

Effect of Lime on Geotechnical Properties of Marine Clay

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ABSTRACT: This paper studies the influence of lime as a soil stabilizing agent. The soil used for the study was marine clay. Various laboratory tests were conducted at varying percentage of lime to find the optimum percentage of lime. The various test conducted was standard Proctor compaction test, Atterberg limits and Unconfined compression strength test. A significant change in the compaction characteristics and index properties of soil was found out. The strength of soil increases. The test results reveals that lime can be used as a soil stabilizing agent.

KEYWORDS: Marine clay, Compaction Characteristics, Atterberg limits, Unconfined compression strength.

I. INTRODUCTION

The most important part of any structure is underlying soil. The strength of soil is very important for the long life of structure. Generally clays are found to have low shear strength value and it is not suitable for construction. But now a day we are forced to build structures on such types of soil due to increased population and land scarcity. So soil with low shear strength values should be stabilized before it is used for construction purposes.

Various methods are practicing for soil stabilization all over the world. Chemical stabilization is one of such techniques. Soil stabilization using lime is an example for chemical stabilization. The optimum quantity of lime that gives maximum strength depends upon the properties of soil and quality of lime used. In this study a series of laboratory test were conducted to determine the suitability of lime as a soil stabilization material and optimum percentage of lime that gives maximum strength to the soil.

II. MATERIALS USED

II.A Soft clay

Soil used for the study was soft marine clay and it was collected from Vallarpadam, Ernakulam district, Kerala, India. The depth of soil collected was 5- 6 m from ground surface. Soil was black in colour. Large amount of moisture was presented in the soil. To remove the moisture, soil was air dried. Various laboratory tests were conducted to classify the soil and to determine the index properties and engineering properties of soil. The properties of soil are given in table 1.

II.B Lime

Lime is a general term that includes three different types, such as quick lime (CaO), hydrated Lime (Ca(OH)₂) and carbonate of lime (CaCO₃). Quick lime and hydrated lime are commonly used in soil stabilization. Lime used for this study was locally available quick lime.

Table 1: Properties of clay

Soil properties	Values
Colour	Black
Specific gravity	2.63
Grain Size Analysis	
Clay (%)	51
Silt (%)	46
Sand (%)	3
Consistency Limit	
LL%	76
PL%	27.6
PI%	48.4
SL%	22.5
Compaction Characteristics	
OMC%	24.3
MDD (kN/m ³)	14.94
UCS (kN/m ²)	31.3
CBR	1.47
Free swell index%	25

III. METHODOLOGY

The soil collected was air dried, pulverized and sieved through different sieves to perform various laboratory tests. The percentage of lime used was 2, 3.5 and 5% for compaction test and 2, 2.5, 3 and 5% for Atterberg limits and unconfined compressive strength test. The soil was replaced by the percentage weight of lime. The test conducted was standard proctor compaction test, Atterberg limits and unconfined compressive strength (UCS) test. All these test was carried out accordance with IS 2720.

IV. EXPERIMENTAL RESULTS

IV.A Compaction characteristics

Standard proctor compaction test was carried out as per IS: 2720 [Part VII], on soil treated with different percentage of lime. Percentage of lime used for the test was 2%, 3.5% and 5%. The result of compaction test is shown in Table 2. The result shows that for 2% of lime the optimum moisture content decreases and maximum dry density increases. Further addition of lime increases the OMC and decreases the maximum dry density. The reduction in dry density is due to the replacement of soil by lime in the mixture which has relatively lower specific gravity compared to that of the soil. The increase in OMC may be caused by the absorption of more water by the additives to carry out chemical reaction. Figure 1 and 2 represents the variation of OMC and MDD with different percentage of lime.

Table 2: Compaction characteristics of soil – lime mix

Percentage of lime	Optimum moisture content (%)	Maximum dry density (KN/m ³)
0	24.3	14.94
2	23.6	15.54
3.5	25.4	14.78
5	26.2	14.56

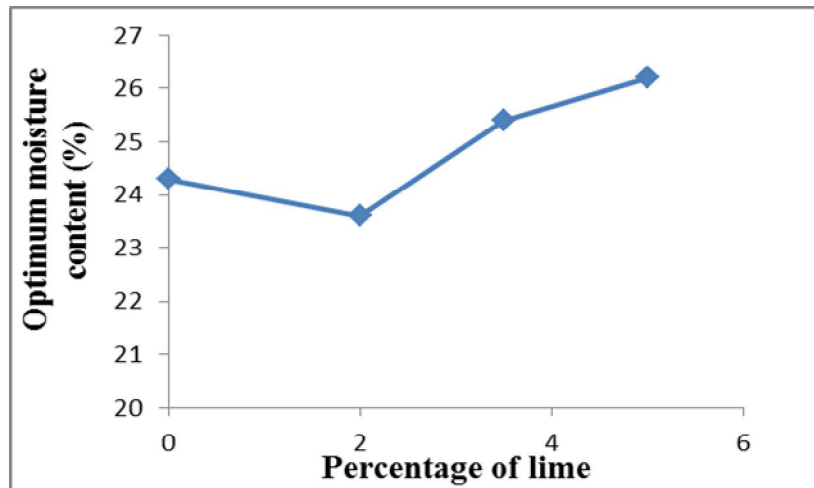


Fig. 1: Variation of OMC with lime

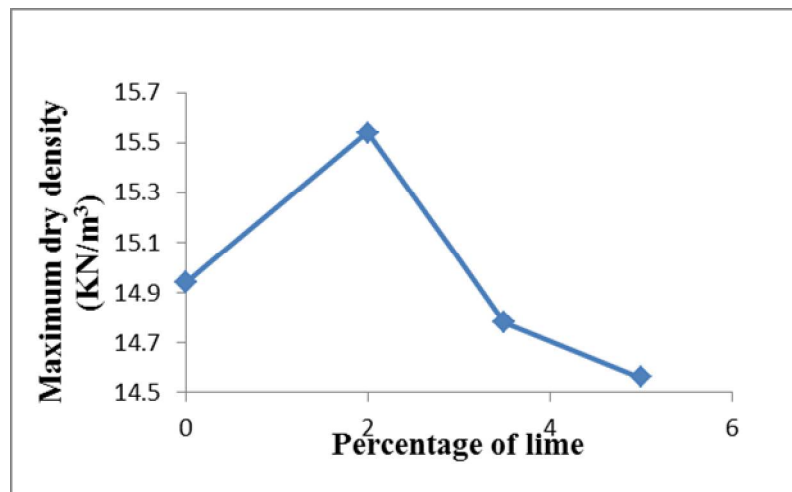


Fig. 2: Variation of M.D.D with lime

IV.B Atterberg limits

The liquid limit and plastic limit test were carried out as per IS: 2720 [Part V] and shrinkage limit test was carried out as per IS: 2720 [Part VI]. Soil was blended with 2%, 2.5%, 3% and 5% of lime. The test was carried out after giving 24 hours of curing period. The test results are shown in Table 3. Liquid limit of soil decreases with increase in percentage of lime, whereas plastic limit and shrinkage limit increases. Due to decrease in liquid limit and increase in plastic limit, plasticity index of the mix reduces.

Table 3: Variation of Atterberg limits with percentage of lime

Percentage of lime	Liquid limit (%)	Plastic limit (%)	Plasticity index (%)	Shrinkage limit (%)
0	76	27.6	48.4	22.6
2	60.4	34.1	26.3	23.5
2.5	57.1	34.7	22.4	24.6
3	54.7	35.4	19.3	25.3
4	53.8	36.1	17.7	26.6

IV.C UCS test

Unconfined compressive strength (UCS) test is the most common and adaptable method of evaluating the strength of stabilized soil. UCS test is the quick and approximate test for the determination of the required amount of additive to be used in stabilization of soil. The UCS test was carried out as per IS: 2720 [Part X]. Samples were prepared at its

optimum moisture content (OMC) and maximum unit weight. The prepared samples were wrapped in a plastic cover to avoid the loss of moisture and tested after 24 hours. The sample size was of 3.8 cm diameter and 7.6 cm length. Percentage of lime used was 2, 2.5, 3 and 4 percentages. It has been observed that the UCS values increase with addition of lime and reaches a maximum value, then it starts decreases. The test results are shown in Table 4. The optimum percentage of lime obtained was 2.5% and further addition of lime reduces the strength. Percentage increase in strength for optimum percentage of lime was 276%.

Table 4: Variation of UCS value with percentage of lime

Percentage of lime	UCS value (KN/m ²)	Percentage increase in strength (%)
0	31.3	---
2	108.1	245
2.5	117.8	276
3	87.0	178
4	79.3	153

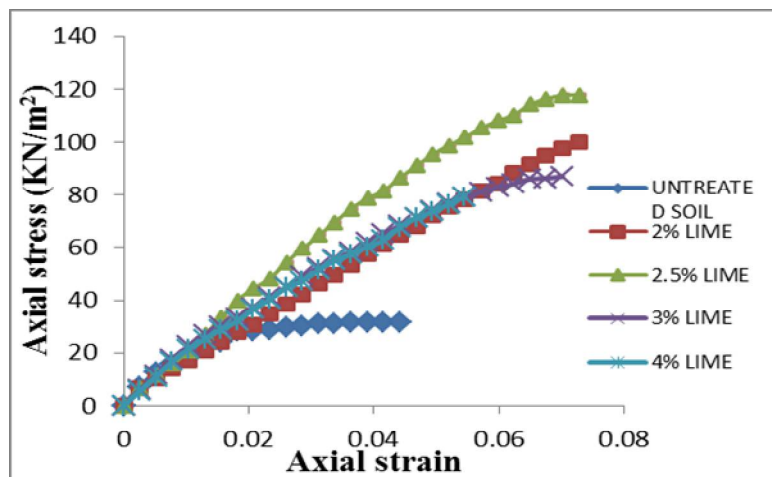


Fig. 3: Stress V/S strain curve for soil lime mix

v. CONCLUSION

Based on the laboratory test conducted on soil-lime mix, it was found that lime can be used as an effective soil stabilization agent. Based on the compaction characteristics it is found that, with increase in percentage of lime, MDD decreases and OMC increases. Addition of lime decreases the liquid limit. Plastic limit and shrinkage limit of soil increases with increase in percentage of RHA. Based on the UCS test, the optimum percentage of lime obtained was 2.5%. The UCS value of the soil increased from 31.3 kN/m² to 117.8 kN/m² for 2.5% of lime. The percentage improvement in strength was 276%. From test result it is clear that, lime can be used as a soil stabilization agent.

REFERENCES

- [1] Shrivastava *et al*, "Effect of lime and rice husk ash on index properties of black cotton soil", International Journal of Engineering Sciences & Research Technology, pp. 4030-4034, vol. 3, No. 4, April 2014,
- [2] A. J. Choobasti *et al*, "Influence of using rice husk ash in soil stabilization method with lime", Front. Earth Sci. China, pp. 471-480, vol. 4, No. 4, May 2010.
- [3] Sabyasachi Biswas *et al*, "Utilization of rice husk with lime in subgrade soil for a rural road", International Conference on Emerging Frontiers in Technology for Rural Area (EFITRA) 2012 Proceedings published in International Journal of Computer Applications (IJCA)
- [4] Jijo James *et al*, "Effect of lime on the index properties of rice husk ash stabilized soil", International Journal of Applied Engineering Research, pp. 4263-4272, vol. 9, No. 18, 2014.
- [5] Dilip Shrivastava *et al*, "Effect of lime and rice husk ash on engineering properties of black cotton soil", International Journal of Engineering and Innovative Technology (IJEIT) , pp. 292-296, vol. 3, No. 2, May 2014.
- [6] D. Koteswara Rao *et al*, "A laboratory study on the effect of rice husk ash & lime on the properties of marine clay", International Journal of Engineering and Innovative Technology (IJEIT), pp. 345-353, vol 2, Issue 1, July 2012.
- [7] Akshaya Kumar Sabat, "Effect of polypropylene fiber on engineering properties of rice husk ash – lime stabilised expansive soil", EJGE, pp. 651-660, vol.17, No.1, 2012.