COMPARATIVE STUDY OF SOIL STABILIZATION USING LIME AND CEMENT

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***Abstract*: Soil stabilization can be explained as the alteration of the soil properties by chemical or physical means in order to enhance the engineering properties of the soil. The key goal of the soil stabilization is to increase the bearing potential of the soil, its weathering resistance and permeability to water. The long-term performance of any building project depends on the soundness of the underlying soils. Unstable soils may cause major problems for pavements or structures, therefore soil stabilization techniques are necessary to ensure the good soil stability so that the load of the structure can be maintained effectively, particularly in highly active soil, as well as saving time and money compared to the method of cutting and replacing unstable soil. This paper presents an analysis of Cement and Lime as the admixture in improving the maximum dry density (MDD), optimum moisture content (OMC), California Bearing Ratio (CBR).**

1. INTRODUCTION

Soil stabilization is a helpful procedure for road, runway development and other major civil engineering projects. To use this technique fully, the quality control must be satisfactory. Soil stablization is the modification by mechanical or chemical means of one or more soil properties to create an improved soil material having required engineering properties. Soils may be stablized to enhance shear strength and durability or to prevent dust generation and erosion. The main motive of the soil stablization is the creation of soil material or soil system that will remain in place under the design conditions for the design life of project. The responsibility of good geotechnical engineer is to select or specify correct method or technique of stablization and quantity of material required. The objective of this study is to help engineers to make adequate decisions. The properties of soil changes from place to place so different parts of the world have different soils of variable engineering properties.

The whole system of road network in developing nations like india, Pakistan, china etc is not easy due to restricted finances available for the development and construction of roads.The shortage of usable land resources and the increased cost of using high quality materials have contributed to the need for local soils to be used in geotechnical projects. However, poor engineering characteristics of these soils cause troubles for construction projects and need to be stabilized to enhance their properties. The stabilization of soil for use in roadbed is an econmical replacement of expensive paving materials. A variety of ground improvement techniques such as the use of prefabricated vertical drains or soil stabilization can be used to improve certain necessary properties such as bearing capacity, shear strength and soil permeability characteristics. Various additives, which may be used for ground modification such as cement, lime and minerial additives such as flyash, silica fume and rice husk have been used under various contexts. On the other hand, extensive studies have been carried out on the stablization of weak soils using various additives mentioned above. There are so many methods for soil stabilization, either mechanical or chemical, but all of them require skilled manpower and equipment to ensure adequate performance.

This paper is an attempt towards the study of cement and lime as the admixture in improving the maximum dry density, optimum moisture content, california bearing ratio. The aim of this work is to estimate the effect of cement and lime on some geotechnical properties of soil, in order to determine their suitability for use as a modifier in the treatment of soil for roadwork

1.1 NEED AND SIGNIFICANCE OF THIS WORK

Liquefiable soils cover large areas in Jammu and Kashmir. These areas include most of the nation's population centers and development schemes. These soils cause high risk to buildings and roads. Therefore, soil stabilization is only possible way to prevent soil against heiving. Research was carried out to improve the engineering properties of soils by chemical additives for improving performance as foundation soils and/or road subgrades. The characteristics that affect the performance of structures laid over liquefiable subgrades are: the very low wetted strength; the potential of heave, especially for lightly loaded structures.It was followed during

1989 Loma Prieta earthquake that the places underlain by deep deposits of soft soils experienced peak ground acceleration two to three times greater than that a nearby sites on stiff soils or rocks.

2. LITERATURE REVIEW

Mr R Prabhakaran in 2019 published a paper that deals with the comparative study on soil stabilization using lime and cement. He uses lime and cement upto 15%. He conducted various tests including liquid limit test plastic limit test cbr test and unconfined compressive strength test. The findings shows that upto 10% substitution is possible beyond 10% the value goes on decreasing in all the tests.

Nivetha babu,emy poulose in november 2018 concluded that the objective and principle of the soil stabilization is to increase the bearing capacity of soil.And in this paper the properties has been discussed clearly and advantages and disadvantages of the lime can be identified very clearly.

A.A. Adavi in 2017 published a paper that deals with theGeotechnical and environmental evaluation of lime-cement stabilized soil. In this work he conducted various experiments which includes California bearing ratio test, unconfined compressive strength test and leaching test. The findindsshow that California bearing ratio strength and unconfined compressive strength values increased. In the leaching test it shows that the binder was able to reduce the heavy metals in the leachate below the regulatory level.

LK sharma in 2017 published a paper that deals with the experimental study to examine the independent roles of lime and cement on the stabilization of mountain soil.The test which he perform was compressive strength test which showed that the compressive strength at 28 days increased 2 to 6 times than that of the untreated specimen. It also shows that the cement has a relatively higher influence on the mechanical behavior of soil as compared to lime.

N.G. Delbridgin 2017 that deals withthepozzolanic reactivity of four fly ashes having different properties is evaluated using unconfined compressive strength of lime fly ash mortars as the criterion of reactivity. The results demonstration that carbon content of fly ash is generally a greater effect on strength of the mortar and appears to a reliable indicator of fly ash reactivity.

R.K. Viskochil in 2014 published a paper that deals with the strength of an artificially cemented soil mass such as soil cement or soil, lime, and fly ash.Assessment of the information on compressive strength shows that density is profoundly significant variable. Compaction to above standard Proctor density expanded 7-day qualities on the normal 100 percent and 28 day qualities 70 percent. A higher compaction to adjusted Proctor density raised the normal to 120 and 110 percent. Compaction to a super-altered Proctor expanded the midpoints to 150 and 130 percent over qualities recently acknowledged at standard Proctor density. The sediment demonstrated impact from over compaction, however the impact evaporated on 28-day curing.

Ehammed A. Basha in 2011 published a paper that deals with thethe laboratory study on the stabilized soils with cement and rice husk ash. The experimental study included the assessment of such properties of the soil as consistency limits, compaction, unconfined compressive quality, and X-Ray diffraction. Three sorts of soils are utilized in these examinations i.e., granite residual soils. Test outcomes show that both concrete and rice husk debris decreases the plasticity of soils. In term of smaller capacity, expansion of debris and concrete declines the most extreme dry thickness and expands the ideal dampness content. From the perspective of plasticity, compaction and quality attributes, and economy, expansion of 6 – 8 percent concrete and 10 – 15 percent rice husk debris are suggested as an ideal sum for soils adjustment.

3. METHODOLOGY ADOPTED

Laboratory experiments were performed on untreated soil samples and treated with varying percentage of quick lime and ordinary Portland cement. The consistency limits, compaction characteristics, California Bearing Ratio tests were conducted.

4. EXPERIMENTAL INVESTIGATION

A number of experiments have been conducted on test soil and soil mixed with additives such as Cement and lime. The experiments have been carried out to determine various properties as mentioned below:

1) Specific Gravity

2) Sieve Analysis

a) Mechanical Sieving b) Hydrometer Test
3) Atterberg's Limits (Liquid Limit, Plastic Limit and

Plasticity Index

4) Proctor Compaction Test

5) California Bearing Ratio (CBR) Test

5. RESULTS AND DISCUSSION

The additives such as cement and lime have added to the soil in ratios as 0%, 3.5%, 6.5%,

9.5%, 12.5% and 15.5% by weight.

Properties of test soil

Various tests have been conducted on virgin soil taken from sopore area, baramulla, India, to determine different properties of soil. The properties of Virgin Soil are given in Table 4.

Property	Value
Specific gravity	2.70
Gravel and sand size particles	8.22
Silt and clay size particals	91.78
Liquid limit	15
OMC	15.35
MDD	1.578g/cc
CBR	4.73

Table 4: Properties of virgin soil sample

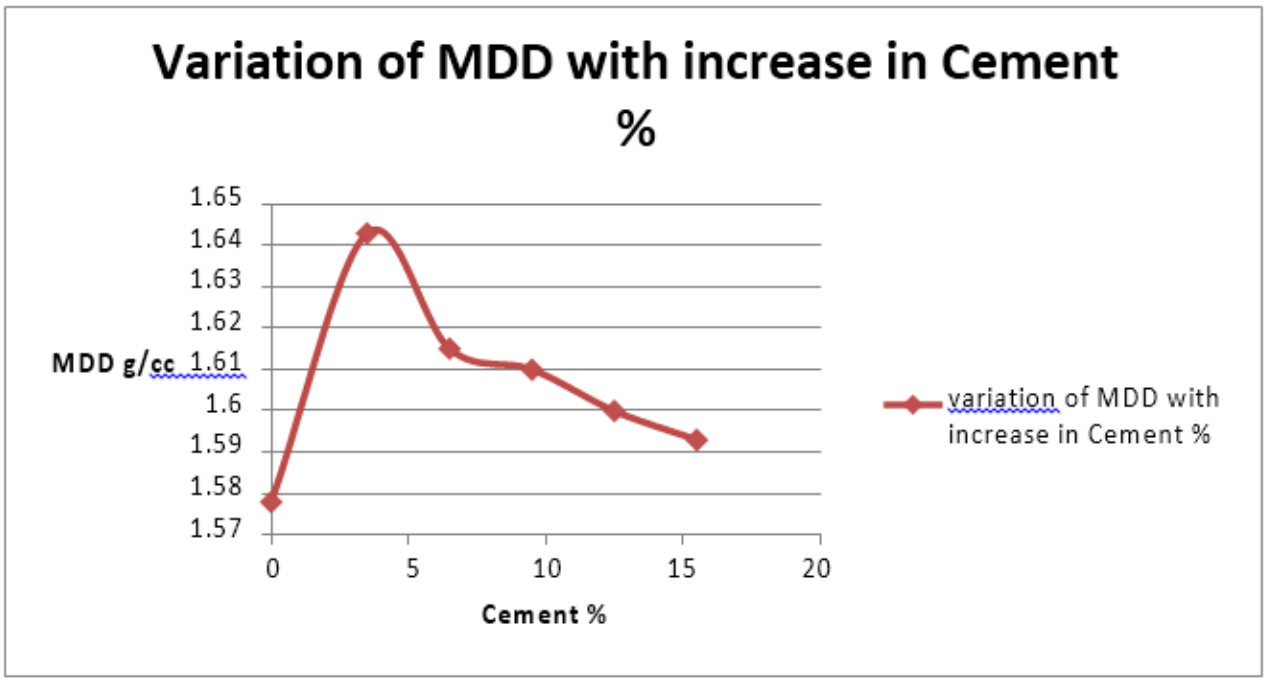

Figure 5: Variation of MDD with percentage of cement

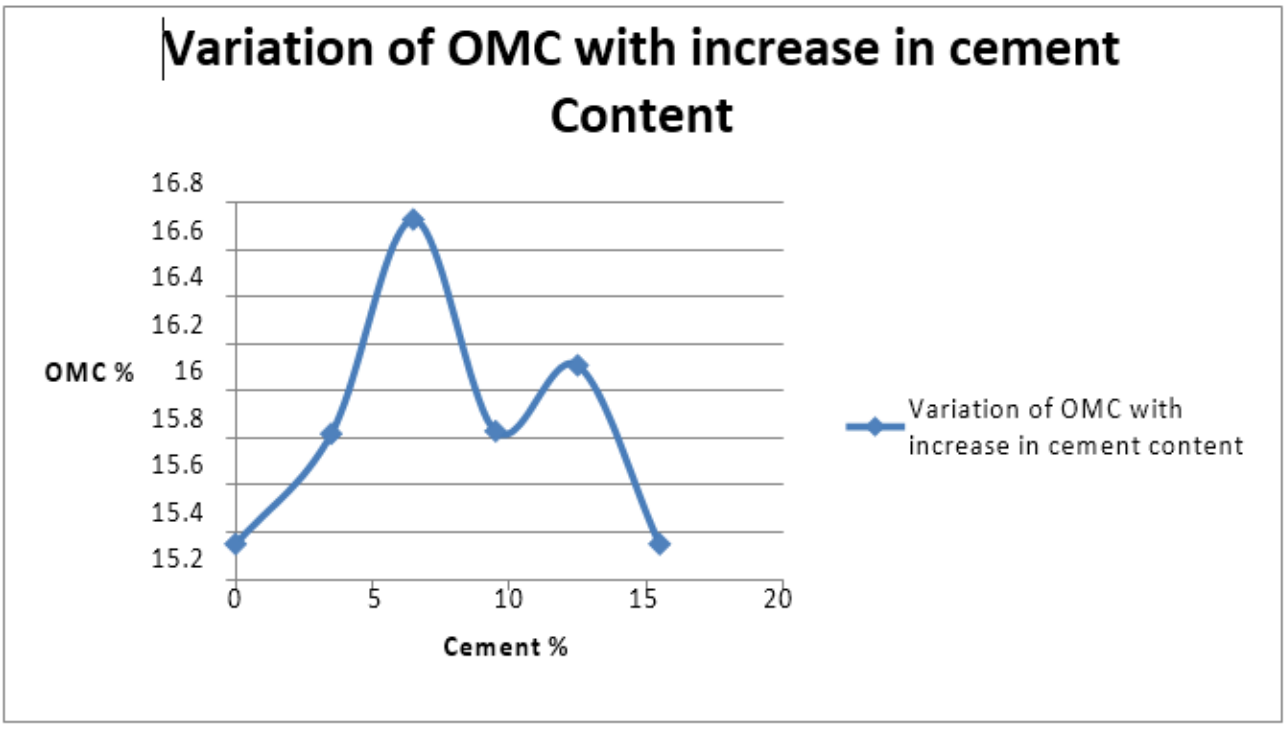

Figure 6: Variation of OMC with percentage of cement

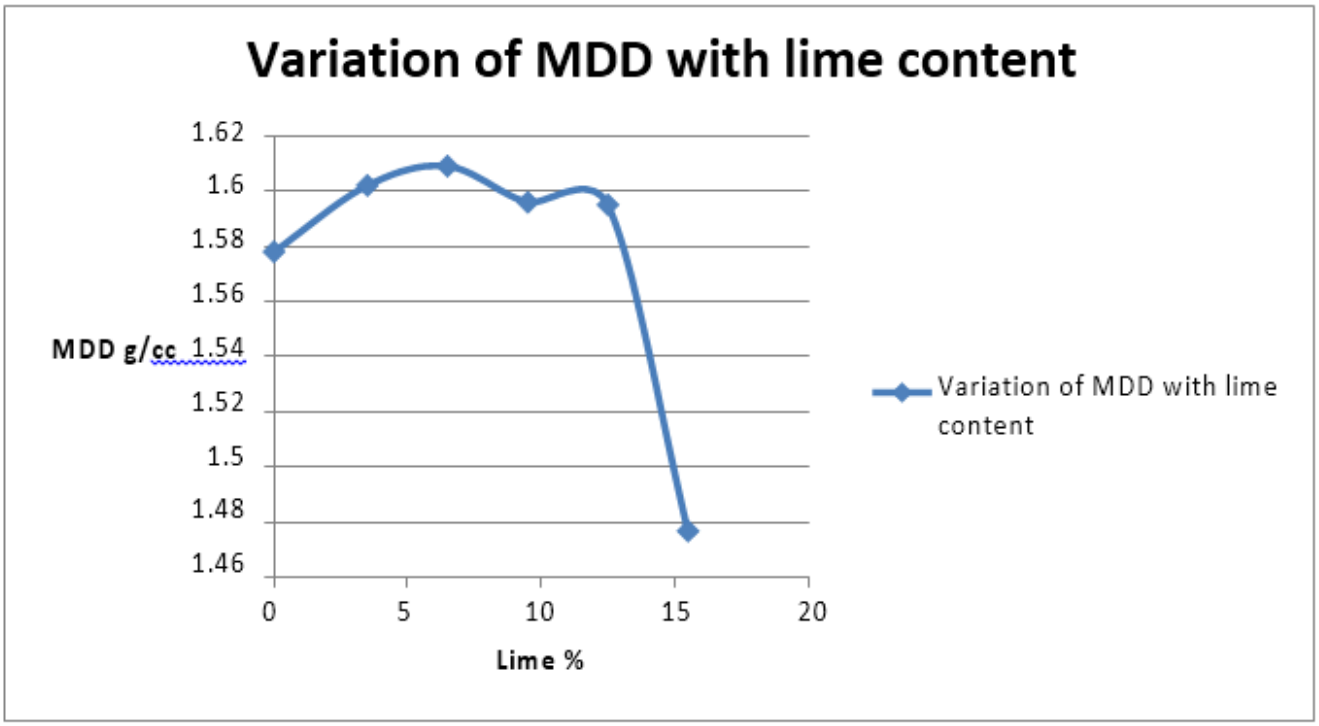

Figure7: Variation of MDD with percentage of lime

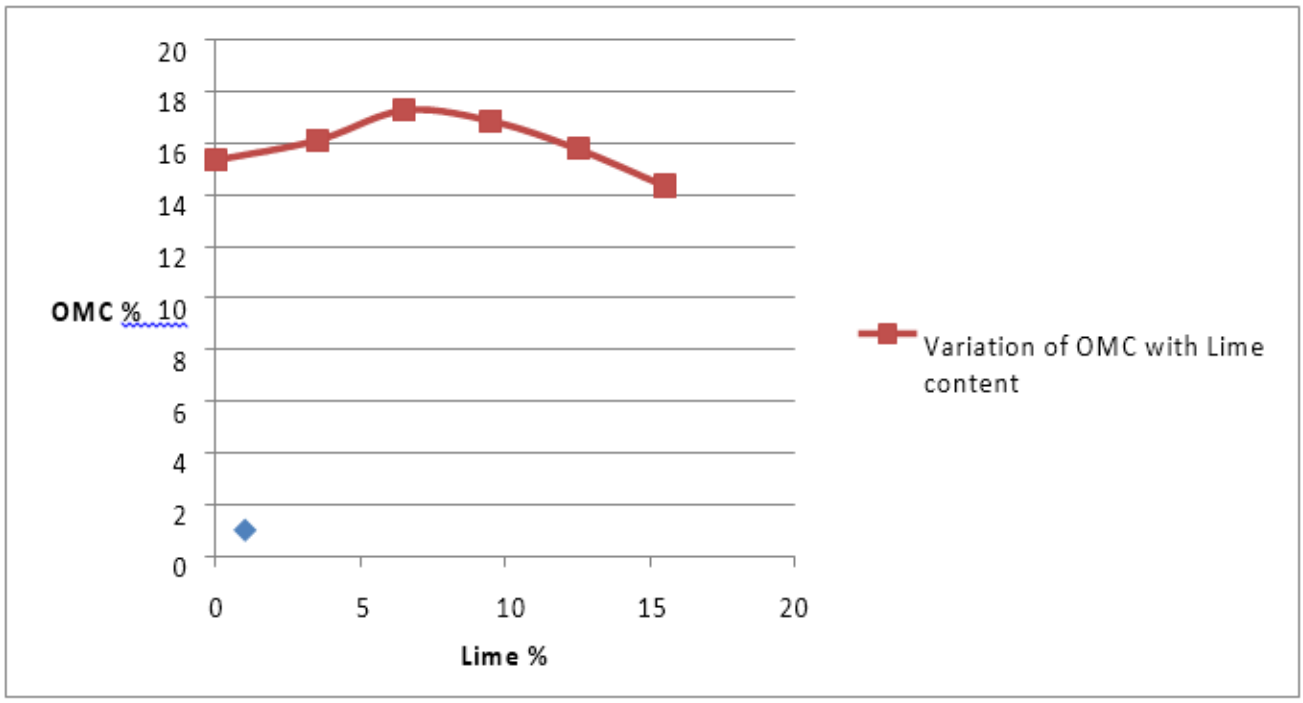

Figure 8: Variation of OMC with percentage of lime

5.3 California Bearing Ratio (CBR) Test on Soil Mixed with Additives

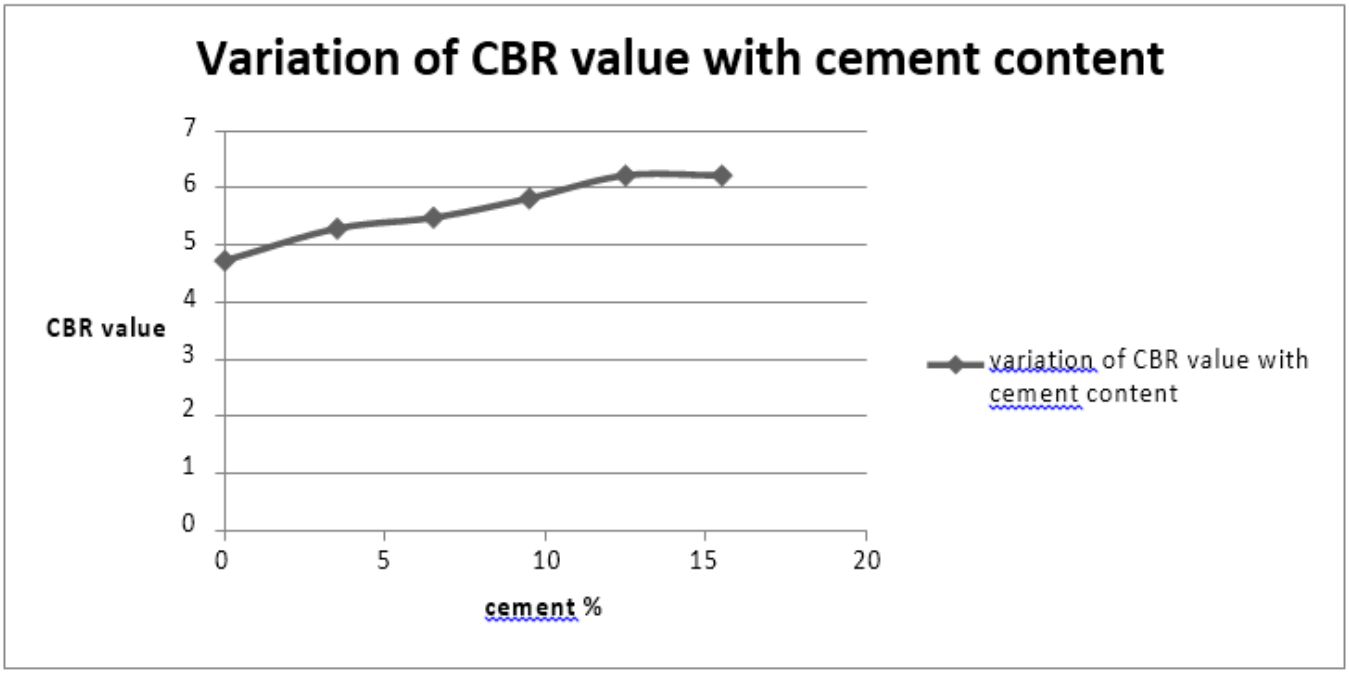

Figure 9: Variation of CBR value with cement content

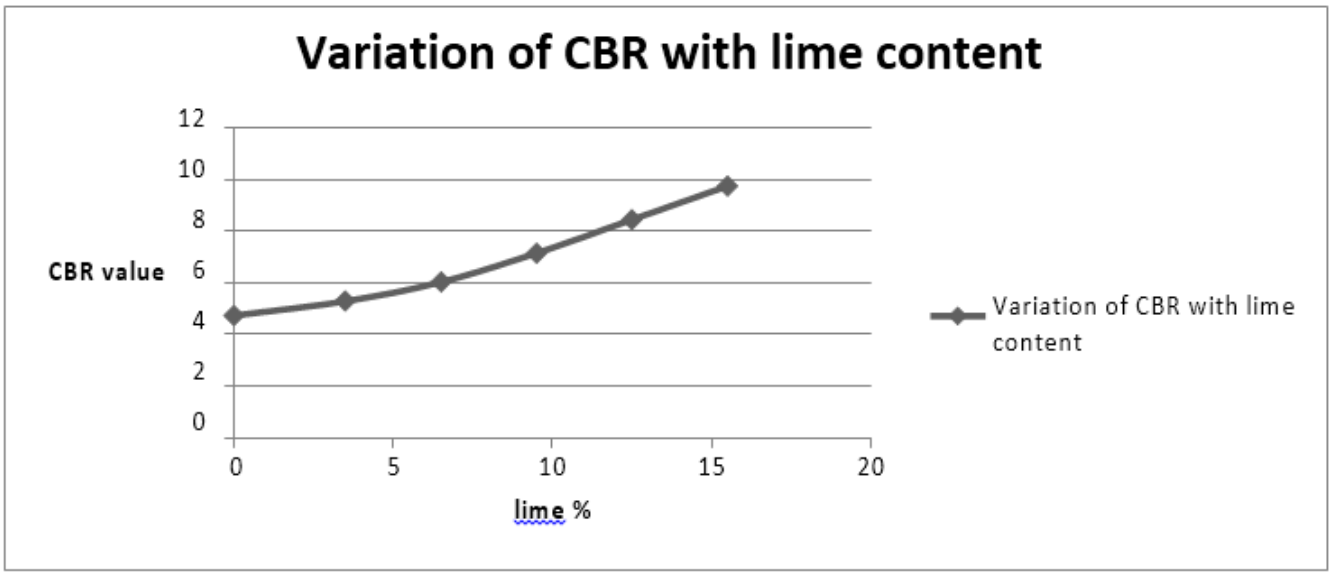

Figure 10: Variation of CBR value with lime content

CHAPTER-6

CONCLUSION

Based on the experimental data collected and analysed, for soil (ML in present case), replaced with cement, lime & fly ash in six different proportions (0-15%), the main conclusions may be drawn as given below:

6.1 For soil only:

a) The specific gravity of the soil used is 2.727 and has been classified as ML soil (Inorganic silts with none to low plasticity) with LL, PL, PI, OMC and MDD as 15, 13.53, 1.47, 17.47% and 1.678 g/cc respectively.
b) The CBR value obtained experimentally is 4.73.

6.2 Soil mixed with cement in different proportions

a) The optimum moisture content changes from 15.35% to 15.25% and shows increasing and then decreasing trend with increase in % addition of cement from 0% to 15.5% with a maximum value at 6.5%.
b) The dry density changes from 1.578 to 1.593 and shows an increasing and then decreasing trend with a maximum value at 3.5%.
c) The experimentally obtained CBR values shows a continuous increasing trend with maximum value as 6.22 for 15.5% addition of cement which is about 31% more compared with
0% addition of cement.

6.3 Soil Mixed with Lime in Different Proportions

a) The optimum moisture content changes from 15.35% to 14.35% and shows increasing and then decreasing trend with increase in % addition of lime from 0% to 15.5% with a maximum value at 6.5%.
b) The dry density changes from 1.578 to 1.477 and shows an increasing and then decreasing trend with a maximum value at 6.5%.
c) The experimentally obtained CBR values shows a continuous increasing trend with maximum value as 9.75 for 15% addition of lime which is about 98% more compared with 0% addition of lime.

The final conclusion that may be drawn that the % increase in CBR value is about 98% for selected soil sample +15.5%Lime i.e. soil sample stabilized with 15% addition of lime in comparison with raw soil sample. Further, other sample of cement added to soil sample shown an increase of 31%. This shows that the CBR value is higher for lime stabilized soil sample as compared to soil samples stabilized with cement. While lime alone works well as a stabilizer, a combination of lime and fly ash is beneficial for low plasticity, higher silt content soil.

REFERENCES

1. L K Sharma -the experimental study to examine the independent roles of lime and cement on the stabilization of mountain soil,Applied clay science volume ,Feb
2018,pages 183-195 .
2. Nivetha babu,Emy poulose,Effects of lime on soil properties,vol.2,November 2018.
3. AA-Adavi ___Geotechnical and Environmental evaluation of lime-cement stabilized soil,transportation geotechnics volume 10,march 2017 pages 1-12
4. N.G Delbridge, jr.First Lieutenant,Reactivity of four types of fly ash with 2017,vol.4.
5. N Krithiga-Soil stabilization using lime and fly ash 2016 volume 8
6. SK Grag "Soil Mechanics and Foundation engineering" Kanna Publishers. 2009.
7. R.K.Vishkochil,Effect of density on strength of lime fly ash stabilized soil,vol.9,2014
8. Ehammed A.Basha,Stabilization of clay and residual soils using cement-rice husk mixtures,vol.5,2011.
9. Bureau of Indian Standard(1980), Method of Tests for Soil, Part III, Determination of Specific Gravity, IS2720, B.I.S, New Delhi.
10. Bureau of Indian Standard(1980) Method of Tests for Soil, Part VII, Determination of Water content-Dry density relation using light compaction of soil, IS2720, B.I.S, New Delhi.
11. F.G. Bell, "Lime stabilization of clay minerals and soils," Engineering geology, 4th ed.,vol. 42, pp. 223-237, 1996.
12. H. Khelifa, M. Ghrici, S. Kenai, G. Khaled (2011), "Use of Natural Pozzolana andLimeforStabilization"Geotech Geol Eng, Vol. 29, Issue 5, pp 759-769.
13. Axelsson, K., Johansson, S., and Andersson, R. (2002)- —Stabilization of organic soils by cement and Pozzolanic reactions -Feasibility study. Swedish Deep Stabilization Research Center Rep. No. 3, Swedish Geotechnical Institute, Linkoping, Sweden.
14. Elective Ibtehaj Taha Jawad, Mohd Raihan Taha, Zaid Hameed Majeed SoilStabilization Using Lime: Advantages, Disadvantages and Proposing aPotential, vol. 8, 2010.
15. Jagmohan Mishra ,R. K.Yadav & A. K. Singhai "Effect Of Granite Dust On Engineering Properties Of Lime Stabilized Black Cotton Soil" IJERT-2014.
16. H.M. Greaves, "An introduction to lime stabilization," Proceedings of seminar on lime stabilization, Loughborough University, Thomas Telford, London, pp. 5-12, 1996.17. N. Krithiga, D. Pujitha, T. Palayam, A. Revathy Sri Muthukumaran, Soilstabilization using lime and fly ash, 2016, vol. 08, DOI: doi.org/10.31033/ijemr.v8i02.11965.
18. Manuel Mateos R.K. Katti, Activation of the lime fly debris response by tracechemicals, vol. 3, 2015.
19. Bagui, Swapan Kumar (2012), "Asphalt Design for Provincial Low Volume Roads Using Cement and Lime Rewarded Base", Jordan Journal of Civil Engineering, Vol. 6, pp. 293-303.

20. BIS (2006). "IS: 2720 (Part 5)-1985-Indian Standard Methods of Test for Soil, Part 5: Determination of Liquid and Plastic Limit (Second Revision)", Bureau of Indian Standards, New Delhi.
21. Neeraj Sharma, Stabilization of a clayey soil with fly debris and lime, vol. 6, June2012.
22. Monica Malhotra, Sanjeev Naval, "Stabilization of Expansive Soils Using Low Cost Materials" International Journal of Engineering and Innovative Technology vol-2, 2013
23. Dr. B C Punmia, Ashok Kumar Jain, Arun Kumar Jain ,"Soil Mechanics And Foundations" Laxmi Publications Pvt. Ltd. 16th Edition.
24. Akshaya Kumar Sabat "A Review Of Literature On Stabilization Of Expansive Soil Using Solid Wastes" EJGE-2014.
25. Dr. Ravi Kumar Sharma & Chayan Gupta "Influence Of Waste Materials On Geotechnical Characteristics Of Expansive Soil" IJERT-2013.