations of the structures founded.

III. CONCLUSIONS

Based on the rigorous literature survey, it was observed that the lime is very effective in stabilizing the expensive soil. However, lime along with the other additives like fly ash, brick powder, sea water slag was observed more effective as compared to the stabilization of soil by lime alone.

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