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A COMPARATIVE STUDY ON VARIOUS ADMIXTURE USED FOR STABILIZATION OF LOOSE SOIL

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Abstract - *Loose soil is an expansive type of soil that undergoes sudden expansion and swelling upon contact with water. This property leads to poor strength and other unfavourable characteristics of the soil. The behavior of loose soil can be highly unpredictable when subjected to various types of stabilizers. Soil stabilization refers to a technique used to address, modify, or enhance the performance of soil. In this study, the effectiveness of limestone, fly ash, and rice husk ash (RHA) powder as beneficial additives for loose soil is evaluated. The analysis focuses on determining the strength properties of loose soil in its natural state and after being mixed with different proportions of limestone powder, fly ash, and RHA. To address the issues of swelling and shrinkage, the soil is replaced with a stabilizing agent comprising 10% of the dry weight. A comparison is made between the properties of 100% loose soil and the combination of various percentages of limestone powder, fly ash, and rice husk ash to assess the impact of the stabilizer on the soil. The results indicate a significant reduction in the swelling and shrinkage of the soil.*

Keywords: RHA (Rice Husk Ash), Stabilization, Strength, Swelling, Shrinkage

1. INTRODUCTION

This project emphasizes the importance of soil in the construction of various structures, including highways, multi-storey buildings, and towers. Among the different types of soil, expansive soil plays a significant role as it covers a considerable portion of the Earth's surface. Expansive soil is characterized by its tendency to swell and shrink due to changes in moisture content, primarily attributed to the presence of montmorillonite in substantial quantities. This instability necessitates the stabilization of the soil. Civil engineers heavily rely on soil as the foundation for their structures. Soil, which can consist of a loose aggregation of minerals with or without organic matter, is located at or near the Earth's surface. It plays a crucial role in the construction of civil engineering structures.

Loose soil is characterized by a lack of structure and cohesion, which can be attributed to various factors such as inadequate compaction during construction, erosion, or excessive tilling. The presence of loose soil can have several adverse consequences. One of the primary concerns is soil erosion, which can result in significant damage to ecosystems and landscapes.

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We have done the experiments by adding the admixtures which increases the engineering properties as we used various admixture (Lime, Fly Ash, RHA) and compared by adding them individually we this the improvement in soil engineering properties such as specific gravity, dry density with varying moisture content and load bearing. They help in soil stabilization because as compared to other lime is better binding material and the comparative test is analysed.

2. LITERATURE REVIEW

Baranwal.A.,et.al (2021) - The purpose of this study was to investigate the effectiveness of admixtures in stabilizing expansive soil. Through a review, Fly ash stabilization significantly enhances the geotechnical properties of soil. It increases the shear modulus while reducing the liquid limit, plasticity index, free swell index, and damping ratio of the soil. Moreover, with an increased curing period, the treated soil exhibits greater rigidity. The addition of a small amount of lime, in conjunction with fly ash, leads to notable improvements in the optimal moisture content (OMC) and California Bearing Ratio (CBR) of the soil. Simultaneously, there is a decrease in the maximum dry density (MDD) and free swell index due to the cationic exchange process. The incorporation of rice husk ash (RHA) with lime results in an increase in the unconfined compressive strength (UCS) of the soil, attributed to the pozzolanic reaction. However, beyond an optimum value, the UCS starts to decrease. Additionally, the plasticity and MDD decrease with the addition of RHA and ordinary Portland cement, but the UCS, OMC, and CBR increase. Beyond the optimum amount of RHA, the CBR value starts to decrease. Chemical stabilization is found to be more effective than mechanical stabilization, with fly ash being a superior stabilizer compared to rice husk ash.

Kumari K, Kumar V.,et.al.(2017) - Silica, present in rice husk ash (RHA), has the potential to replace exchangeable ions in clay minerals, leading to a reduction in the soil's shrinkage and swelling characteristics. When RHA is added solely to the test soil, it initially increases the California Bearing Ratio (CBR) value. However, as the amount of RHA increases, the CBR value eventually starts to decrease.

Gupta.L et.al (2016) - The aim of this research was to investigate the effectiveness of combining lake cinder and jute fiber in enhancing the subgrade quality of poor soil. To achieve this, standard tests including the California Bearing Ratio (CBR) and unconfined compressive strength tests were conducted on soil samples that were partially replaced with different proportions of lake cinder (10%, 20%, 30%, and 40%). Additionally, the soil was mixed with varying lengths (1 cm, 2 cm, and 3 cm) and concentrations (0.5%, 1.0%, and 1.5%) of jute fiber. Based on the results obtained from the tests, it was concluded that the most favourable outcomes and significant improvement were observed when utilizing a combination of soil, 30% lake cinder, and jute fiber with a length of 1 cm and a concentration of 1.5% (referred to as L-1cm, 1.5%).

Devdatt.S et.al. (2015) - Experimental tests were conducted to investigate the soil adjustment using coconut coir fibers. Black cotton soil was stabilized by incorporating different percentages (0.25%, 0.50%, 0.75%, and 1.0%) of coconut coir fibers based on the dry weight of the soil. California Bearing Ratio (CBR) tests were performed for both soaked and unsoaked soil conditions. The results of the tests revealed that the CBR value of both soaked and unsoaked soil increased as the percentage of coconut coir fibers increased. For instance, with the addition of 1% coconut coir fibers, the soaked CBR value increased from 3.9% to 8.6%, while the unsoaked CBR value increased from 8.1% to 13.2%. This indicates an improvement in the soil's load-bearing capacity with the incorporation of coconut coir fibers. Furthermore, it was observed that the addition of coconut coir fibers led to a reduction in the density of the asphalt. This reduction in density contributed to an increased CBR value due to the reduced density of the asphalt layer.

Singh P.et.al., (2014) - In this study, the objective was to assess the influence of marble dust on the index properties of black cotton soil. Various percentages of marble dust, ranging from 0% to 40% of the dry weight of the soil, were added. The findings revealed noteworthy effects on the soil's index properties. As the percentage of marble dust increased, the plasticity index of the black soil gradually decreased, decreasing from 28.35% to 16.67%. Conversely, the shrinkage limit of the soil increased from 8.06% to 18.34% with the addition of 40% marble dust. This indicates a reduction in the soil's susceptibility to shrinkage. Moreover, the expansiveness of the soil decreased significantly as the percentage of marble dust increased. The soil shifted from a very high level of expansiveness to a low level. This reduction in expansiveness enhances the suitability of the soil for construction purposes. Overall, the incorporation of marble dust in black cotton soil demonstrated a positive impact on its index properties, including a decrease in plasticity index and expansiveness, and an increase in shrinkage limit.

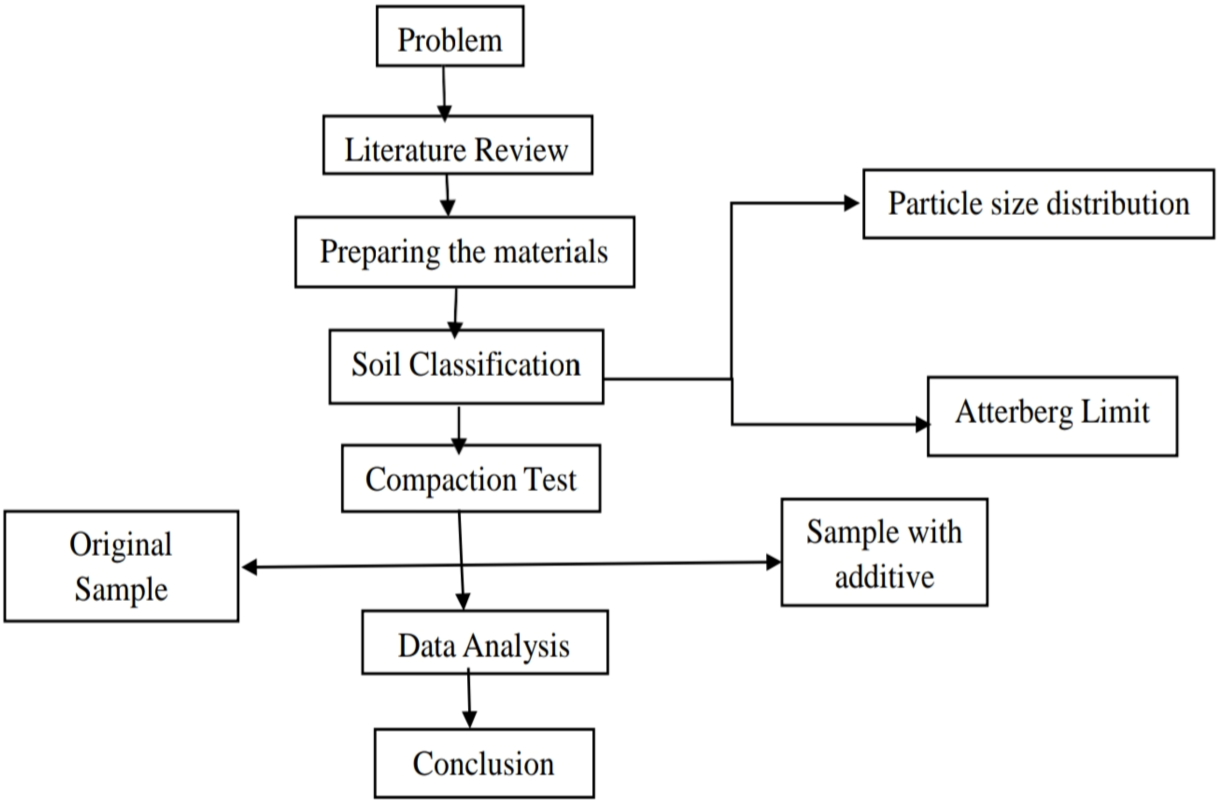
3. METHODOLOGY

3.1 Mechanical Process

When dealing with soils that exhibit a lack of cohesion, mechanical energy can be employed to reorganize the particles and enhance interlocking, thereby facilitating effective stabilization. Physical methods are utilized to alter the soil's physical characteristics, often involving the application of vibration or compaction. These methods may include soil reinforcement, compaction techniques, or mechanical remediation techniques. These approaches aim to improve the overall stability and strength of the soil through physical manipulation.

3.2 Chemical Process

Stabilization agents, including cementitious materials or admixtures, can be introduced to the soil with the purpose of enhancing its properties and achieving stabilization. When these agents are added, chemical reactions occur between the soil and the stabilizing material, transforming the soil's behavior from problematic to favourable. Various admixtures such as fly ash, Portland cement, rice husk ash (RHA), lime, plastic waste, shredded tires, and glass dust can be employed for soil stabilization. Through the utilization of these agents, the soil can be rendered more stable, enabling it to provide better support for structures and vegetation.



Flow chart

4. EXPERIMENTAL SETUP

4.1 Materials

4.1.1 Lime

Lime is known for its binding properties and its ability to set and harden. By combining lime with volcanic ash and pulverized brick supplements, a hydraulic binder can be created. Stabilization of soil can be achieved by adding lime at a volume ranging from 7% to 16%, with a lower percentage suitable for granular soil and a higher percentage recommended for coarse soil. However, it is crucial to dispel the misconception that lime can effectively stabilize any type of soil. In reality, certain soil types may necessitate a lime content exceeding 16% for effective stabilization.

Fig 4.1 Limestone Powder

4.1.2 Fly Ash

Fly ash, although it may not exhibit substantial cementitious properties independently, has the capacity to develop such properties when it comes into contact with moisture. Upon this interaction, fly ash undergoes a chemical reaction that leads to the formation of cementitious compounds. These compounds contribute to the improvement of the compressibility and strength properties of soil. Therefore, fly ash can play a valuable role in enhancing the performance of soil through its cementitious properties.

Fig 4.2 Fly Ash

4.1.3 Rice Husk Ash (RHA)

Rice husk ash (RHA) is often considered a waste product generated by rice mills and is commonly disposed of through burning near the mills. However, incorporating RHA into soil can yield several advantages, including improved resistance to moisture and reduced erosion. The presence of silica in RHA contributes to these benefits, as it enhances the soil's hydrophobic properties, reducing water infiltration and increasing its ability to repel water. By utilizing RHA, the soil's performance can be enhanced, offering advantages such as enhanced moisture resistance and reduced erosion.

Fig 4.3 Rice Husk Ash

4.2 Experiments

4.2.1 Liquid Limit Test

The liquid limit of soil refers to the threshold at which the soil begins to exhibit characteristics of a viscous liquid. It signifies the point at which the soil demonstrates a reduced ability to resist deformation and displays low shear strength.

Fig 4.4 Liquid limit test

4.2.2 Standard Proctor Test

The purpose of this test is to establish the correlation between the moisture content and dry density of a soil under a specified compactive effort.

Fig 4.5 Standard proctor test

4.2.3 Specific Gravity Test

The Specific Gravity Test is carried out on a dry soil sample to determine the specific gravity of the soil. This is accomplished by dividing the bulk density of the soil by the density of water.

Fig 4.6 Specific gravity test

4.2.4 California Bearing Test

The test offers crucial information regarding the load-bearing capacity of the soil subgrade, making it a valuable tool for assessing the soil's suitability to withstand heavy loads.

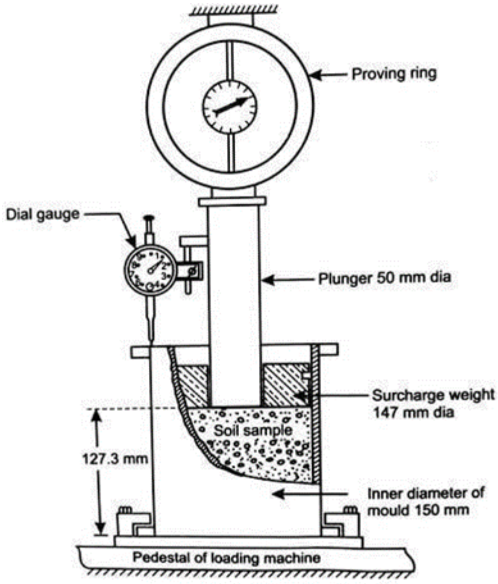
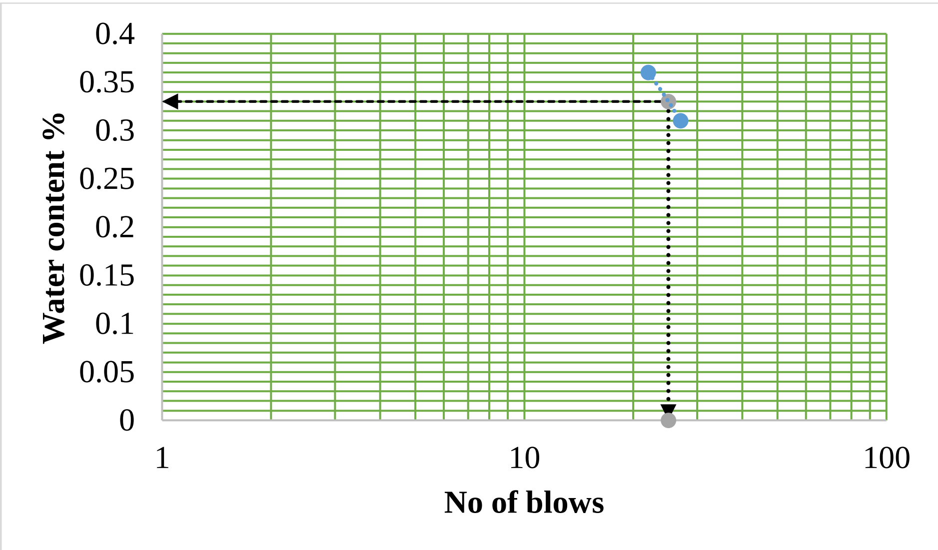


Fig 4.7 CBR Testing Machine

5. Result

5.1 Liquid limit

Graph 1: Liquid limit graph (Semi log graph)

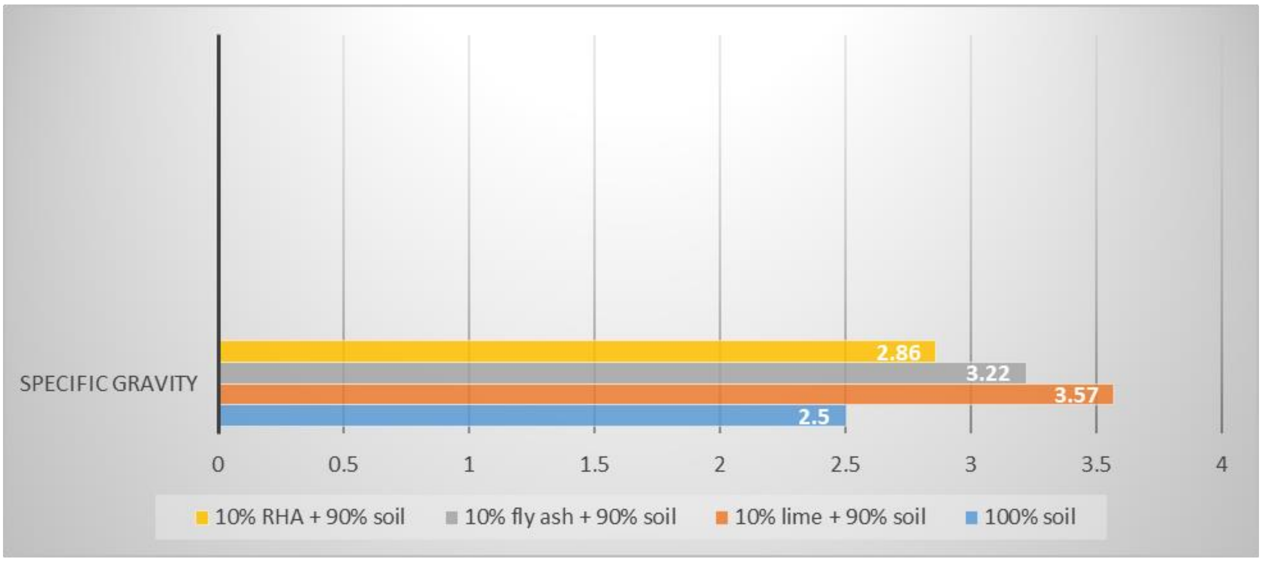


Liquid limit = 0.33

5.2 Specific gravity comparison

This chart signifies the various comparison of specific gravity obtained while experiments performed using various admixture where lime shows higher peak.

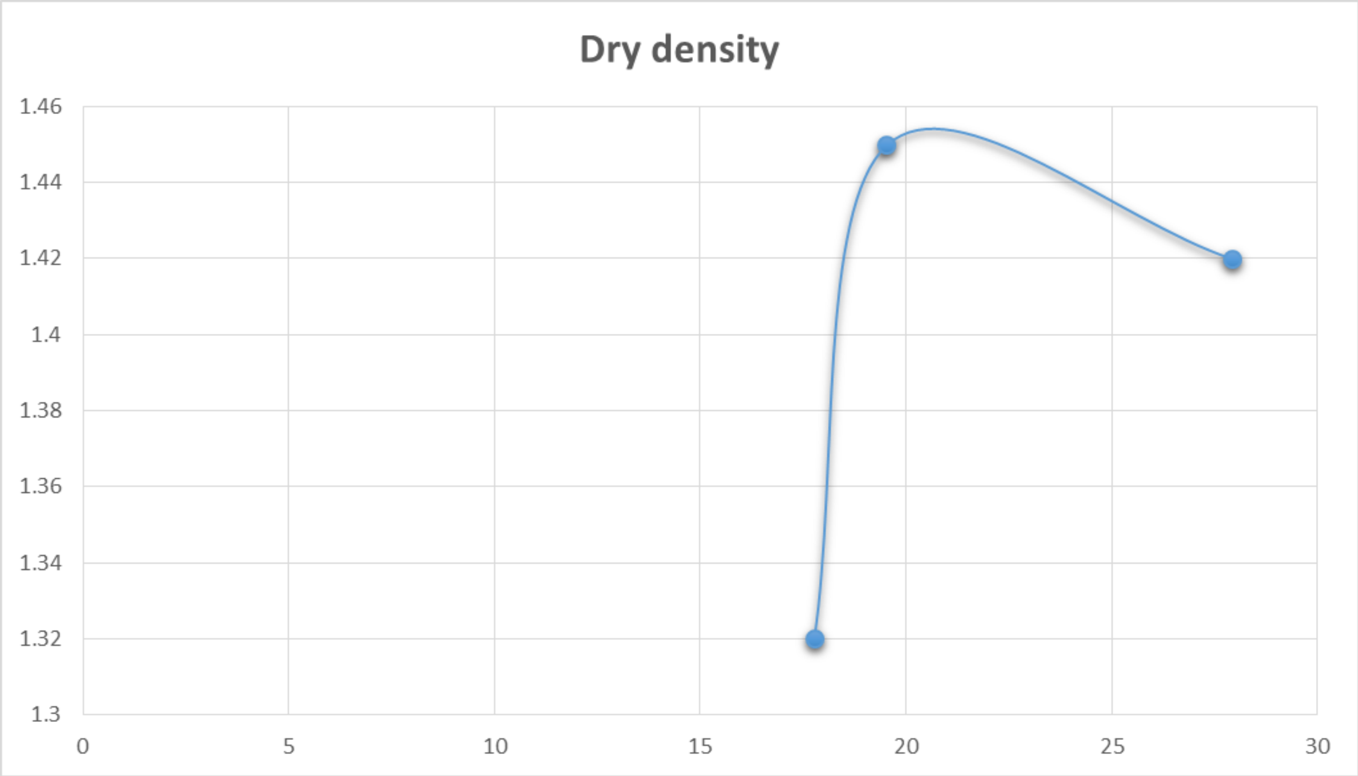
Chart 1: Specific gravity comparison



5.3 Dry density charts

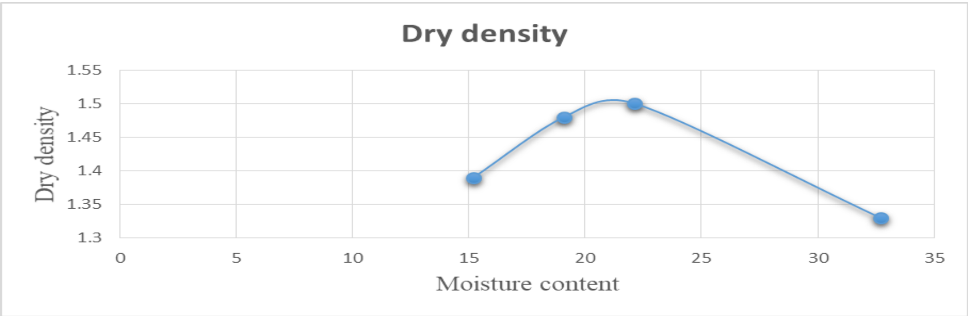
Dry density	1.32	1.45	1.42

Chart for 100% Soil



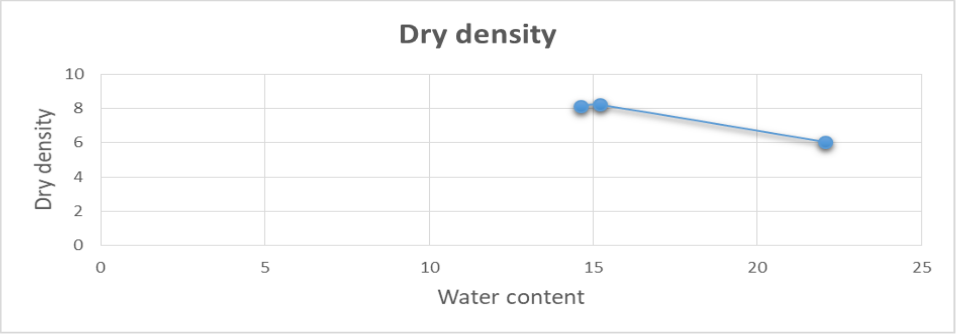
Dry density	1.39	1.48	1.50	1.33

Chart for 10% soil+ fly ash



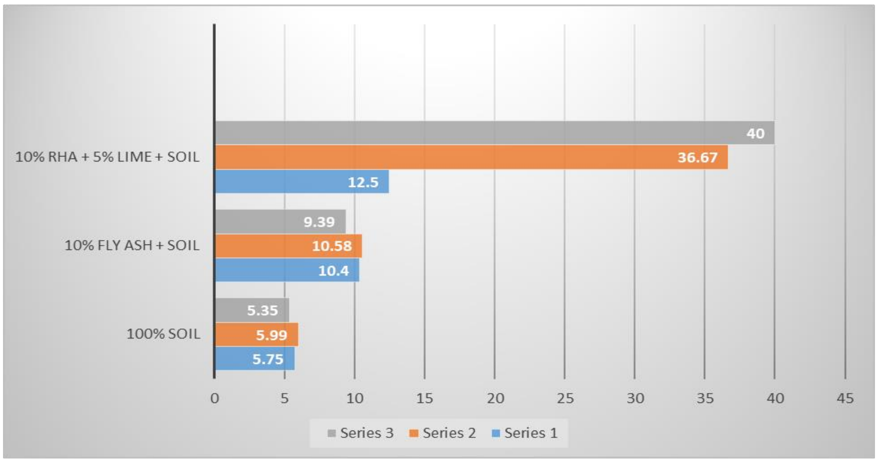
Dry density	8.13	8.220	6.030

Chart for 10% RHA+ 6% lime+ soil



5.4 California bearing test

Chart 2: CBR comparison chart



Above chart signify the variation of load bearing capacity of soil using various admixture.

6. Conclusion

Based on the results obtained and the comparisons made in the project, the following conclusions can be drawn:

During the consistency experiments, specifically the liquid limit and plastic limit tests, a liquid limit value of 0.33 was determined. Due to the high silt content in the soil, attempts to form a 3mm diameter thread were unsuccessful as the soil crumbled easily, and it exhibited a tendency to retain water. Consequently, the soil can be classified as loam with loose properties and a high silt content.

Various tests were conducted including specific gravity tests, standard Proctor tests, and California bearing tests. Through these comparisons, it was concluded that fly ash stabilization improves the engineering properties of the soil. Additionally, the addition of rice husk ash (RHA) with lime enhanced the soil's load-bearing capacity, attributed to the pozzolanic reaction. Overall, it was observed that soil stabilization with lime and RHA yielded better results compared to the use of fly ash.

These findings highlight the effectiveness of fly ash and lime-RHA combinations in enhancing the engineering properties and load-bearing capacity of the soil, indicating their potential for soil stabilization applications.

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