# Effect of Lime and Cement on Unconfined Compressive and Shear Strength of Soil in Baleli and its Vicinity

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**Abstract**

*This study was carried out with an intention to observe any sign of improvement of clayey silty soil due to addition of lime and cement. This paper focuses on the primary research of using blends of lime and cement on the soil of Baleli and its vicinity region to evaluate the features of cement and lime at the shear strength of unsaturated soil through carrying out direct shear and unconfined compression tests on soil samples. Soil admixed along with natural or artificial admixtures is one of the techniques to improve its physical characteristics, consequently we need to alter some features of soil that could make it expedient to calculate the bearing ability of the soil and even stabilize the weight bearing potential. The values obtained here are in comparison with unblended soil samples, at 5% admixed soil with cement and lime showed maximum angle of friction and moderate cohesion but shear strength 30.32 psi achieved at this percentage of lime and cement was greater than other percentages. The unconfined strength of this blended soil presented a compression of 86.32 N/mm$^2$ at 0.0503 mm/mm percent strain which is lower than maximum percentages of lime and cement and conclusions are drawn toward the usability of lime and cement as a value effective approach. Soil sample admixed with 7% lime and cement presented less cohesion than those blended with 3% and 5% lime and cement but greater shear strength as compared to all of the samples including simple soil. The unconfined strength of this blended soil presented a compression of 115.32 N/mm$^2$ at 0.0755 mm/mm percent strain which is lower than maximum percentages of lime and cement. As a significance, its miles better to combine distinctive types of soils collectively to improve the soil vitality back ground.*

**Keywords:** Stabilization; Lime; Cement; Unconfined compression test; direct shear test

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## INTRODUCTION

For any land-based structure, the foundation may be very crucial and has to be strong to maintain the entire structure. So as for the foundation to be sturdy, the soil close by it plays a completely acute role. Soil stabilization is the way toward enhancing the execution of a soil as a development material by utilizing added substances with soil to enhance its volume stability, quality, penetrability and strength. Baleli and its vicinity soil is clayey silty soil. Therefore it possesses some plasticity, low shear strength, which are main reasons of settlement in different engineering structures. We need to stabilize the soil which makes it less complicated expecting the load bearing capability of the soil and even enhance the load bearing potential with help of Chemical additives (cement, fly ash, bitumen, cement and lime). The major goal and objective of the studies described herein is to gain knowledge on the number of outcomes of lime and cement on the Baleli soil. The material set forth in this report is fundamental in serving as a foundation for subsequent research in this field. The study conducted by Ramaji (2012) discussed about lime treated soil types display diminished versatility, lessens volume change qualities and enhanced workability. It ought to be noticed that the properties of lime soil blend relies on the soil types, curing conditions and % of lime. Lime is white or grayish white material. When water is sprinkled over lime than its structure is known as hydrated lime or slaked lime which is for the most part utilized as a part of mortars, concretes and as a dirt stabilizer. Portland bond can be utilized for alteration or change of soil or for cementation of trouble soils. Because of established activity the quality and solidness of soil increments. The measure of bond to be utilized will rely on whether the concrete is to be utilized for alteration or adjustment reason. Portland concrete is water driven bond got by warming lime stone and mud together.

A study showed by Canakci et al. (2014) with a purpose to look at any sign of development of clay soil due to addition of waste soda lime glass powder (WSLGP). Waste soda lime glasses were crumpled and sieved via #200 sieve and combined with clay in 3%, 6%, 9%, and 12% in dry weight of the clay. Shear and consistency check have been accomplished on mixed modes after curing. The test results indicated that the addition of WSLGP into clay has a significant effect on the strength and consistency properties of the clay.

This study by Binala et al. (2016) revealed that little work has been done on clay-silt soil stabilization using organic additives, however, much work has been documented in the literature on the use of traditional additives such as lime, cement, and fly ash. Engineers will be more inclined to use stabilization techniques to strengthen pavement structure in the wake of such factors as increasing aircraft payload, traffic frequency, scarcity of sites with good subgrade bearing values, and the dwindling supply of conventional aggregate revealed that soil mixtures with lime, cement, and fly ash (LCF) base courses have been used extensively, and complex, long-lasting chemical reactions that produce resultant material with acceptable mechanical properties were obtained under the right conditions of temperature and moisture

The study conducted by Cuisinier et al. (2011) discussed about the residue adjustment by presenting distinctive percentage of lime in it. The primary point of this study was to look at the change in microstructure of residue grains immersed in water. The other side shows that as lime particles are extremely littler then sediment ones so there comes an adjustment in the general molecule size of residue which was of various class because of which the dry thickness of residue is expanded however as from past studies the soaked water powered conductivity happens just through bigger spaces between grains which alone residue can enhance by compaction. In this manner this property is very little changed with expansion of lime.

In this study Le-Runigo, et al. (2011) examined that the change was carried by blending the lime with the silty soil. When soil was treated with lime was then opened for long haul conditions. The point of this paper was to know the effect of water powered conditions on the mechanical shear quality of a lime treated silty soil and the impact of beginning conditions i.e. lime substance and compaction conditions on lime settled toughness.

It can be seen that use of soil stabilizers as construction materials has been encouraged since long time. Several studies have been carried out to assess impact of lime and cement as soil stabilizer for improving engineering properties of soil. Decrease rate of erosion during compression test makes a Portland cement a stabilizing agent for all types of soils, except soil having $P^H$ lower than 5.3 or having organic content exceeding 2%. Maximum dry density of sand and highly plastic clay increases with cement and lime treatment, whereas for silt it decreases. It also shows that increment in cement and lime decreases plasticity index.

## MATERIALS AND METHODS

This study is focused on characterizing the soil obtained from depth of 5 feet via digging various pits in Baleli and its vicinity, by performing the natural moisture content, particle size distribution, Atterberg limits, Standard proctor test and reviewing the literature related to the nature of laboratory work and performing standard mixing of stabilizers with soil. The soil testing will be defining the effectiveness of several percentages of lime and cement on shear and compressive strength of soil with direct shear box and unconfined compressive test respectively. All the samples used in this study were examined inside the laboratory by means of American Society of Testing and Materials. The experimental process consists of the subsequent steps:

- Natural moisture content (ASTM D4643)
- Sieve Analysis (ASTM 6913)
- Determination of Atterberg Limits (ASTM 4318)
- Liquid limit by Casagrande’s apparatus
- Plastic limit
- Determination of the maximum dry density (MDD) and the corresponding optimum moisture
- Content (OMC) of the soil by Standard Proctor Compaction test (ASTM 698)
- Preparation of admixture containing soil samples
- Determination of the shear strength by:
- Direct shear test (ASTM 6528)
- Unconfined compression test (ASTM D2116)

## RESULTS AND DISCUSSION

### Sample Preparation

Soil attained from different locations of Baleli and its vicinity were dried in oven at 110-115 C° temperature. After drying, admixtures were added at different percentages along with the mentioned OMC and then compacted with standard proctor test. Direct Shear tests and Unconfined Compression tests were conducted after the compacted soil samples were removed from molds as shown in Figure 2 and 3 respectively.

Direct shear box test of blended soil with 3%, 5%, 7% lime, cement and lime plus cement are presented in figure.4. 5% lime plus cement shows greater amount of increment in shear strength and cohesion as compared to that of simple soil sample as shown in figure 4 and 5. It also indicates that this percentage has huge amount of shear strength difference than other percentages of admixtures. The increase in shear strength of blended soil with 5% lime plus cement compared to simple soil represents a difference of 22.99 psi, While that of 5% cement it's around 21.56 psi as shown in figure 4. The shear strength obtained from this percentage of lime plus cement is the greatest according to this research.

**Table 1:** Basic Geotechnical Properties

| Parameters | Determination |
|---|---|
| **Moisture content (%)** | 13.54 |
| **Liquid Limit** | 24 |
| **Plastic Limit** | 23.66 |
| **Plasticity Index** | 1.64 |
| **OMC (%)** | 14.7 % |

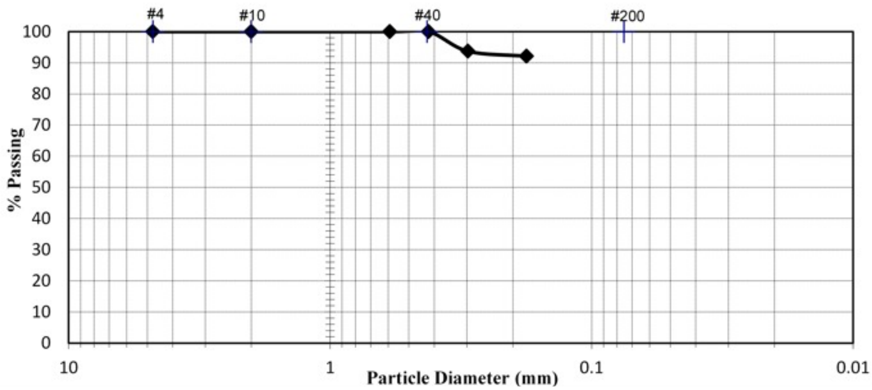


**Figure 1:** Sieve Analysis

**Figure 2:** Direct Shear Sample

**Figure 3:** UCT Sample

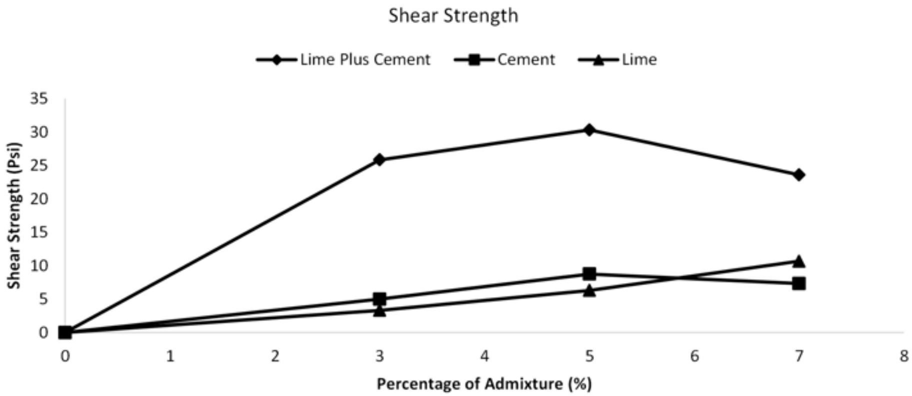


**Figure 4:** Direct Shear of Blended Soil Sample

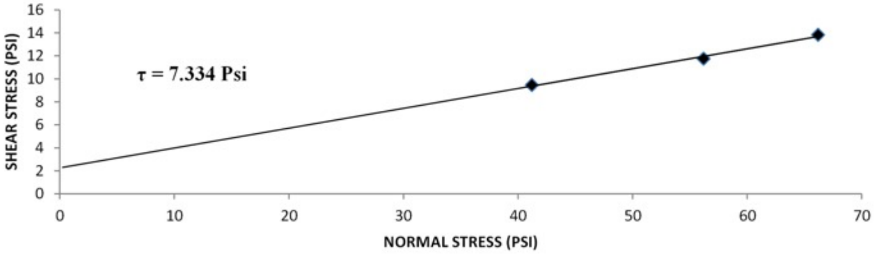


**Figure 5:** Direct Shear test of Simple Soil

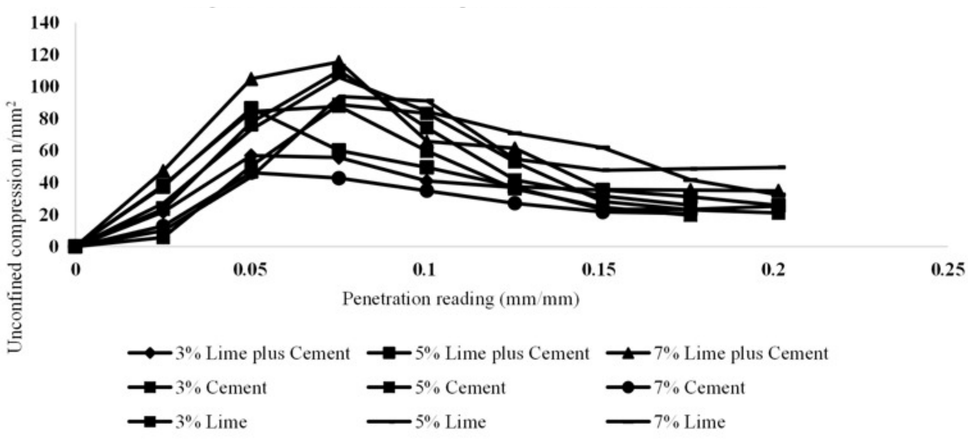


**Figure 6:** Unconfined Compression test of Blended Soil

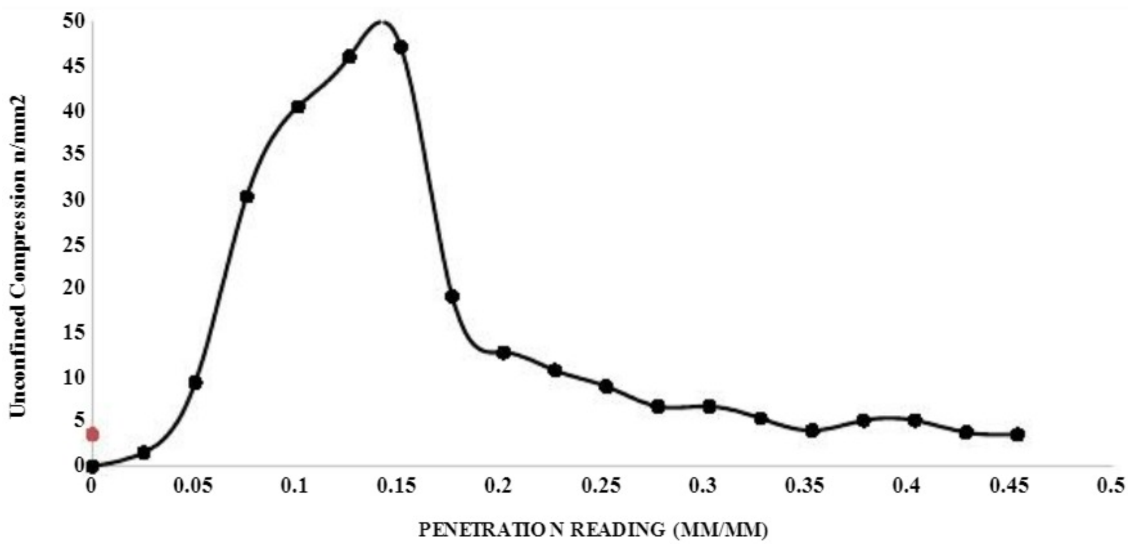


**Figure 7:** Unconfined Compression Test of Simple Soil

The compression test was performed on blended soil with percentages of 3%, 5%, and 7% Cement, Lime and lime plus cement, which was prepared with OMC to evaluate its compression strength. The variation in UCT was determined and the test results showed a maximum value of 56.87 N/mm$^2$ at 3% lime plus cement against a percentage strain of 0.0503 mm/mm, a maximum value of 86.32 N/mm$^2$ at 5% Lime plus cement against a percentage strain of 0.0503 mm/mm and a maximum value of 115.32 N/mm$^2$ at 7%. Lime plus cement against a percentage strain of 0.0755 mm/mm as presented in figure 6. Maximum Compression was achieved at 7% lime plus cement admixed soil. The unconfined compression test was performed on raw soil which was prepared with OMC to evaluate its compression strength. The variation in UCT was determined and the test results showed a maximum value of 46.08585 N/mm$^2$ against a percentage strain of 0.12598 mm/mm as shown in figure 7.

## CONCLUSION

Soil sample admixed with 7% lime and cement presented less cohesion than those blended with 3% and 5% lime and cement but greater shear strength as compared to all of the samples including simple soil. The UCS conclusions of this blended soil presented a compression of 115.32 N/mm2 at 0.0755 mm/mm strain which is lower than maximum percentages of lime and cement 5% admixed soil with cement and lime showed maximum angle of friction and moderate cohesion but shear strength achieved at this percentage of lime and cement was greater than all of the blended percentages. The UCS conclusions of this blended soil presented a compression of 86.32 N/mm2 at 0.0503 mm/mm percent strain which is lower than maximum percentages of lime and cement. Outcome of 3% lime and cement showed greater cohesion than 5% admixed soil sample while less angle of friction and shear strength characteristics. But it should be noted that shear strength and compression characteristics was greater than those samples blended with only one parameter.

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