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Experimental Approach for Stabilizing Sub Grades on Expansive Soil

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Abstract:- *The cyclic heave and settlement of expansive soils is one of the major reasons for damages to the roads and highways in considerable part of country like India. Expansive clays usually have low bearing capacity, high shrinkage & swelling properties. Due to tendency to swell, it causes large uplift pressures and upheaval of structures built on them. Replacing expansive soil in most of the cases is not practically possible, hence stabilization measures must be undertaken to treat them. This paper presents an experimental investigation for treatment of expansive soil with lime to improve its bearing capacity and minimize swelling. Expansive soil treated with lime with varying quantity of 0%, 2%, 4%, 6%, 8% & 10% w.r.t dry weight of soil taken was studied. California Bearing Ratio & free swell index for each soil composite were evaluated. It was found that with addition of lime, CBR of soil composite increased and swelling declined. The optimum content of lime found to be 10% with most significant improvement in strength and reduction in swelling properties of the soil. Based on the results, it is concluded that lime admixture can be considered as a suitable option for the stabilization of expansive subgrades.*

Keywords: Lime, Expansive Soil, Shrinkage & Swelling, CBR, Compaction characteristics, Subgrades.

Abbreviations: CBR- California Bearing Ratio, FSI- Free Swell Index

I. INTRODUCTION

Dealing with soft subgrade or unsuitable soil is one of the major problems for civil engineering projects. This situation may arise in roadways or highway construction. Since there is reduction in sites for construction development, it is crucial to find ways for soil improvement techniques to respond to the demands. Such soils need addition of some strengthening elements to decrease the compressibility and to enhance the strength of the subgrade so that cost effective construction of works is possible. One of the reliable stabilizing material is lime. It is a calcium-containing inorganic mineral in which oxides and hydroxides predominate. Calcium hydroxide (traditionally called slaked lime) is an inorganic compound with the chemical formula Ca (OH) $_2$. It is a colorless crystal or white powder and is obtained when lime is mixed or slaked with water. Calcium hydroxide is used in many applications, including food preparation. Limewater is the common name for a saturated solution of calcium hydroxide.

Many research works have been done in past decade on introduction of lime in expansive soil. Muzahim et al., 2012 studied improvements of geotechnical properties of expansive soil behavior due to the lime-clay reactions, mainly a pozzolanic reaction, using microscopic analysis. Guillaume et al., 2012 examined the impact of a wetting and drying path on the swelling/shrinkage of a compacted lime-treated expansive clayey soil both at the macro- and micro-scales. The study showed that lime treatment had a limited effect on lime-treated compacted soil shrinkage whilst preventing swelling. T. Thyagaraj et al., 2012 attempted to study the precipitation of lime in soil by successive mixing of $CaCl_2$ and NaOH solutions with the expansive soil in two different sequences. Experimental results indicated that in situ precipitation of lime in soil by sequential mixing of $CaCl_2$ and NaOH solutions with expansive soil developed strong lime-modification and soil-lime pozzolanic reactions. Results also showed that the sequential mixing of expansive soil with $CaCl_2$ solution followed by NaOH solution is more effective than mixing expansive soil with NaOH solution followed by $CaCl_2$ solution. Sireesh et al., 2013 initiated to understand the behavioral mechanisms of lime and cement stabilized organic soils. Eight natural expansive soils bearing different organic contents (varying between 2 and 6%) were selected for the investigation. Further research work carried out by M. R. Asgari et al., 2013 which showed that addition of a few percentages of lime results in increase of unconfined compressive strength also According to the results of compaction tests, the effect of lime is more than effect of cement on optimum water content and maximum dry unit weight so that the changes of optimum water content and maximum dry unit weight due to addition of cement content do not have a general tendency, whereas addition of lime decreases maximum dry unit weight and also increases optimum water content. Based on the CBR and compressive strength tests, Amir Modarres et al., 2015 showed that the addition of coal waste powder and its ash to some extent enhances the soil bearing capacity. However, the combination of these additives with lime results in considerably higher compressive strength and CBR especially in saturated conditions. Argaw et al., 2016 studied stabilization of expansive soil (C) with steel slag (SS), rice husk ash (RHA), and quick lime (L). The geotechnical properties, shearing strength characteristics, and dynamic properties of stabilized soil have been studied. The optimum mix is found to be in the proportion of 65C + 20SS + 5L + 10RHA. The stiffness of stabilized soil increases to 58–78% as compared to clay soil. Moghal et al., 2016 studied stabilization of expansive soil (C) with steel slag (SS), rice

husk ash (RHA), and quick lime (L). The geotechnical properties, shearing strength characteristics, and dynamic properties of stabilized soil have been studied. The optimum mix is found to be in the proportion of 65C + 20SS + 5L + 10RHA. The stiffness of stabilized soil increases to 58–78% as compared to clay soil. Moghal et al., 2016 studied two stiffness of stabilized soil increases to 58–78% as compared to clay soil. Moghal et al., 2016 studied two different types of synthetic fibers, Fiber Mesh and Fiber Cast, as a stabilization alternative for expansive soils in the presence of lime. California bearing ratio (CBR) is chosen as a performance indicator as it is a good pointer towards pavement effectiveness. The deterministic approach showed that the improvement in CBR increased with higher fiber contents and longer lengths and the effect was prominent when lime was used as a stabilizer. Liet Chi Dang et al., 2017 presented a paper on experimental investigation on the enhancement of swelling behavior and soil water characteristic curve (SWCC) of bagasse fiber and lime stabilized expansive soil. The results revealed that lime-bagasse fiber treatment of expansive clay has a significant effect on swelling behavior and SWCC response of treated soils. G. Sridevi et al.2019 performed experiments on Red mud stabilized with 4% lime and lime-stabilized red mud is added to the expansive soil in different percentages varying from 10 to 50% in increments of 10%. Tests are also conducted on soils stabilized with lime-stabilized red mud and fly ash, adding them in equal quantities along with 4% lime. The results show that red mud as well as red mud–fly ash improves the geotechnical properties of the soil.

2. MATERIALS AND METHODS

2.1 Materials

The materials used in the present work are black cotton soil and hydraulic lime.

2.1.1 Black Cotton Soil

Soil sample received was dried in sun. The clods were broken with wooden mallet. Organic matters like grass & roots and matters other than soil were removed. The geotechnical properties of selected soil are mentioned in table 1.

Table. 1 Geotechnical properties of selected soil

S.NO.	*CHARACTERSTICS*	*VALUE*
1	Liquid Limit, (%)	53
2	Plastic Limit, (%)	24
3	Plasticity Index, (%)	29
4	Classification (ISSCS)	CH
5	Maximum Dry Density, (g/cc)	1.7
6	Optimum Moisture Content, (%)	17
7	California Bearing Ratio, (%)	2.48
8	Free Swell Index	45

2.1.2 Hydraulic Lime

Lime used in this study is hydraulic lime. The term "hydraulic lime" covers materials that vary in properties such as setting times and strength development, but they are never to be thought of or used as a cement substitute. Hydraulic lime are characterized by good workability, low shrinkage, salt and frost resistance, adequate compressive and good flexural strength. The properties of hydraulic lime are influenced by the existence of certain impurities and by the methods of burning and slaking. If clays or other suitably reactive forms of silicates and aluminates are present in the original limestone the resulting lime will have hydraulic properties, i.e. it will have some ability to set in wet conditions.

2.2 Methods

2.2.1 Sample Preparation

Soil composites were prepared by mixing soil with 2%, 4%, 6%, 8% & 10% of lime by weight of dry soil. Mixing was done manually with proper care to make a uniform mix.

2.2.2 Tests

Laboratory tests have been carried out as per IS 2720 to find out the type and properties of virgin soil. For each soil composites experiments were performed to determine free swell index and CBR.

3. RESULTS AND DISCUSSIONS

3.1 Results

The results obtained from various laboratory investigations are summarized in table 2.

Table. 2 Summary of test results

S.NO	% LIME ADDED	FSI	CBR
1	0	45	2.48
2	2	36	4.5
3	4	29	6.1
4	6	21	7.9
5	8	16	9.2
6	10	12	9.1

3.2 Discussions

3.2.1 Variation of FSI

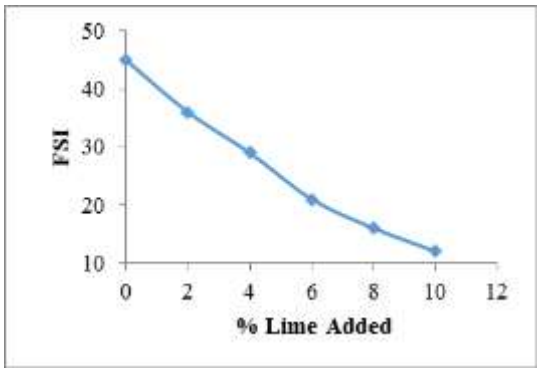

Fig. 1 FSI vs %lime

Fig 1 shows that addition of lime reduced swelling tendency of soil. The change is following decreasing trend throughout.

3.2.2 Variation of CBR

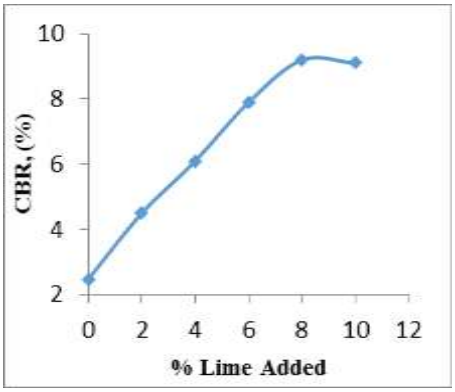

Fig. 2 CBR vs %lime

Figure 2 shows variation of CBR with varying percentages of lime in soil composite. Figure illustrates that with addition of lime, CBR of soil increased linearly. Maximum increase in CBR is observed at 8% lime content by dry weight of soil. However beyond 8% mix, the value of CBR did not show any considerable change.

4. CONCLUSIONS

1. Inclusion of hydraulic lime raised CBR of the soil. The increase is directly proportional to lime content to a maximum of 8% beyond which change is not significant.
2. Addition of lime also reduced swelling of soil. There is constant decrease in swelling as the content of lime is increased. Swelling reduced from FSI-45 to FSI-12 for 10% mix.
3. Based on results it may be concluded that addition of 10% lime can raise CBR and reduce swelling of weak expansive subgrades and hence is suitable as an additive for road stabilization.

References

[1] Muzahim et al., Microstructure and geotechnical properties of lime-treated expansive clayey soil, Elsevier, Engineering Geology 139-140 (2012) 17–27

[2] Guillaume et al., Multi-scale analysis of the swelling and shrinkage of a lime-treated expansive clayey soil, Elsevier, Applied Clay Science 61 (2012) 44–51

[3] Thyagaraj et al, Laboratory Studies on Stabilization of an Expansive Soil by Lime Precipitation Technique, (ASCE), J. Mater. Civ. Eng., 2012, 24(8): 1067-1075

[4] Sireesh et al, Swell-shrink and strength behaviors of lime and cement stabilized and expansive organic clays, (Elsevier), Applied Clay Science 85 (2013) 39–45