EFFECT OF LIME AND SODIUM SILICATE ON THE STABILIZATION OF SOIL

Subzar Ahmad Mir[1], Er Vishal Yadav[2]
[1]Research Scholar, Department of Civil Engineering, Desh Bhagat University Mandi Gobindgarh Punjab
[2]Assistant Professor, Department of Civil Engineering

Abstract; Soil is the basic foundation for any civil engineering structures. It is required to bear the loads without failure. In some places, soil may be weak which cannot resist the oncoming loads. In such cases, soil stabilization is needed. Soil stabilization can be explained as the alteration of the soil properties by chemical or physical means in order to enhance the engineering quality of the soil . This paper deals with the complete analysis of the improvement of soil properties and its stabilization using lime and sodium silicate. Road damage is commonly observed when it is founded on weak sub grade. Hence soil stabilization is essential. The soil is treated with lime and sodium silicate with different percentages.

Key Words; Lime, Sodium Silicate, Unconfined Compression Test, CBR Test, Standard Proctor Test

1.Introduction

Many parts of the world are facing problems in construction work due to clayey soil or black cotton soil or expansive soil. Damages to structure and road pavements has been reported regularly and many losses occur in term of lifes and money. Replacement of soil will suitable one but it is costly process and this is difficult in developing country like ours where cost of construction is so high. Moreover pavement on clayey soil requires a more thickness of base, sub-base course which directly increases construction cost of project. To overcome this problem it is necessary to increase the strength of the soil which in-turn will help reducing the thickness of the pavement layers and so project cost. There are many stabilizers like fly ash, rice-husk ash, lime, sodium silicate, jute, gypsum tyres etc. are used to strengthen the properties of soil. So, In the present study, we added Lime and sodium silicate as stabilizer to increase the engineering properties of clayey soil.

2.Literature Review

Mitchell et al. (1961) Researchers have illustrated the impact of lime addition on the strength of clay soils depends on several factors. These include, soil type, curing time and method, moisture content, soil unit weight and time elapsed between mixing and compaction.

Al-Rawi et al. (1981) Comparatively fewer studies have focused on the impact of lime stabilization on the compressibility as much as by the shear strength. in addition, sodium silicate as a glass material can be used efficiently in soil stabilization because it is cheap and available. This work shows that the sodium silicate can improve the geotechnical properties by increasing strength of soil and reducing its volume change.

Bell et al. (1988) The amount of lime is known as lime fixation.When the lime in excess of lime fixation is added to soil and water, silicones and aluminous material in clays enter into alumina silicate complexes having binding property that participate on the soil grains and holds the grain property that participate on the soil grains and holds the grains together. With passage of time, the lime soil transforms into a hardened mass having strength of sustain loads(Bell, 1988). Thus addition of lime in excess of modification optimum contributes to increase in strength. It is observed that if lime is 4 percent above the modification and resistant to frost provided soil activity is 0.75 or less.

Dal Hunter et al. (1988) For effective stabilization, a soil must have not less than 15% fraction passing a 425 micron sieve and its plasticity index should be at 10. The organic content should not be more than 20% and the sulphate content should be more than 0.2% impurities such as sulphates of calcium and sodium induces considerable have in lime soil. Hence it is desirable that the hydrated lime should be free of such impurities. For proper mixing the soil should pulverized to about 25mm and smaller size, about 50 to 60% passing a 4.75
Pulverization and mixing of soil and lime in the field can be done manually or mechanically. The mix is contacted at OMC making allowance for moister loses .it is recommended that all compaction should be completed within four hours after mixing of soil , lime, and water . the base should be cured for 7 to 28 days under moist conditions.

Goswami et al. (2007) In their study of the leaching characteristics of residual lateritic soils stabilized with fly ash and lime for geotechnical applications. With the help of single batch leaching test and column leaching test for different soil-fly ash-lime mixes found that the high pH induced by lime treatment of the mixes helps in keeping most of the metals within the stabilized soil matrix. The release response for different metals was different. The observed characteristics provide insights towards the potential and realistic estimates of leaching of metals and its variation due to change in fly ash and lime content in the stabilized mix. concentration for drinking water recommended by the World Health Organisation (WHO).

3.Methodology

3.1Material properties ;The materials used to stabilize the soil are soil, lime, sodium silicate, water. The properties of these materials are presented below.

Table 3.1.1 Properties of soil;

1.	Colour	Light Brown
2.	Liquid limit (%)	48.47
3.	Plastic limit (%)	26.67
4.	Maximum dry density (gm/cc)	1.7
5.	O.M.C (%)	16.50
6.	Unconfined compressive strength (kg/sq.cm)	4.10
7.	(a) CBR (%) Unsoaked (b) CBR (%) Soaked	6.2 3.2

Table 3.1.2 Properties Of lime;

1.	Minimum assay(Acidic-metric)	90%
2.	Maximum limit of impurities	-
	(a) Chlorides	0.04%
	(b)Sulphates	0.04%
	(c)At,Fe and insoluble matter	1%
	(d)Arsenic	0.0004%
	(e)Lend	0.0004%

3.1.3Water

Ordinary potable water from tap was used throughout the study. The water was neat, clean and without any suspension material.

3.1.4 Sodium silicate

Sodium silicate used in experimental programme was bought from Amorphous Chemicals Srinagar. The price of sodium silicate was 30 rupees per kilogram. It is used in powder form in the experiments.

3.2 Various tests performed;

(a) Standard proctor test for determination of O.M.C and maximum dry density.

(b) Unconfined compressive strength test.

(c) California Bearing Ratio test.

4. Results and Discussion

4.1 Results and observation table for proctor test (light compaction);

Table 4.1.1 Variation of maximum dry density of soil samples having different percentages of lime (sodium silicate = 0%)

Sr.no.	Lime%	Maximum dry density(gm/cc)
1	0	1.70
2	2.5	1.63
3	4.5	1.57
4	6.5	1.52

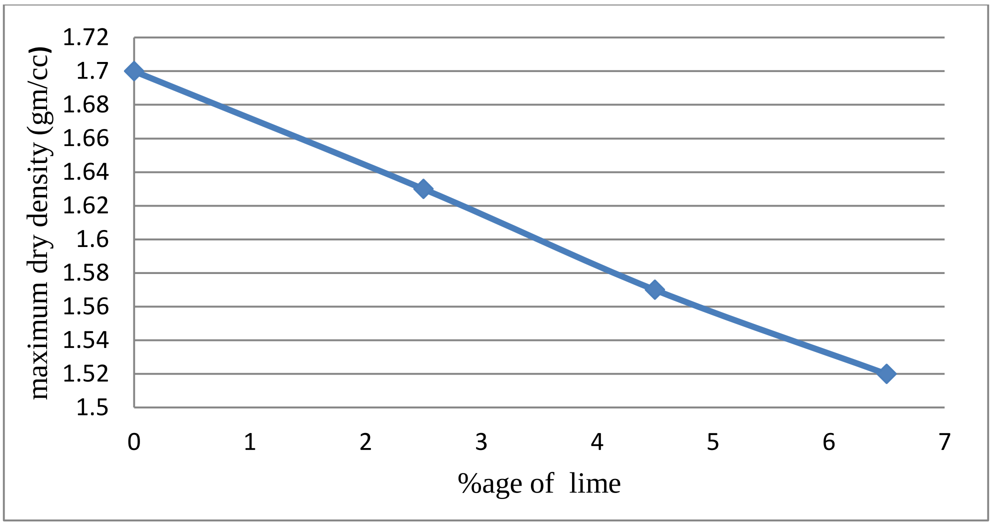

Figure 4.1.1 : Maximum dry density variation with different percentages of lime [sodium silicate 0%]

4.2 Results and observation for unconfined compression test

Table4.2.1 Unconfined compressive strength of various cured sample having different percentages of lime and sodium silicate

Sample No.	Soil+Lime	Sodium silicate (%)	Unconfined compressive strength (kg/cm²)
1	Soil +2.5%	0	5.78
2	Soil +2.5%	1.5	7.45
3	Soil +2.5%	2.5	8.40
4	Soil +2.5%	3.5	7.18
5	Soil +4.5%	0	7.50
6	Soil +4.5%	1.5	9.35
7	Soil +4.5%	2.5	10.27
8	Soil +4.5%	3.5	9.38

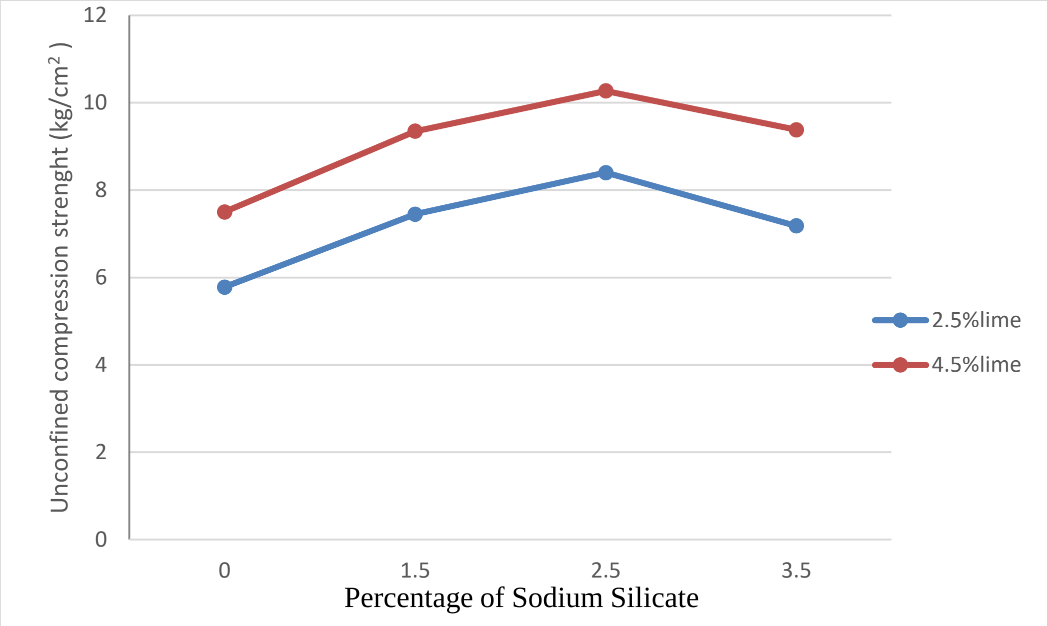

Figure 4.2.1 : Variation of unconfined compression strength of cured samples having different percentages of sodium silicate

Table 4.3 CBR values and percentage increase in CBR values of different soil samples at specified penetrations (2.5 and 5.0mm).

Types of soil mix	CBR value %				%age increase in CBR			
	2.5mm penetration		5.0mm penetration		2.5mm penetration		5.0mm penetration	
	Unsoaked	Soaked	Unsoaked	Soaked	Unsoaked	Soaked	Unsoaked	Soaked
Virgin soil	6.0%	3.0%	6.9%	3.12%	_	_	_	_
Soil + lime 4.5%	15.6%	5.4%	14.9%	5.21%	160%	80%	115.9%	66.9%
Soil +lime 4.5% +sodium silicate 2.5%	18.7%	8.6%	18.8%	8.15%	211%	186%	172.4%	161.2%

5. CONCLUSION

1. Lime acts immediately and improves various properties of soil such as resistance to shrinkage during moist conditions, reduction in plasticity, increase in CBR value and subsequent increase in the compression resistance with the increase in time.

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

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

4. The maximum dry density decreased by the addition of lime and sodium silicate to the soil.

5. The optimum moisture content increased by the addition of lime and sodium silicate to the soil.

6. The unconfined compression strength increased by 137% for uncured sample of soil + 4.5% lime + 2.5% sodium silicate mix as compared to virgin soil. The increased in unconfined compression strength for cured sample of soil + 4.5% lime + 2.5% sodium silicate was 152% as compared to virgin soil.

7. The California bearing ratio of soil + 4.5% lime increased by 160% (unsoaked) and 80% (soaked) at 2.5 mm penetration, and 115.9% (unsoaked) and 66.9% (soaked) at5.0 mm penetration.

8. The California bearing ratio of soil + lime 4.5% + sodium silicate 2.5% increased by 211% (unsoaked) and 186% (soaked) at 2.5 mm penetration, and 172.4% (unsoaked) and 161.2% at 5.0 mm penetration.

REFRENCES

[1] AI.Rawi (1981), "Behavior of Granular Soils Reinforced with Discrete Randomly Oriented Inclusions," J.Geotextiles and Geomembrances , Geotextile Society, Elsevier Science Publishers,England,10(4),pp.319-333

[2] Bell, F.G. (1988),"Randomly Distributed Fibre Reinforcement Soil ."The state of the art, "Indian Geotechnical Journals,Vol. 70.

[3] Cokca (2001), "Jute Geotextile : An Ideal Ecofriendly ,Cost Effective Geo-textile."

[4] Dall Hunter (1988), "Lime induced heave in sulphatebearing clay soils," Journal of Geotechnical Engg.Div.ASCE, Vol. 114,No. 2

[5] Goswami (2007), "Standardization of Geosynthastics materials and test methods in India an approach,"

[6] Mitcher (1981), "Performance studies on California Bearing ratio Value Geosynthetics."

[7] Andersland and Khattak, (1979), "Shear strength of KaolinitieFibre Soil Mixtures ," Proceedings, International Conference on soil reinforcement , Vol. I, Paris .France,pp.11-16

[8] Arora ,K.R., "Soil Mechanics and Foundation Engineering,"

[9] Bansal ,R.K . and Jain A. (2000), "Advance in Ground Improvement Techniques,"