The geotechnical improvement of Talesh peat soil with cement

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ABSTRACT: Chemical stabilization of soil using cement is one of the old methods which have been used to improve the soil performance. Many research papers on the usage of cement as the soil stabilization material has been done all around the world; but peat stabilizing with cement has been in the less research attention so far. Since, many of the upper layers of linear project `s substructure, like roadway and railroad as well as pipeline projects especially in forest lands and agriculture fields is from organic soils, then it would be worthwhile making the substructure `s soil stabilization appropriately. This study attempts to test the improvement of the physical and geotechnical properties of stabilized peat soils using some laboratory samples with different percentages of peat soil, cement and sand. The results indicate that the use of cement and sand mixture in peat stabilizing obviously makes significant improvements on the geotechnical properties of these kind of soils.

1 INTRODUCTION

All soils with organic content greater than 20% are known as organic soil. Peat is partially or totally decomposed remains of dead plants which have accumulated under water for tens to thousands of year. The content of peat soil differs from location to location due to the factor such as the origin fiber, temperature and humidity. Peat soil is an organic soil with organic content of more than 75% (Huat, 2004).

Peat is a mixture of fragmented organic material formed in wetlands under appropriate climatic and topographic conditions and it is derived from vegetation that has been chemically changed and fossilized (Edil and Dhowian, 1980).

Peat soils have been classified to 10 degrees of humification (H1-H10) by Von post (1922) based on degree of humification, botanical composition, water content and content of fine and coarse fibers.

Consistency or Atterberg limit is not generally used for classification of peat because plasticity gives little indication of the characteristics of peat (Hobbs, 1986), and the existence of fiber makes it difficult or impossible to carry out the test for determination of liquid limit and plastic limit of most peat. Nevertheless, some researchers have reported the liquid limit and plastic limit of fibrous peat soil (Huat, 2004).

The presence of fibers makes both liquid limit and plastic limit measurement difficult but the determination of Atterberg limits for amorphous or granular peat may be possible (MacFarlane, 1969).

Stabilization with chemical additive involves treatment of the soil with some kind of chemical compound, which when added to the soil, would result in chemical reaction. The chemical reaction modifies or enhances the physical properties of a soil (Van Impe, 1989).

Cement chemical reaction alone is insufficient to provide the desirable function for peat stabilization. Adding some portion of well graded sand, which act as filler material is also effective for soil-cement stabilization. Compared with clay and silt, peat has a considerably lower content of clay particles that can enter into secondary pozzolanic reactions (Janz and Johansson 2002).

To evaluate the physical and geotechnical properties improvement of stabilized peat, laboratory investigation on stabilized soil was performed to formulate a suitable and economical mix design that could be effectively used for the soil stabilization.

In this study the effect of cement and sand mixture is examined on the Atterberg Limits, Compactibility and Unconfined Compressive Strength.

2 MATERIALS

2.1 Peat

Peat soil has been identified as one of the major groups of soils found in Northern area of Iran.

Peaty soils for this laboratory testing investigation were obtained at depth of 0.1 to 0.4 m below the ground surface from Kolou area, Rezvanshahr County at Talesh Mt forests in Guilan province.

Water table was at the ground surface. Therefore the soil is completely saturated. From visual observation on the peat the color was dark.

2.2 Cement

A Portland cement particle is a heterogeneous substance, containing minute tricalcium silicate (C_3S) dicalicum (C_2S), tricalcium (C_3A), and solid solution described as tetra calcium aluminoferrite (C_4A) (Lea,1956). When the pore water of the soil encounters with cement, hydration of the cement occurs rapidly and the major hydration (primary cementitous) produces hydrated calcium silicates (C_2SH_x, C_4AH_x), and hydrated lime $Ca(OH)_2$ (Bergado et. al, 1996).

2.3 Sand

The sand as a fillers fills the voids by creating a more compact and higher load-bearing capacity. The filler has no chemical reaction but increases strength. By replacing a certain portion of the cement with sand, the cost of stabilization may at least theoretically be reduced (Janz and Johansson 2002). The sand that was used in the laboratory experiments was collected from Kiashahr Port in Guilan Province.

Grading diagram of sand are used in this investigation are presented in Figure 1.

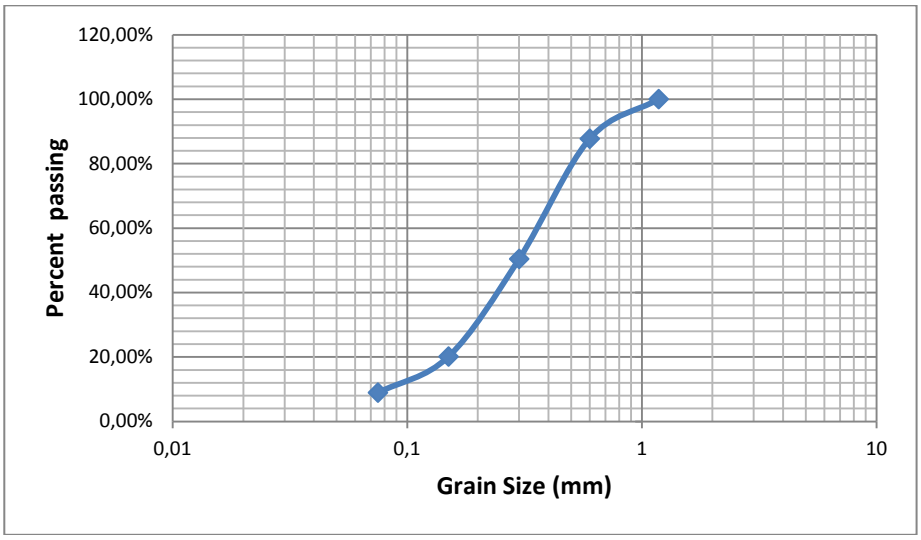


Figure 1: Grading diagram of sand

3 LABORATORY PROCEDURES

3.1 Preparation of Samples

Samples of forest soils were collected from Kolou area and were transported to Guilan University to be tested in the laboratory. Passing soil through sieve No. 30, roots and coarse particles were removed from the natural state of wet forest soils. This process was followed to create homogeneity in soil samples. At the initial stage, physical properties tests and after that Atterberg Limits tests, Compaction test and Unconfined Compressive Strength test were performed on untreated soil. All of the referred tests were based on ASTM.

During the next stage, Cement and Sand of different mixing proportions were gradually added to soil.

For performing UCS Test, samples which have been removed from the mold, are cured for 7, 14, 28 day in desiccators. Then they are put in the water container for 4 hours to be saturated.

3.2 Testing process

In the testing process, preliminary tests such as tests of moisture content, specific gravity, organic content, etc. on natural peat was done based on ASTM.

Atterberg Limits Test and Compaction Test were performed on the peat. The results of such tests were evaluated to see the effects of different ratios of Cement and Sand on physical properties of peat.

The results of Unconfined Compressive Strength Test were evaluated to see the effects of different ratios of Cement and Sand on geotechnical properties of peat.

For soil homogenization, the naturally saturated peat was allowed to pass through sieve NO. 30. A mixer was then used to mix the peat to ensure that moisture, cement and sand was uniformly distributed throughout the soil.

4 RESULTS AND DISCUSSIONS

4.1 Physical properties

Some basic properties after performing preliminary tests on Peat are presented in Table 1.

Table1. Kolou peat basic physical properties

Parameters	Value
Liquid limit (%)	71.8
Plastic limit (%)	70.9
Organic content (%)	85
Specific gravity	1.6
Natural Moisture Content (%)	400
Ash Content (%)	14.9
Fiber Content (%)	75
pH	4.2
Degree of humification (von Post system)	H8

4.2 Atterberg Limits Test

Cement and Sand mixture has a considerable influence on decreasing the limits of liquid and plasticity. In this process, improvement is indicated by significant reduction of liquid and plastic limits. (Figures 2& 3)

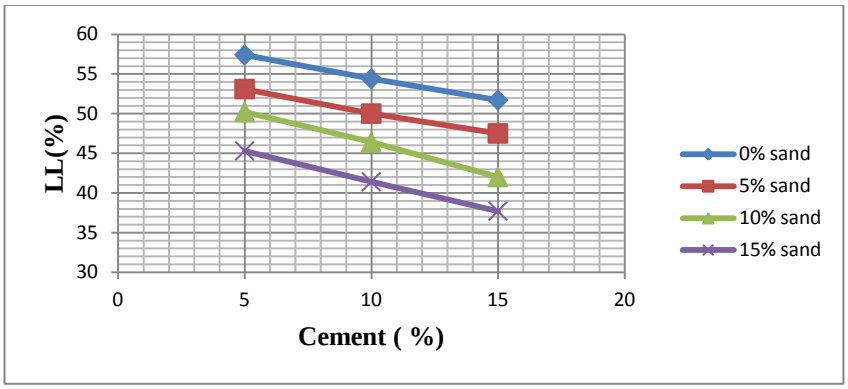


Figure 2: Liquid Limit of Stabilized Peat

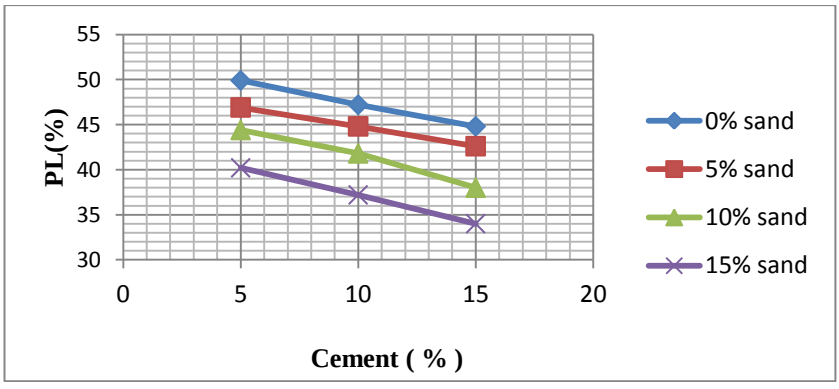


Figure 3: Plastic Limit of Stabilized Peat

4.3 Compaction (Standard Proctor) Test

In order to finding maximum density of dryness and optimum content of moisture Compaction Test based on ASTM D 698 Method A is performed. Standard Protector Test was conducted on untreated and treated peat after mixing process. The results of such observation have been shown in Figure 4.

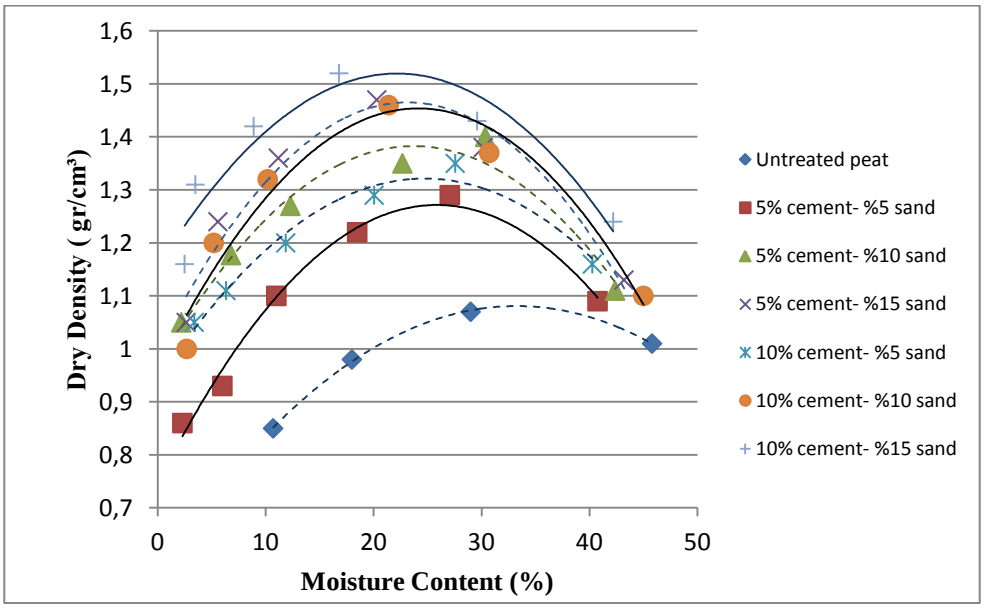
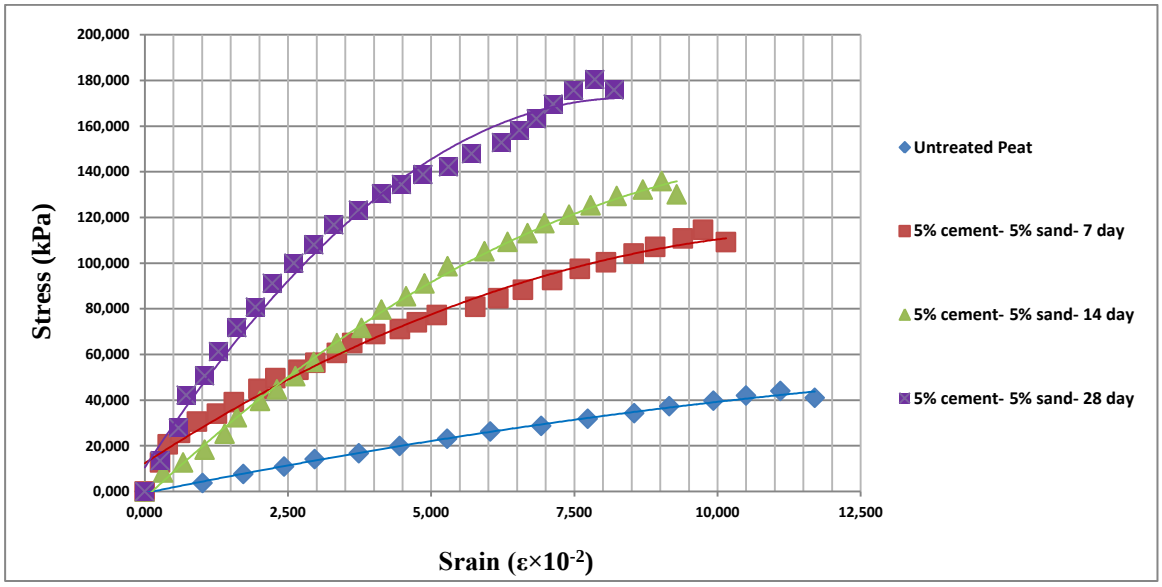


Figure 4: Compaction test results on treated and untreated Peat

4.4 Unconfined Compressive Strength Test

The UCS tests for stabilized peat samples were conducted after being cured at ages of, 7, 14, and 28 days. It is worth to put forward that the unconfined compressive strength of untreated soil was 44 kPa in its natural state. Unconfined compressive strength of soil increases when cured. Diagram related to unconfined compressive strength test in Figure 5 has been shown.

Understood from the results that cement by creating adhesion between the particles of soil and sand, it has good effects on unconfined compressive strength.



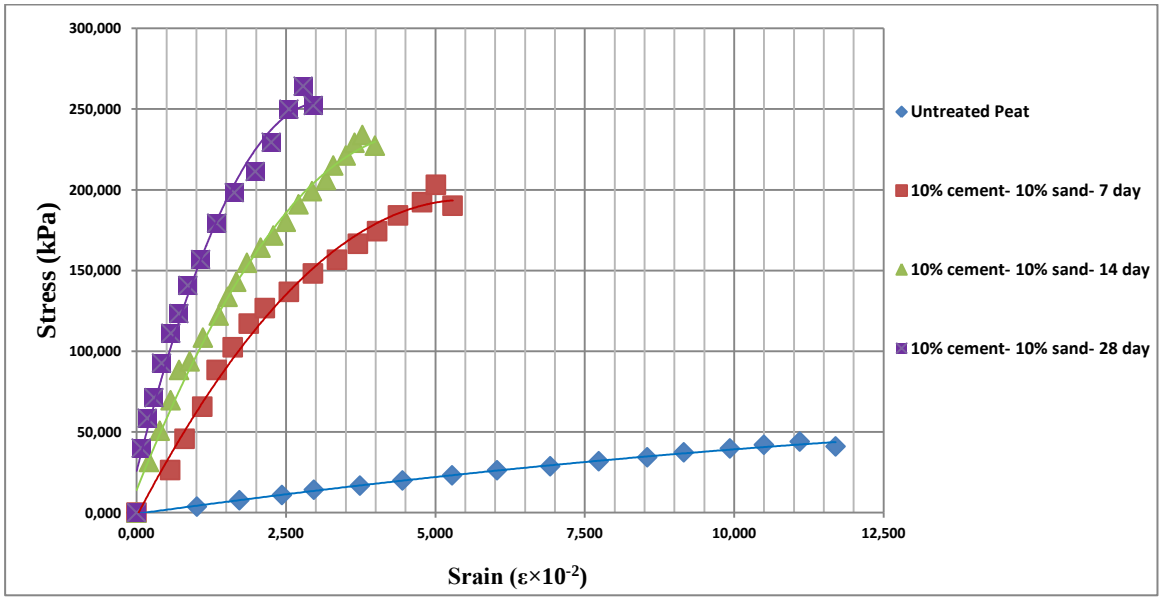


Figure 5: Unconfined Compressive Strength Test Results on Treated and Untreated soils.

5 CONCLUSIONS

The present study was conducted to investigate the effects of various quantities of Cement and Sand mixture on the physical and geotechnical properties of the peat soils of Talesh Mt Areas. This laboratory investigation led to the following conclusions:

- The results of this investigation show us Cement and Sand mixture affected on liquid limit and plastic limit of peat.

- The results of Standard Proctor Test showed that by an increase in the cement and sand content, the Maximum dry density of treated sample of the peat have noticeable change.

- Regarding the results, adding of cement and sand mixture causes increasing of unconfined compression strength in soil. In 5% cement- 5% sand sample, UCS after 28 days curing increases up to 180.4 kPa and this value for 10% cement- 10% sand sample increases up to 264.1 kPa.

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