Soil Stabilization Using Lime and Fly Ash

Harshad Ranadive, Mansi Yadav, Mizab Ansari, Abdul Batin Shaikh, Jay Patel
[1] *Assistant Professor, Department of Civil, Shree L.rTiwari College of Engineering*
[2,3,4,5] *UG Student, Department of Civil, Shree L.r Tiwari College of Engineering*

Abstract: Soil stabilization has emerged as a critical topic in building engineering. The number of studies on the effectiveness of utilizing chemical wastes is steadily growing. Soil stabilization is the process of improving the bodily qualities of soil in order to increase its toughness and durability, and so on by combining or combining with chemicals. Soil stabilization methods include: soil stabilization using coconut coir fibres, soil stabilization with jute fibre, and soil stabilization with fly ash and lime. When the soil stabilization method is used in construction, the overall cost is lowered when compared to the conventional method of construction. The primary goal of this study is to investigate the usage of chemicals that act as stabilizers such as fly ash and lime in geotechnical applications and to analyze the consequences of these chemical elements on the load capacity of unsaturated soil using California soil testing. Bearing ratio studies on soil samples with two distinct chemical stabilizers. The results for these two stabilizers are compared, and conclusions are reached about the usage and efficiency of fly ash and lime as a cost- effective foundation replacement. With this in mind, an experimental investigation on soil samples combined with varied percentages is carried out using fly ash and lime.Soil samples are produced at their maximum dry density, matching to their optimum moisture content, for California Bearing ratio (CBR) and standard proctor test (SPT). The percentages of fly ash and lime by dry weight of soil are 5%, 10%, 15%, and 20%, and CBR and SPT tests are performed in the laboratory for each stabilizer concentration. The addition of fly ash and lime reduces building costs, resulting in the economy of foundation and roadway construction. In this section of my study, I will explore how chemical stabilizers such as fly ash and lime can boost soil carrying capacity to make it acceptable for any structure at a low cost of stabilization.

Keywords: FLY ASH, LIME, CBR, SPT, OMC, MDD, PLASTIC LIMIT TEST, LIQUID LIMIT TEST.

I. INTRODUCTION

Soil is described as the aggregation containing flaky substance formed through rock disintegration (physical or chemical), as well as air, water, biological materials, and other substances that may be present. Uneven, porous material known as soil earthy engineering- behaving materials are impacted by moisture content and density fluctuations. The dirt on-site is not always suitable for construction. It may be weak or compress excessively under the effect of a load. In such cases, it is preferable to transfer the facility or change the soil structure, therefore stabilizing the soil.

The technique of stabilizing soil enhancing the technical qualities of weak dirt by applying various stabilizing agents. Stabilization is described as a modification or conservation of one or more dirt qualities in order to better a dirt's engineering features and performance.

II.SOIL STABILIZATION AND ITS NEED

The role of soil is crucial part in the design and construction of a building, a bridge, or a road, a runway, or a railway track. This is due to the fact that it functions as a medium for the successful burden transfer into the dirt. This implies that a poor dirt foundation will ultimately compel the structure to collapse resulting in failure. The practise of improving the technical properties of the dirt prior to construction is known as stabilization. It is a procedure that transforms a dirt's physical properties to offer long-term irreversible strength benefits. Stabilization is done to improve dirt capacity and shrink swelling potential are increased, hence improving the load-bearing ability and overall safety of dirt. Dirt stabilization is a process for refining and improving dirt technical features. These properties include mechanical strength, permeability etc.

Stabilized dirt provide a stable working platform that serves as the basis for all other project components. Weak dirt can be improved after stabilization measures by the establishment of permanent pozzolanic reactions. That is, soils are not prone to leaching and have significantly reduced permeability, resulting in less shrink and higher freeze-thaw resilience. Furthermore, dirts that have been stabilized have undergone some alteration. In other words, the soil has altered physically, making compaction simpler and decreasing flexibility. Easier compaction facilitates reaching maximal dry density. The plasticity index is a fundamental geotechnical Statistic that takes into account the critical water content of dirts. When their sturdiness is reduced, they become softer and more practical. The following are the reasons for soil stabilization:

• In the case of low-cost highways, to strengthen sub-bases, bases, and sometimes surface courses.

• To reduce the cost of road and building construction.

• Using lesser grade locally available soils/materials. (Whenever if the required or mandated power cannot be found in the local material dirt stabilization treatments can be utilized)

• To ameliorate unfavorable dirt qualities such such as excessive swell or shrinkage, high plasticity, compaction issues, and so forth.

• Increased carrying capability and settling.

• Reduce settlement and, hence, compressibility.

III. LITERATURE REVIEW

Needhidasan et al. (2019) Soils are challenging because of the performance of clay constituents, which have the ability to demonstrate unfavourable technical traits as in poor bearing capacity, The different characteristic of the dirt makes it unsuitable for technical use in its native state, therefore dirt stabilization can be done physically or chemically to improve its engineering quality and make it more usable. For a long time, dirt stabilization has been accomplished by applying mixes. An experiment was carried out to investigate the both individually and collectively impacts of admixtures, admixture one and admixture two on the geotechnical features of problematic dirts First, problematic dirt is combined with four percent and eight percent admixture one, followed by ten percent admixture two plus four percent admixture one and ten percent admixture two plus eight percent admixture one. Results show that putting admixture one instead of admixture two in various percentages to problematic soils reduced the liquid limit, plastic limit, while growing the maximum dry unit weight and dirt's admixture strength. The plasticity features, ideal moisture content, and differential free swell index with admixture-filled voids are reduced, whereas the maximum dry unit weight and therefore strength of dirt admixtures grows when compared to ideal dirt.

Pagadala et al. (2019) Water characteristics in dirt is a typical challenge in dirt stabilization today. Dirt is difficult to design or manufacture because of its less bearing capability, more shrinkage properties. Stabilization of the dirt is a common practise for increasing its strength. The physical properties of the dirt were determined using IS standards. It is a finely divided accumulation created by the combustion of the earth or crushed coal in power plants. It has a high water-holding capacity. Admixture one is readily available in a short distance for the inquiry. Dirt was tested without changes to find the right liquid and plastic limits. Various amounts of admixtures were applied.

Sangyo et al (2019) Treatments with admixture one and admixture two, admixture one minimize problematic soil from swell. The free swell, decreased as the admixture one and admixture two content increased. As curing time grew, the swelling pressure of admixture one and admixture two treated dirt decreased. As the admixture one and admixture two content increased, along with the correct water content and top dry unit. There are low changes in compressive strength as the admixture one gets higher without curing. The use of admixture two greatly improved its strength. The best admixture one percentage for treated dirt's with a seven-day curing time is found to be nine to twelve percent.

Yong et al. (2020) Admixture one and admixture two have frequently been employed to reduce the thickness of problematic dirt. Using lab experiments, scanning electron microscopy, and X ray diffraction, this study studied the stabilizing effect of admixture one and admixture two on problematic dirt. Before and after stabilization, the parameter mechanical features, mineral content of problematic dirt got compared. The experiment reveal that adding five percent admixture two based on admixture two reduces the problematic dirt's normal weight by sixty four point nine percent the increase in volume ratio to almost ten percent, and the unloaded increase in volume ratio to nearly four percent, and the stabilized dirt no longer exhibits the problematic feature. The compressive and tensile strengths of the stabilized dirt increase first, then decline as the admixture one content increases. The unconfined compressive and tensile strengths both increase significantly after the addition of five percent admixture two. The best modifier combination ratio is ten percent admixture one plus five percent admixture two. Images show that the ferrite of the stabilized problematic soil range from irregular flake structures to blocky structures, and the compactness of the dirt sample is improved. According to the x ray diffraction data, quartz is the major component of the stabilized dirt. These are the root causes of the increase in strength. The study's findings can be used for engineering design and construction of problematic dirt.

IV. OBJECTIVE

- Identifying soil technical features
- To examine the role of fly ash on soil technical behaviors.
- Comparison of fly ash and lime as soil stabilizer.

V. METHODOLOGY

GENERAL: In this chapter, I divided my project into distinct phases based on the literature studies I conducted and ran various lab tests to validate my study, and the findings of the lab tests were also analyzed at the conclusion.

COLLECTION OF SAMPLES: A soil sample was collected from Shree L.R. Tiwari Campus Thane, where the soil is in poor condition. The soil was crushed down to remove lumps, and all unnecessary waste was carefully picked out and cleaned.

APPLICATION OF FLY ASH AND LIME:

Fly Ash: Fly ash is a molten mineral residue that is recovered through electric precipitation following the combustion of coal in a thermal power plant. It comprises alumina (Al_2O_3), silica (SiO_2), and calcium oxide (CaO) and has cementations qualities as well as acting as a binder. I used several percentages of fly ash in the soil, such as 5%, 10%, 15%, 20%, and 25%, and ran various tests on it, including specific gravity tests, plastic limit tests, liquid limit tests, standard proctor tests, and California Bearing Ratio tests.

Lime: Lime is an inorganic calcium-containing substance made mostly of oxides and hydroxide, most commonly calcium oxide and calcium hydroxide. It is also the name given to calcium oxide, which is found in coal seam fibers and altered limestone xenoliths in volcanic ejecta. I added lime to the soil in various percentages, such as 5%, 10%, 15%, 20%, and 25%, and then tested it for specific gravity, plastic limit, liquid limit, standard proctor, and California Bearing Ratio.

LIST OF TESTS PERFORMED:

1. Sieve analysis
2. Specific gravity test
3. Liquid limit test
4. Plastic limit test
5. Standard proctor test
6. California bearing ratio test.

FUTURE SCOPE OF WORK

Lime and Fly Ash are both agricultural and industrial waste. Both of them contain a significant proportion of siliceous substance. The lime manufacturing method is based on a chemical reaction caused by heating calcium carbonate ($CaCO_3$), which produces quicklime (CaO). This process will inevitably produce CO_2. These CO_2 emissions, which are inherent in the lime production process, are referred to as process emissions. These process emissions alone account for 70% of overall CO_2 emissions from the lime production process and are unavoidable. Coal-fired power facilities in India generate around 196 million tonnes of fly ash each year. The management of fly ash has thus been a source of worry, given the vast amount of land required for disposal and the potential for pollution of air and water. Although the cement business is heavily utilizing, it has hit its utilization level. As a result, a new region for its disposal is urgently required. One of the finest options for soil stabilization is to use fly ash. The use of fly ash in bulk in building and soil stabilization has a lot of potential. NHAI is now utilizing 100 lakh Tone fly ash in construction on various NH projects across India, with plans to double it in the future. The application of fly ash in road building includes the following:

- Embankment stabilization and roadway backfill
- Pavement subgrade stabilization
- Railway embankment stabilization.

REFERENCE

[1] Saleh, S. A., & Hussein, S. K. (2020). Effect of Soil Stabilization on Subgrade Soil Using Cement, Lime and Fly. Eurasian Journal of Science & Engineering, 39-52.

[2] Andavan, S., & Pagadala, V. K. (2019). Experimental study on addition of lime and fly ash for the soil stabilization. Materials Today: Proceedings, 1-5.

[3] Chen, K., Huang, S., & Ding, L. (2022). Improving Carbonate Saline Soil in a Seasonally Frozen Region Using Lime and Fly Ash. Hindawi Geofluid, 1-12.

[4] Indiramma, P., Sudharani, C., & Needhidasan, S. (2019). Utilization of fly ash and lime to stabilize the expansive soil. Materials Today: Proceedings, 1-7.

[5] Islam, M. S., Islam, T., & Khatun, N. (2020). Permeability Alteration of Low Plastic Clay and Poorly Graded Sand Using Lime and Fly Ash. Springer Nature, 1-12.

[6] KALYANE, A., & PATIL, R. (2020). Experimental investigation of Black Cotton Soil by Lime and Fly Ash Stabilization. Bulletin of Engineering, 1-6.

[7] Lav, M. A., & Cokca, E. (2021). Improvement of an Extremely Highly Plastic Expansive. Springer Nature Switzerland, 1-16..

[8] Renjith, R., Robert, D., Setunge, S., & Mohajerani, (2021). Optimization of fly ash based soil stabilization using secondary. Journal of Cleaner Production, 1-14.

[9] Panikkar BR, Sreedharan R, Aniruddh C (2015) Swell compressibility characteristics of lime-blended and cement-blended expansive clays - A comparative study. Geomech Geoeng Int J 10(2):153–162

[10] George S, Ponniah D, Little J (1992) Effect of temperature on lime-soil stabilization. Constr Build Mater 6(4):247–252

[11] Kang X, Kang GC, Chang KT, Ge L (2015) chemically stabilized soft clays for road- base construction. J Materials Civ Eng. 27(7):04014199

[12] Geiman, C.M. (2005). Stabilization of Soft Clay Subgrades in Virginia Phase-I Laboratory Study, M.S. Thesis, Virginia Polytechnic Institute and State University

[13] Seed HB, Woodward RJ Jr, Lundgren R (1962) Prediction of Swelling Potential for Compacted Clays. J Soil Mech Found Div 88(3):53–87

[14] Kolay PK, Ramesh KC (2016) Reduction of expansive index, swelling and compression behavior of kaolinite and bentonite clay with sand and class C fly ash.Geotech Geol Eng 34:87–101

[15] Skempton, A.W. (1953). The colloidal activity of clays. Proc., 3rd Int. Conf. Soil Mech. Found. Eng., Vol.1, Switzerland, 57–61

[16] Mitchell JK, Raad L (1973) Control of volume changes in expansive earth materials. In: Lamb DR, Hanna SJ (eds) Proc Workshop Expansive Clays and Shales in Highway Design and Construction, vol 2. Federal Highway Administration. Denver, CO, pp 200 219.

[17] Wilson SD (1950) Small soil compaction apparatus duplicates field results closely. Eng News Record 135(19):34–36

[18] Su¨t U¨ nver I˙ (2018) Static and Cyclic Properties of Expansive Clays Treated with Lime and Fly Ash with Special Reference to Swelling and Resilient Moduli. Ph.D. Thesis, Istanbul Technical University, Turkey

[19] Mitchell JK, Soga K (2005) Fundamentals of soil behavior, 3rd edn. Wiley, USA

[20] Nelson JD, Miller DJ (1992) Expansive soils: problems and practice in foundation and pavement engineering. Wiley, USA