Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 5, No.13, May : 2024

USES OF LIME AND FLY ASH IN THE STABILIZATION OF EXPANSIVE SOILS

Gudiya Kumari PG Student, Department of Civil Engineering, Technocrats Institute of Technology-CSE Bhopal, India
Dr. Kashfina Kapadia Memon Professor, Technocrats Institute of Technology, Bhopal, India
Corresponding Author: igudiyasingh@gmail.com

ABSTRACT
These days, a major problem in soil stabilization is the characteristics of the water in the soil. Clay soil has low bearing limit, high shrinkage and swell characteristics, and high dampness defencelessness, making it difficult to design and treat. It is usual procedure to stabilize this soil in order to increase its strength. The physical characteristics of the soil were determined in compliance with IS guidelines. It is a finely divided accumulation caused by crushed or powdered coal that has been ignited by power plants. It has a large capacity to hold water. Lime for the study is readily accessible nearby. In this test program, the ideal moisture content, unconfined compression test, direct shear test, liquid limit and plastic limit, and moisture content were all attempted without the use of any additional substances. Lime and fly ash were added in different amounts.

Keywords: Fly Ash, Stabilization and Lime, environmental problems, chemical and physical properties.

1.0 INTRODUCTION
Poor quality soils often have the ability to display unfavourable construction characteristics, such as limited bearing capacity, high swell and therapist potential, and high moisture susceptibility [1]. It is customary to modify these types of soils by adding various additives since it becomes unfeasible to replace the foundation material with high-quality soils. To improve the soil's designing character, soil adjustment may be defined as the change of soil parameters by chemical or physical means [2–7]. The main objectives of soil adjustment are to increase the soil's carrying capacity, shield it from long-term processes, and increase soil piety. This document oversees the comprehensive analysis of improving soil qualities and adjusting them using lime.

2.0 THEOLOGY OF LIME THERAPY
1) When quicklime is used for drying, it hydrates (mixes chemically with water) and releases heat right away. Because water in the soil contributes to this process and because more moisture might be evaporated by the heat produced, soils become dry. These early reactions will yield hydrated lime, which will then react with clay particles (described below). Due to their subsequent reduction in the soil's ability to store moisture, these processes will gradually cause further dryness. When hydrated lime or hydrated lime slurry is substituted for quicklime, the soil undergoes chemical changes that decrease its water-holding capacity and increase its stability, which is the only way that drying takes place. Figure 1 shows how applying lime reduces the water content from Wn to W'n.
2) Adjustment: Following the initial mixing, water and other ions are replaced by the calcium ions (Ca^{++}) from the hydrated lime as they move to the surface of the clay particles. The soil becomes more workable and compactible as it gets friable and granular. At this point, the soil's propensity to swell and contract as well as its Plasticity Index, as shown in Figure 1, both sharply decline. Known as "flocculation and agglomeration," the process usually takes place in a few hours.

3.0 Immediate Impact: Enhancement of Soil.
1) A decrease in the plasticity index: The soil becomes crumblier (stiff and gritty) instead of plastic (yielding and sticky). It is simpler to dig, load, discharge, compact, and level in the latter state.

2) An enhancement of the soil's compaction characteristics: The soil enters a readily compactible humidity range as the maximum dry density decreases and the ideal water content increases. Clearly, this action is beneficial when applied to soils that contain a lot of water. Hence, quicklime treatment enables the conversion of sticky plastic soil—which is challenging to compact—into a rigid, manageable substance. The soil has outstanding capacity to support loads after compaction.
3) Increased bearing capacity: Two hours after treatment, a treated soil's CBR (California Bearing Ratio) is typically four to ten times greater than that of an untreated soil. This response significantly eases the burden of on-site mobility issues.

4.0 LITERATURE REVIEW

According to Zhao et al. (2020) For both moisture-controlled and air-dried curing settings, the UCS increased monotonically as the SA dose was increased; the greatest improvement, attained for 3% SA after 15 days of curing, was around 198% and 96% for both circumstances, respectively.

According to Sujatha and Saisree (2019) The mobilized UCS increases with increasing GG dose and/or curing length; only little improvements are shown after 14 days of cure. After 90 days of cure, the greatest improvement of almost 200 percent was obtained for 2% GG.

According to Weng et al. (2023) With an XG dose increase, the UCS showed a rise-fall pattern that peaked at an ideal XG dosage of 1.5%; in every instance, longer curing increased the mobilized UCS even more. After 28 days of healing, the maximum improvement of around 93% was attained for 1.5% XG.

According to Hamza et al. (2023a) Only little improvements were seen at 1.5% XG in the UCS, which supported raising the XG dose and/or lengthening the curing time. After 60 days of cure, the greatest improvement of around 892% was obtained for 5% XG.

According to Bozyigit et al. (2023) The mobilized UCS increased with increasing XG dose and/or extended curing time; nevertheless, no clear optimal dosage range was found for the studied range. Approximately 619% improvement was achieved with 2% XG after 28 days of cure.

According to Aditya Agrawal, et al (2023) [6]. The percentage improvement is negligible beyond 2.0%, at which point the compressive strength, split tensile strength, and flexural strength rise when human hair replaces cement. By adding human hair to the concrete, the partial use of natural resources may also be reduced. The use of human hair in the concrete will also result in less waste. The appropriate use of concrete buildings may also help to reduce the issue of human hair deterioration.

According to Shweta Kandpal (2017) When lime is added in greater percentages, the maximum dry density drops up to a specific point, or 5% lime content, beyond which it grows and the optimal moisture content falls. This suggests that adding a specific amount of lime is the only way to improve the compaction behavior of soil. Prior to this, the lighter-weight lime strands were replacing the gaps in the soil, which caused the dry density to fall. The same reasoning may be used to explain the decline in the ideal moisture content. As the graph illustrates, it is also possible to draw the conclusion that dry density rises as lime concentration increases. As a result, the curve seen in the typical proctor exam moves to the upper left corner. Thus, using lime is only advantageous when a certain amount is used. Even so, adding lime has excellent results and may be used to big projects.

According to Agrawal A [19], Compared to the typical mix, the sample was determined to be more cost-effective and environmentally friendly. Together with the weight reduction, there has also been a 5% gain in strength. Additionally, it downplayed the issue of global plastic waste.

5.0 METHODOLOGY

1) Initial Pulverization and Scarification: The subgrade may be partly pulverized and scarified to the necessary depth and breadth after the soil has been brought to line and grade. Turf, aggregates, roots, stumps, and other non-soil elements bigger than three inches should all be removed. Scarification is carried out because, at the time of lime application, a pulverized or scarified subgrade provides increased soil surface contact area for the lime. Figure 1: Shows the scarification of lime over the soil layer

Figure 1: Shows the scarification of lime over the soil layer

2) When spreading lime, the soil is usually scarified and a distribution truck is used to apply the slurry. Since slurry lime is much less concentrated than dry lime, two or more passes are sometimes needed to get the desired level of lime solids. Immediately after each spreading pass, the slurry is blended into the soil to minimize runoff and the ensuing uneven distribution of lime. Figure 2: Shows the spreading mechanism of lime over the bed layer of soil.

Figure 2: Shows the spreading mechanism of lime over the bed layer of soil.

3) Preliminary Mixing and Watering: Prior to adding water to start the chemical reaction that will stabilize the soil, the lime must be evenly distributed throughout the soil and first ground up. Water has to be introduced either during or just after this procedure to guarantee full hydration and a high-quality stabilization project. Figure 3 shows the addition of water particles at the lime layer.

Figure 3 shows the addition of water particles at the lime layer

6.0 CONCLUSIONS

- When it comes to very dynamic soils that often expand and contract, lime is an effective soil stabilization element.
- Lime works instantly to enhance a number of soil properties, including carrying capacity, resistance to shrinkage in damp circumstances, decrease in plasticity index, rise in CBR value, and, over time, an increase in compression resistance.
- The soil stabilizes in a matter of hours due to the rapid response.
- The aforementioned graphs provide a good understanding of how adding lime improves the qualities of the soil.

REFERENCES

1. Anil Kumar Singhai, Laboratory study on soil stabilization using fly ash. March 201, vol: 03.
2. Bashir Ahmed Mir, Soil studies on effect of fly and lime mechanical properties of expansive clay. september 2015, vol: 13.
3. Shailendhar Singh, Stabilisation of black cotton soil using lime. june 2015, vol:04.
4. Sujit Kumar Dash, Lime stabilization of soil: reappraisal. june 2012 vol:24, DOI: 10.1061/(ASCE).MT.1943-5533.0000431.
5. Magdi Zumraw, Stabilization of pavement subgraded by using fly ash activated by cement. december 2015, DOI:10.12691/ajcect-3-6-5.
6. Aditya Agrawal, et al (2023). An Experimental Study of Introducing the Human Hair as a Fibre Material in Concrete, Journal of Ceramics and Concrete Sciences, 8(1), 17-23.
7. Evans, P., (1998). “Lime Stabilization of Black Clay Soils in Queensland, Australia,” Presentation to the National Lime Association Convention, San Diego, California.
8. Graves, R. E., Eades, J. L., and Smith, L. L., (1988). “Strength Developed from Carbonate Cementation of Silica-Carbonate Base Course Materials,” Transportation Research Record No.1190
9. Basma, A. A., and Tuncer, E. R., (1991), “Effect of Lime on Volume Change and Compressibility of Expansive Clays,” Transportation Research Record No. 1295.
10. Dawson, R. F., and McDowell, C., (1961), “A Study of an Old Lime-Stabilized Gravel Base,” Highway Research Board, Lime Stabilization: Properties, Mix Design, Construction Practices and Performance, Bulletin 304.
11. Doty, R., and Alexander, M. L., (1968) “Determination of Strength Equivalency for Design of Lime-Stabilized Roadways,” Report No. FHWA-CA- TL-78-37.Dumbleton, M. J. (1962) “Investigations to Assess the Potentialities of Lime for Soil Stabilization in the United Kingdom”, Technical Paper 64, Road Research Laboratory, England.
12. I.S: 2720 (Part XVI)-1965: “Indian standard for laboratory determination of CBR”, Bureau of Indian Standards Publications, New Delhi.
13. B.C.punamiya and A.K.Jain, “Soil mechanics and engineering property”.
14. C.E.G.Justo and S.K.Khanna, “ highway engineering
15. S.Z. George et al (1992) Effect of temperature on Lime-soil stabilization. Journal of Construction of Building Materials, Volume 6, 247-252.
16. F.G. Bell (1996) Lime Stabilization of Clay minerals and soils. Journal of Engineering Geology, ELSEVIER, 223-237.
17. Bell, F.G. (1988). Stabilization and treatment of clay soils with Lime. Part 1. Basic principles. Ground Engineering, 21, 10–15
18. Determination of liquid limit and plastic limit. Indian standard methods for testing of soils-IS2720 (a) Indian standard Institution, New Delhi, India, part 5, pp 109-144,1985.
19. Agrawal,A., “Improving Bitumin Road Properties by Involving Plastic Waste”, Journal of Civil & Construction Engineering, 6(2), 2020, pp 25-27. Available at: https://doi.org/10.46610/JOCCE.2020.v06i02.004.

20. Agrawal,A., Shrivastav,J., Lange,A., Chourasia,S., “Analysis for Compressive Strength with Fly Ash in Concrete”, Journal of Civil and Construction Engineering. MAT Journal. 3(3), pp 1-4. Available at https://doi.org/10.46610/JOCCE.2017.v03i03.001.
21. Agrawal,A., Shrivastav,J., “Treatment of wastewater by effluent Treatment Plant”, Journal of Environmental Engineering and Studies. MAT Journal. 3(1), pp 1-8. Available at https://matjournals.in/index.php/JoEES/article/view/2196.
22. Dhone,K., Agrawal,A.,et.al, “FLOATING CONCRETE WITH LIGHT WEIGHT AGGREGATES”, International Journal of Research and Analytical Reviews (IJRAR), 7(3), 2020. (UGC Approved-43602, IF 5.75. Available at: http://dx.doi.org/10.13140/RG.2.2.12677.93920.
23. Kapadia K, Agrawal A. Municipal Solid Waste to Energy Options-A Review. Proceedings of Recent Advances in Interdisciplinary Trends in Engineering & Applications (RAITEA). 2019 Mar 28. Available at https://dx.doi.org/10.2139/ssrn.3361532.
24. Kapadia K, Agrawal A, Sharma H, Malviya N. India’s renewable energy potential: A review. In Proceedings of 10th International Conference on Digital Strategies for Organizational Success 2019. Available at https://dx.doi.org/10.2139/ssrn.3329776.
25. Agrawal,A., “Solid Waste Management Of Indore City: A Review”, International Research Journal of Engineering and Technology (IRJET), 4(11), 2017, pp 1906-1909. Available at https://irjet.com/archives/V4/i11/IRJET-V4I11344.pdf