International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-9, Issue-2, April 2022
https://doi.org/10.55524/ijirem.2022.9.2.52
Article ID IJIR-2255, Pages 349-352
www.ijirem.org

Study on Stabilization of Soil Using Plant Roots and Lime

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ABSTRACT- Soil stabilisation is the process of modifying soils in order to improve their physical qualities. Stabilization can improve a soil's load bearing capacity to support pavements and foundations by increasing its shear strength and controlling its characteristics. Stabilization can be used to remediate a variety of soil types, including expansive clays and granular materials. A wide range of additives, such as silica, lime, plant roots, fly-ash, and cement, are used in this process. This project deals with studying the stabilization of soils using plant roots and lime. Samples were collected in this experiment from the Heerpora area of Shopian (J&K) in the year 2021 with the aim to quantify the effect of plant roots and lime on unconfined compressive strength, california bearing ratio. The physical and engineering qualities of the soil were determined through experimental examinations. The material accessible at this area was fine-grained dirt that was silty and clayey in nature. The treatments consisted of five samples with lime and plant roots (0%, 1.5% 3%, 5.0%, 7.0%). The unconfined compressive strength showed an increase with the addition then decrease the study found that optimum percentage of lime and plant root is 3% of dry soil.

KEYWORDS- Lime, Plant Roots, Soil samples, California Bearing Ratio, Cement, Fly Ash

I. INTRODUCTION

This Soil is a precious resource that can be used for a variety of reasons. Gravel, sand, silt, or soft clays may be included in the sample, depending on the type of environment[1]. It can be used for a variety of purposes depending on its classification, including fill material, landscaping, agriculture, landfill covers, creating wetlands for water quality enhancement, bank stability, island development, and wildlife habitat wetlands, among others[2]. All renovation procedures include the use of construction equipment, and choosing the right equipment is crucial[3]. Soil can be utilized as backfill material, flood control. Soil bioengineering is the process of employing plants and their resources to stabilize the soil. The power of the roots stabilizes and strengthens both natural and man-made soils[4]. By combining plants and lime in this project, we may boost the strength of the soil, which is now deficient. The plant's root is taken and inserted into a soil sample, which is then limed. Roots not only offer the soil strength, but they help stabilise the soil mass, keeping it stable during landslides and earthquakes [5]. This can be especially useful in areas where landslides, soil erosion, floods, and earthquakes are common. As a result, test specimens were made with the soil and a 2:1 mixture of lime and plant roots (by dry weight of the soil) at maximum dry density and optimum moisture content, and submitted to various tests as per conventional methods [10]. According to geotechnical investigations, adding this mixture to the soils increased the strength characteristics of the soils. Lime: plant root treatment of these soils results in a significant increase in unconfined compressive strength [6]. The study's key contributions to practise include assessing improvements in mechanical behaviour as a result of lime: plant root treatment and underlining the fact that higher percentages of this mixture could transform stabilisation from an useful to a dangerous procedure [7]. Overall, the primary goal of this research is to successfully manage soil in a way that is safe for people's health and the environment around them. The treated product can be utilised for a variety of applications, including highway and railway embankment, among others. The current research focuses on this element of soil valuation [8]. It looks into how plant roots and lime can be used to stabilise soil and improve its qualities. The relevant parameter has been chosen to be the engineering qualities of soil. The effects of adding lime and plant root in a 2:1 ratio at different percentages ranging from 1.5 percent to 7% on the engineering qualities of the soil were carefully researched [9]. In this study, I will show how varied amounts of lime and plant root mixture affect soil parameters.

II. MATERIALS AND METHODS

Samples were collected in this experiment from the Heerpora area of Shopian (J&K). On visual inspection, the soil sample collected at depth of two meters from the natural ground surface. Various tests and analysis were done to see the effect of lime and plant root on the Soil. Grain size distribution(IS: 460-1962) was done in which passing 75 micron sieve was 75%. Specific gravity of virgin soil was found as 2.63. Consistency of clay(Atterberg limits IS 2720-5 (1985) (Polito 2001) was found to determine liquid limit(A Casagrande), plastic limit and as 39.305, 22.133 respectively. Optimum Moisture Content, Maximum Dry Density were determined by standard proctor test(IS-2720-PART-7-1980) as 21% and 1.623g cc^{-1}(Light Compaction)

and 16.2% and 2.677g cc^{-1} (Heavy Compaction). Unconfined compressive strength is 1.06 kg/cm^2. Consistency of soil shows soil is stiff. Based on these tests, the optimum quantity of lime and plant root required for effective stabilization of Soil was determined. The experimental work of the project was done in two phases. In the initial phase, the basic tests of plain soil sample were done as per relevant IS Codal provisions. In the second phase, the same tests were repeated on the addition of various percentages of lime and plant roots and the deviations from the initial phase were noted and plotted on graphs.

III. RESULTS AND DISCUSSIONS

In this chapter we will study the results of the test which have been conducted on locally available soil stabilized using lime and plant roots are given below:

At 1.5% additives unconfined compressive strength is 2.4225 kg/cm².Calfornia Bearing Ratio is 5.355%.At 3**%** additives unconfined compressive strength is 2.7649 kg/cm²**.**Calfornia Bearing Ratio is 5.813%.At 5% additives Unconfined compressive strength is 1.6885 kg/cm,²Calfornia Bearing Ratio is 5.638%.At 7% additive**s** Unconfined compressive strength is 0.5628 kg/cm².Calfornia Bearing Ratio is 5.535%.Unconfined compressive strength was increased upto 3% of plant roots and lime, same was found by (Ping Guo, Zhenyao Xia, and Wennian Xu 2020)for plant roots.CBR value also increased and then decreased after 3%of additives. (G.S.Utami January 2014) found that CBR value of soil increased to percentage of 5% and 10% of lime while decreased for 15% of lime. The shear strength and UCS of the soil having 4% lemon grass roots is almost double that of the natural soil.Lime acts immediately and improves various property of soil such as carrying capacity of soil, resistance to shrinkage during moist conditions, reduction in plasticity index, increase in CBR value and subsequent increase in the compression resistance with the increase in time found by (Ankit Singh Negi, Mohammed Faizan, Devashish Pandey Siddharth, Rehanjot singh). Table 1 shows the Properties of UCS & CBr at different mixes. Table 2 shows the characteristics of Pure Soil.

Table 1: Properties of UCs & CBR at different Mixes

PROPERTIES	**1.5% mix**	**3% mix**	**5% mix**	**7% mix**
Unconfined compressive strength	2.4225 kg/cm²	2.7649 kg/cm²	1.6885 kg/cm²	0.5628 kg/cm²
CBR	5.355%	5.813 %	5.638%	5.535%

A. Pure Soil Material Characteristics

Table 2: Soil Characteristics

PROPERTIES	**PURE SOIL MATERIAL**
Specific gravity	2.63
Liquid limit	39.305
Plastic limit	22.133
Plasticity index	17.172
Classification	CM
Flow index	31.653
Toughness index	0.542
Max.dry density (light compaction)	1.623 g/cm^3
OMC (light compaction)	21%
Max.dry density (heavy compaction)	2.67 g/cm^3
OMC (heavy compaction)	16.2%
CBR (unsoaked & light compaction)	5.089%
Unconfined compressive strength	1.06 g/cm^2

B. Unconfined Compression Strength Test

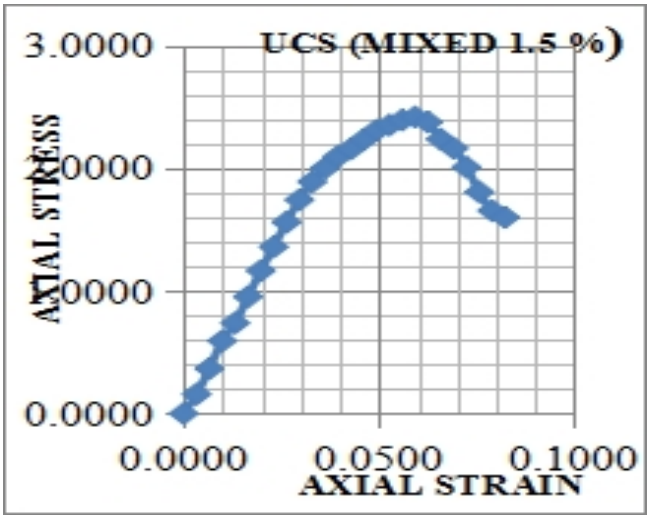

Figure 1: Graph between Axial Stress & Axial Strain at UCS 1.5%

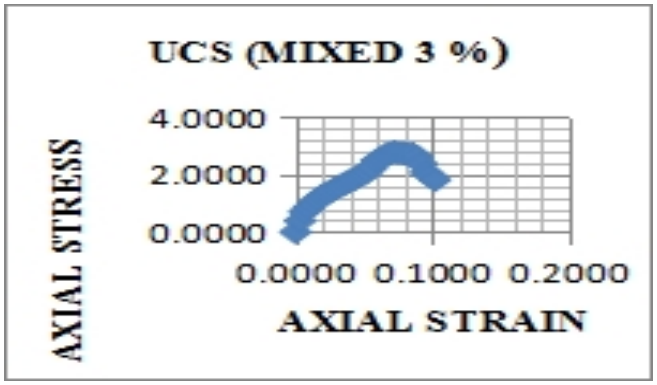

Figure 2: Graph between Axial Stress & Axial Strain UCS at 3%

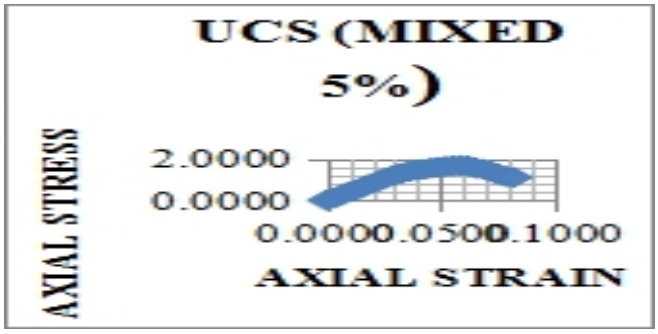

Figure 3: Graph between Shear Stress & Axial Strain UCS at 5%

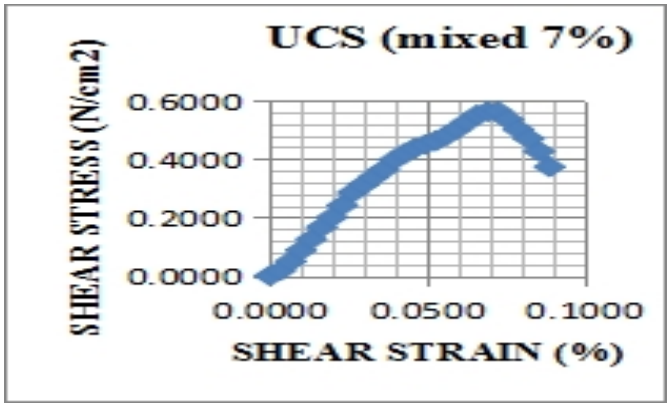

Figure 4: Graph between Shear Stress & Axial Strain UCS at 7%

Figure 1 shows the Graph between Axial Stress & Axial Strain at UCS 1.5%. Figure 2 shows the Graph between Axial Stress & Axial Strain UCS at 3%. Figure 3 shows the Figure 3 & Figure 4 shows the Graph between Shear Stress & Axial Strain UCS at 5%. & 7%

C. CBR Test

The Results of CBR test in which sample is mixed with 1.5%, 3%,5%,7% shown in Figure 5 to Figure 8.

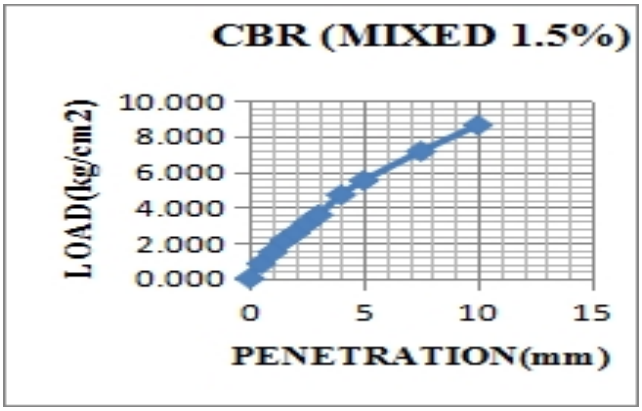

Figure 5: Graph between Load & Penetration CBR at 1.5%

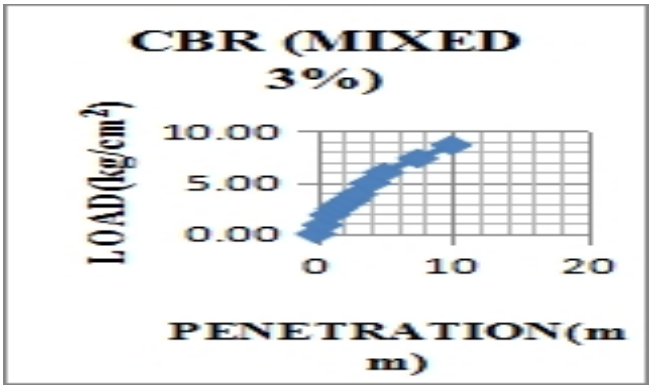

Figure 6: Graph between Load & Penetration CBR at 1.5%

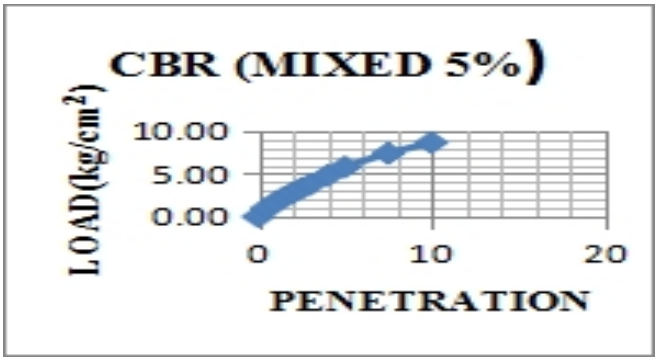

Figure 7: Graph between Load & Penetration CBR at 1.5%

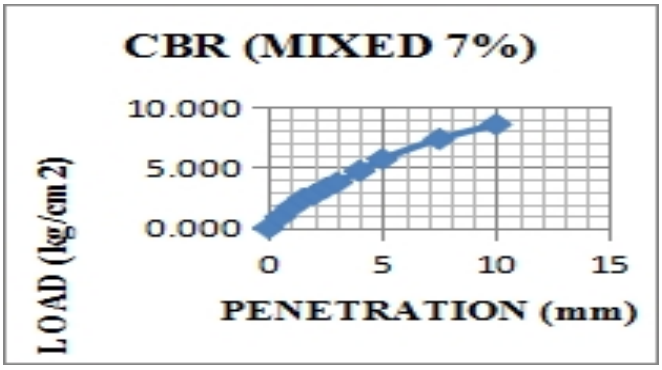

Figure 8: Graph between Load & Penetration CBR at 1.5%

Load penetration curve of UCS & CBR tests are shown in Figure 9 Figure 10

IV. LOAD PENETRATION CURVE

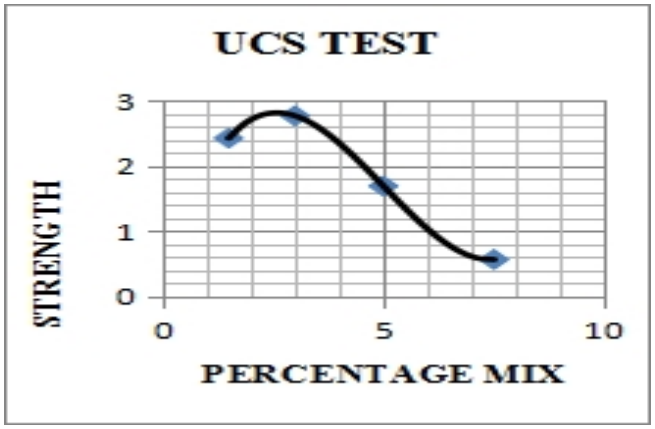

Figure 9: Graph between Load & Penetration CBR at 1.5%

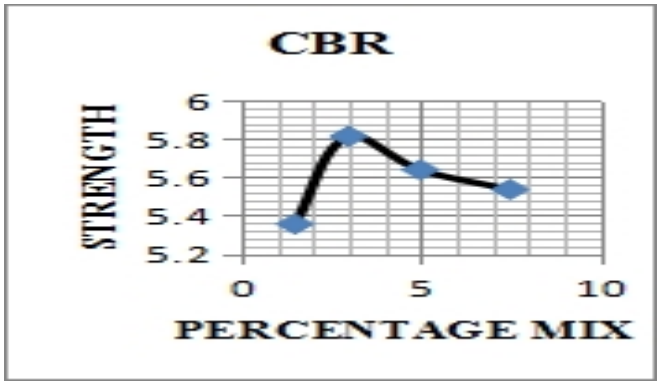

Fig 10: Graph between Load & Penetration CBR at 1.5%

V. CONCLUSIONS

The influence of plant roots and lime combination on various soil material qualities is presented in this study. The following conclusions can be derived from the tests: In an unconfined compression test, pure soil shear strength was reported to be 1.191 kg/cm2. After adding the plant root and lime mixture the strength gradually increased and then decreased. When 3 percent plant root and lime mixture was applied to the soil material, the highest shear strength was 2.7649 kg/cm. As a consequence, the optimal plant root and lime mixture concentration was discovered to be 3%. In percentage terms, the strength grew by 1.5739 percent.

ACKNOWLEDGEMENT

First of all I am extremely indebted to my guide **Er. Ashish Kumar,** Assist. Proffessors, Department of Civil Engineering, RIMT university Mandi Gobindgarh, this work would not have been possible without their support, guidance and his kindness. They have given me enough freedom during my research. I will always remember their calm and relaxed nature, I'm thankful to Almighty for giving me mentor like them.

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