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Study on Lime and Fly Ash as a Stablizing Agent on Soil Subgrade

Shahid Ahmad Dar[1], and Ashish Kumar[2]

[1]M.Tech. Scholar, Department of Civil Engineering, RIMT University, Mandi Gobindgarh, Punjab, India
[2]Assistant Professor, Department of Civil Engineering, RIMT University, Mandi Gobindgarh, Punjab, India

Correspondence should be addressed to Sahid Ahmad Dar; darshahidgurre5@gmail.com

ABSTRACT- Today, poor soil properties constitute a significant issue in engineering projects. Sometimes altering the qualities of the wrong soil is the first step in construction. Pavement that collapses too quickly is one of the early warning indications of degradation in pavement systems on poor soil subgrades. In most cases, clayey soil has the potential to have unfavourable engineering characteristics like low bearing capacity, high shrinkage and swell characteristics, and high moisture susceptibility. Stabilizing these soils is a typical method to improve their tensile strength. A process known as soil stabilisation adds a binder to the soil in order to improve the engineering performance of the soil.

KEYWORDS- Lime, Fly ash, Clayey soil, Admixtures, CBR, Soil stabilization, Index, Engineering properties**.**

I. INTRODUCTION

A substantial infrastructure, including a network of structures and roadways, is required for a developing country like India because of its sizeable population and geographic region. Land is being used all over for a wide range of structures, including basic houses, skyscrapers, airports, bridges, and motorways. Almost all civil engineering structures are erected on several soil strata[3]. One definition is that soil is made up of clay, sand, silt, and rock pieces. It is produced by the gradual breakdown or disintegration of rocks as a result of organic activities, such as the stress-induced disintegration of rocks brought on by temperature-related expansion or contraction[4]. Weathering and decomposition, which are chemical processes brought about when water, oxygen, and carbon dioxide progressively combine with the minerals within the rock formation, result in the creation of sand, silt, and clay. many soil types, including those in river deltas and sand dunes, and glacial deposits, which originate from the movement of soil particles by wind, water, and ice. Temperature, precipitation, and drainage are important elements in the formation of soils in the various climatic zones[5]. Under differing drainage regimes, various soils will evolve from the same basic rock formation. and glacial deposits, which originate from the movement of soil particles by wind, water, and ice. Temperature, precipitation, and drainage are important elements in the formation of soils in the various climatic zones. Under differing drainage regimes, various soils will evolve from the same basic rock formation[6][7].

India's soils fall into six categories: alluvial soil, marine soil, laterite and lateritic deposits, expansive soils, sand dunes, and boulder deposits. Since man has no control over the process of soil formation, the soil strata at the site must be accepted as they are and building must be done in a way that takes into consideration the subsurface conditions. The current soil at the provided area could not be acceptable for sustaining the necessary infrastructure, such as buildings, bridges, dams, and other structures, because its safe bearing capacity might not be enough to maintain the stated load [8]. The Engineers may regularly encounter situations when they determine that the selected location cannot withstand the weight of the planned development. Numerous soil stabilising procedures are employed in these circumstances to improve the properties of the earth. The main objective of soil stabilisation is to improve the site's soil characteristics. The field of soil stabilisation is rapidly growing due to the depletion of suitable development sites[9][10].

II. LITERATURE REVIEW

N. Krithiga et al. [1] conducted study on soil stabilisation and found that stabilising the soil usually results in strengthening the soil. To enhance the engineering performance of the soil, a process called soil stabilisation adds a binder to the soil. This study describes how the addition of both lime and fly ash increased the cohesive soil's localised strength. According to studies, stabilising the soil first and then applying chemicals improves the soil's workability and mechanical behaviour. Lime and fly ash were among the local industrial and natural materials used for chemical stabilisation. Fly ash has been used to bind non-cohesive soil, granular soil, or soil that is poorly cohesive in place of the typical employment of lime alone in soil that contains clay and is highly cohesive. Fly ash is frequently used to support the base course or sub base. They came to the conclusion that soil stabilisation with lime and fly ash is a particularly efficient method for strengthening soil. The clay, on the other hand, reaches its strongest stage. Lime and fly ash are inexpensive building materials that produce a structure that is incredibly durable and sturdy.

Pratik Somaiya et al. [2] have carried out extensive laboratory / field trials and abstracted the findings after conducting research in the field of soil stabilisation. These trials have shown encouraging results for the application of such expansive soil after stabilisation with additives like sand, silt, lime, fly ash, etc. Fly ash can be used to stabilise expansive soils for a number of reasons because it is easily accessible for projects close to thermal power plants. The experiment described in this research sought to ascertain whether the addition of fly ash at various quantities improved the qualities of growing soil.

III. EXPERIMENTAL INVESTIGATION

A. Materials Used for Study

1)Lime

The main elements of lime, a calcium-containing mineral, are oxides and hydroxides, commonly calcium oxides and hydroxides. The qualities of the soil can be improved with lime, particularly its workability and bearing capacity. It also improves the stability and impartibility of the soil, leading to reduced downtime and greater workspace [12].

2)Fly Ash

Class C fly ash's self-cementitious qualities allow it to be utilised as a stand-alone material. By combining Class F fly ash with a cementitious component, soil stabilising applications are achievable (lime, lime kiln dust, CKD, and cement) [11]. Fly ashes' self-cementitious activity is quantified using ASTM D 5239. After seven days of customary moist curing, a conventional method is utilised in this test to assess the compressive strength of cubes made of fly ash and water (the water/fly ash weight ratio is 0.35). The qualities of self-cementitious are rated as follows: The results from ASTM D 5239 should be emphasised because they do not, by themselves, provide a basis for analysing the potential interactions between the fly ash and soil or aggregate; rather, they just describe the cementitious properties of the fly ash-water blends. When using fly ash for soil stabilisation and modification, regional environmental regulations regarding leaching and potential interactions with nearby streams and ground water may be applicable.

B. Methodology

1)Grain Size Analysis (IS 2720)

The results of the test will reflect the state and characteristics of the population from whom the sample was taken. Since the distribution of different grain sizes impacts the engineering capabilities of soil, it is crucial to get a disturbed representative sample that is representative of the source being studied.

2)Hydrometer Analysis (IS 2720)

The test findings will reflect the condition and features of the aggregate from which the sample was drawn. Collecting a disturbed representative sample that is representative of the source under study is vital because the range of varied grain sizes affects the engineering capabilities of soil.

3)Specific Gravity (IS 2720)

The specific gravity of a soil determines the phase relationship, or the proportion of solids to water and air in a given volume of soil, as well as the relationship between soil weight and volume. Practically all calculations for laboratory testing as well as almost all pressure, settlement, and stability issues in soil engineering are impacted by specific gravity. Needs and Goals

4)Liquid Limit (IS 2720)

Understanding liquid limit is crucial for comprehending the origins of stress and the basic traits of the soil encountered during construction. The findings of the liquid limit can be utilised to calculate the compression index. With the help of the compression index value, we may carry out settlement analysis. When the moisture content drops below the liquid limit, the soil becomes harder and brittle.

5)Plastic Limit (IS 2720)

The percentage of water that a soil possesses when it changes from the plastic to the semi-solid state is known as the plastic limit. In addition to serving as the basis of buildings, soil is used to create bricks, tiles, and soil cement blocks. Additionally, whether alone or in combination with other soil parameters, it's widely utilised to link engineering traits like compressibility, permeability, shrinkswell, and shear strength.

6)Standard Proctor Exam (IS 2720)

The evaluation of the link between soils that have been compacted with a 2.5 kg rammer dropped from a height of 30 cm and their density and moisture content. The results of this test will be helpful in increasing foundation bearing capacity, lowering hydraulic conductivity, decreasing unwanted volume changes, decreasing undesirable settlement of structures, and enhancing slope stability

7)CBR Definition

It is the amount of pressure needed to use a traditional circular piston to penetrate a layer of soil at a pace of 1.25 millimetres per minute. to that needed to pierce an equivalent depth with a common substance. The test load/standard load is the CBR. The typical load for a 2.5 mm penetration is 1370 kg. The Standard Load at 5.0 mm penetration is 2055 kg.

8)Tests Conducted on Soil Samples

- specific gravity,
- liquid limit & plastic limit,
- standard proctor test,
- direct shear
- California bearing ratio,
- California bearing ratio.

IV. RESULT AND DISCUSSION

A. Standard Proctor Test

The maximum dry density is at 2.5% fly ash by mass of soil. The dry density decreases to 1.135%, 1.44% at 5% and 7.5% fly ash by mass of soil (see table 1).

Table 1: Standard Proctor Test of Simple Soil

As per IS-2720(Part-5)				
VOL. OF MOULD (V) = 3418 cc				
Determination	1	2	3	4
Weight of Empty mould (W1) kg	6.352	6.352	6.352	6.352
Weight of mould + compacted soil (W2) kg	10.65	10.83	10.67	10.68
Weight of compacted soil = (W2 - W1) kg	4.298	4.482	4.318	4.336
Bulk Density, = M/V = (W2-W1)/ V	1.25	1.311	1.263	1.268
Water Content (w%)	8	11	14	17
Dry density = ρ/(1+w)	1.15	1.18	1.107	1.08
RESULTS				
Optimum water Content (%) =	11			
Maximum. Dry density (g/cc) =	1.18			

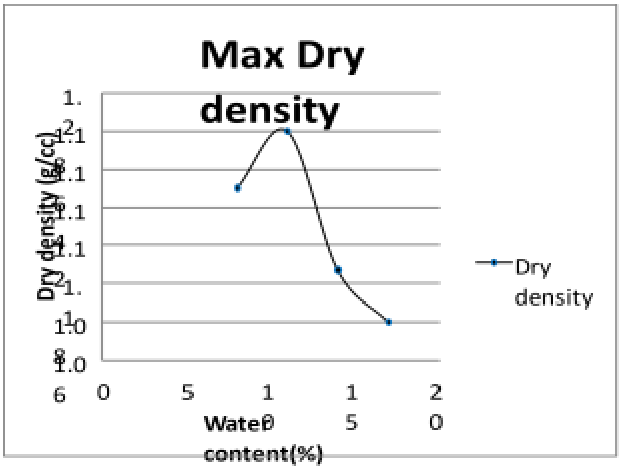

Figure 1: Soil sample (5 Kg) with Fly Ash (2.5%) and Lime (5%)

The maximum value of California Ratio is at 2. 5% of Fly ash keeping Lime constant at 5% by Mass of soil. The California Bearing Ratio decreases with variation in Fly ash from 2.5-10%. The maximum value 460 is observed at 2.5 % of Fly ash by weight (see figure 1).

B. California Bearing Ratio Test

CBR is the ratio expressed in percentage of force per unit area required to penetrate a soil mass with a standard circular plunger of 50 mm diameter at the rate of 1.25 mm/min to that required for corresponding penetration in a standard material. The ratio is usually determined for penetration of 2.5 and 5 mm . When the ratio at 5 mm is consistently higher than that at 2.5 mm, the ratio at 5 mm is used.
Result of unsoaked test is described below in table 2 and in graph mentioned as figure 2.
And for soaked soil is described in table 3 and shown on graph that is figure 3.

Table 2: California Bearing Ratio Test of Simple Soil (Un-soaked)

As per IS-2720(Part-16)		
PENETRATION (mm)	PROVING RING READING	LOAD (Kgf)
0.5	1.1	70.4
1.0	1.8	236.88
1.5	2.3	459.08
2.0	2.8	747.6
2.5	3.1	1035.09
3.0	3.3	1323.96
3.5	3.6	1689.12
4.0	3.9	2094.3
4.5	4	2424.8
5.0	4.1	2762.17
RESULTS		
C Bearing at 2.5 (%) : 75.5		
C Bearing at 5 mm (%) :130.03		
Reported CBR (%) : 130.03		

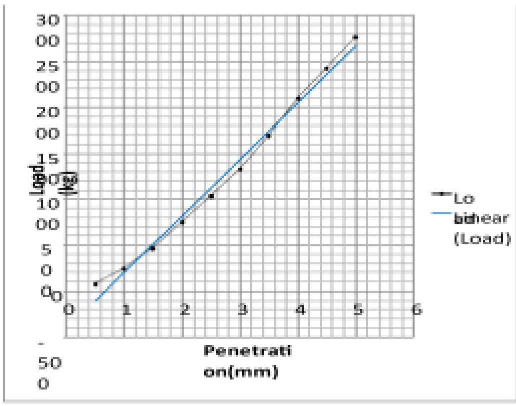

Figure 2: Load Penetration Curve for CBR Test (un-Soaked condition)

Table 3: California Bearing Ratio Test of Simple Soaked Soil

As per IS-2720(Part-16)		
PENETRATION (mm)	PROVING RING READING	LOAD (Kgf)
0.5	0	0
1.0	0.1	13.16
1.5	0.15	29.94
2.0	0.17	45.407
2.5	0.2	66.76
3.0	0.22	88.264
3.5	0.24	112.60
4.0	0.29	115.93
4.5	0.3	181.86
5.0	0.3	202.11
RESULTS		
C Bearing at 2.5 (%) : 4.8		
C Bearing at 5 (%) : 9.8		
Reported CBR (%) : 9.8		

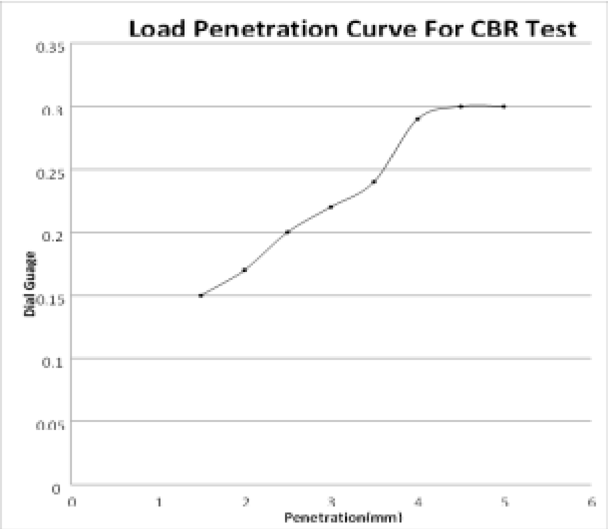

Figure 3: Variation in value of CBR at different values of Fly Ash Keeping Lime Constant at 5%

C. Direct Shear Test

The maximum value of Direct Shear test is at 5% Fly Ash by weight of soil keeping lime constant at 5%. The shear stress varies from 3-18 Kg/cm2 at 0.5 kg maximum at 5% Fly ash. The maximum value will be 18 Kg/cm2 . 1 kg varies with 45-70 Kg/cm2 with a maximum value of 70. Hence the maximum value of shear stress is at 5% lime and 5% Fly ash

V. CONCLUSION

- The current study can be expanded to take into account different lime and flyash quantities as well as other admixtures. Field tests can be conducted to obtain more useful results. In order to establish the effectiveness of lime and flyash as a general or all-purpose soil stabilizer, it is important to examine their effects on various types of soils as well.
- It is observed that the maximum dry. density decreased from 1.18 g/cc to 1.85g/cc on Addition of 2.5% FlyAsh &5% Lime.
- The California Bearing value increased from 130.03 to 458 on addition of 2.5% FlyAsh &5% Lime. The maximum value of Direct Shear test is at 5% Fly Ash by weight of soil keeping lime constant at 5%.
- Thus the Local Materials Lime and Flyash is a satisfactory stabilizing agent for clayey soils.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

[1] N. Krithiga, D. Pujitha. Palayam, and A. Revathy (2017) “Soil Stabilization Using Lime and Fly Ash.

[2] Neeraj Kumar Sharma, S.K Swain, Umesh C. Sahoo, “Stabilization of soil using Lime and

[3] Fly Ash: A Micro Level Investigation”, Received: 17 November 2011 / Accepted: 11 June 2012 © Springer Science + Business.

[4] Abhimanyu Gorka , Shakshi Chalotra. Study of Stabilization of Soil with Stone dust, Fly Ash and Coir Fiber International Journal of Innovative Research in Engineering & Management (IJIREM), *9(2), 2022*

[5] Pratik Somaiya, Yashwant Zala, Rushikesh Dangar, “Stabilization Of Expansive Soil Using Fly Ash”,2013

[6] Jawad, I. T., Taha, M. R., Majeed, Z. H., & Khan, T. A. (2014). Soil stabilization using lime: Advantages, disadvantages and proposing a potential alternative. Research Journal of Applied Sciences, Engineering and Technology.

[7] Effect of Soaking on the CBR-Value of Subbase Soil. *Engineering and Technology Journal*, 29(6), 2011.

[8] Arasan S (2005) Investigation of the effect of cement, lime, silica fume and fly ash on swelling pressure and cation exchange capacity of fine grained soils, MS Thesis, Ataturk

[9] University, Erzurum, Turkey.

[10] FRED G. BELL; The Influence of the Mineral Content of Clays on their Stabilization by Cement. *Environmental & Engineering Geoscience* 1976;; xiii (4): 267–278. doi: https://doi.org/10.2113/gseegeosci.xiii.4.267

[11] Surender Malik , Bhavana Arora. Effect of Fly Ash and Rice Husk Ash on the Properties of Burnt Clay Bricks*International Journal of Innovative Research in Computer Science & Technology (IJIRCST)*, 3(4), 2015

[12] Bhuvaneshwari S, Robinson RG, Gandhi SR (2005) Stabiliza- tion of expansive soils using fly ash. Fly Ash Utilization Programme, (FAUP), Technology Information Forecasting & Assessment Council (TIFAC), Department of Science and Technology (DST), New Delhi, India.

[13] Shirkhanloo S, Najafi M, Kaushal V, Rajabi M. A Comparative Study on the Effect of Class C and Class F Fly Ashes on Geotechnical Properties of High-Plasticity Clay. Civil Eng. 2021; 2(4):1009-1018.

[14] https://doi.org/10.3390/civileng2040054

[15] https://en.wikipedia.org/wiki/Lime_(material)#:~:text=Lime%20is%20a%20calcium%20-containing%20inorganic%20material%20composed,in%20altered%20limestone%20xenoliths%20in%20volcanic%20ejecta.%20