Permeability of Polymer Modified Sulfate Contaminated CL Soil

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1-Abstract: Several cases have been reported describing the premature failures of stabilized sulfate soil subgrades. The reasons for these failures could be the ineffectiveness of stabilizer dosage or due to loss of stabilizer from soil over a period of time due to flooding and rainfall infiltration. In this study performance of polymer treatment was compared to the lime treated sulfate soil. The performance of the treated soils was characterized based on permeability tests.

2-Introduction

The American Society of Civil Engineers estimates that most of the projects built on sulfate soils will develop some damage with time. The study claims that these soils are responsible for more home damage every year than floods, tornadoes, and hurricanes combined. Gypsum is soluble and along with associated sulfates, such as calcium sulfate and magnesium sulfate, can dissolve in water to form a weak acid solution that is corrosive to concrete in areas where the percentage of sulfate soil is greater than 1%. Sulfate -induced corrosion of unprotected concrete slabs, walls, and masonry in the blocks in metropolitan areas and the damage can become severe after just a few years of exposure. Lime, Portland cement and fly ash are the popular compounds used to stabilize clayey soils. Though these chemicals stabilize the soil temporarily, their effectiveness is lost over a period of time. This effect of losing the additive from treated soils is mainly caused from external activities such as fluctuating water table and rainfall infiltration (Chittoori 2011). Leaching of a soil is the parameter used to measure the permanency of the stabilizer. This permanency decreases with time due to environmental effects like surface runoff. In this study, a simulation of water inflow into the sulfate soil due to rainfall was replicated with the help of leachate apparatus (Fig.1). Monitoring the amount of water leached out of the untreated sulfate soil and treated sulfate soil using 6% lime and 10% of polymer solution up to seven days.

3-Objectives

The objective of this study was to compare the effect of polymer treatment to the lime treatment of sulfate contaminated CL soil based on the permeation characteristics of the soil.

4-Materials and methods

The fine-grained soil samples were first dried in an oven at approximately 105 °C to perform the physical characterization tests. Uncontaminated soil was initially analyzed for index properties and classified using the unified soil classification system. All the laboratory tests were performed using the ASTM specifications. Field soil was contaminated using 4% of calcium sulfate. Permeability tests for treated and untreated sulfate contaminated soil using 6% lime and 10% of polymer solution (P) were performed. The treated soil samples using lime and polymer solution were compacted at their optimum moisture contents and tested at a hydraulic gradient of 49 and 84 respectively. Time versus discharge (mL) was recorded up to 7 days.

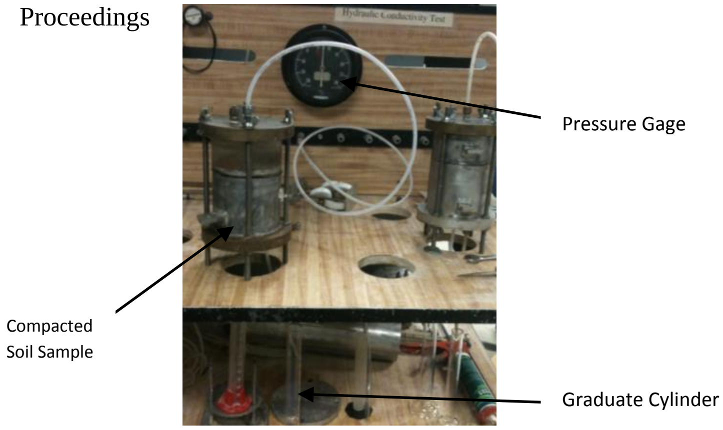

Figure 1. View of the Permeability Test

Table 1. Index and Compacted Properties of Selected Soil

Soil Type	LL %	PI %	OMC %	$\gamma_{dmax.}$ (gm/cm^3)	Gs
CL	23	9	10	1.88	2.66

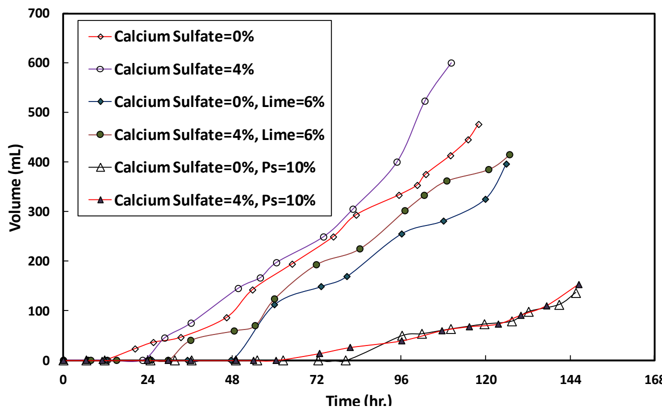

Figure 2. Relationship Between Water Penetrated with Time

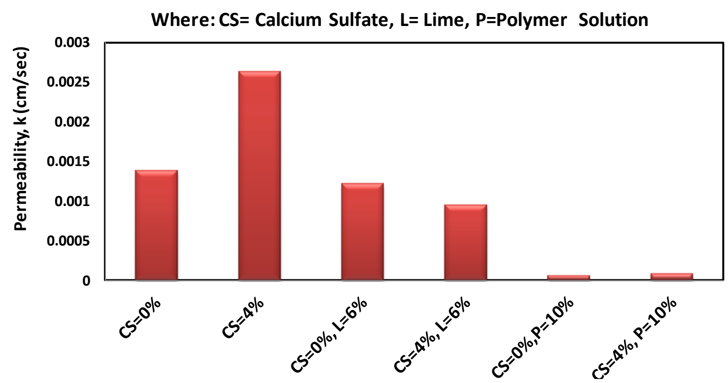

Figure 3. Permeability Test Results for soils

5-Analysis and Discussion:

The calcium sulfate concentration in the soil was 4% (40,000 ppm), the soil samples were cured for seven days at 25°C and 100% humidity before testing. The permeability of the compacted CL soil was 1.37*10^{-3} cm/sec. The coefficient of permeability of treated sulfate soil using 6% lime and 10% Ps were reduced by 43% and 90% respectively.

6- Conclusions

Based on this study on a sulfate contaminated CL soil treated using polymer solution (P), the coefficient of permeability was reduced by 95% and 96% for the soils with 0% and 4% of calcium sulfate content respectively. Also the polymer treated soil had lower permeability than lime treated soil.

7- Acknowledgements

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8- References:

1. Chittoori, S., Puppala, A.J., Pedarla, A., Hoyos, L., Nazarian, S. and Saride, S. (2011).” Leachate studies on lime and portland cement treated expansive clays.” Geo-Frontiers, ASCE, pp. 4479-4488.
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