Behavior of Polymer Modified Expansive CH Soil

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Abstract: In this study the effect of stabilizing an expansive CH soil using a polymer solution was investigated. Modified clay specimens were characterized based Atterberg limits, standard compaction, and unconfined compressive strength. Based on the limited experimental study the expansive CH clay soil behavior was modified.

1. Objective

The main objective of this study was to investigate the effect of polymer treatment on the geotechnical behavior of an expansive CH soil.

2. Introduction:

Expansive clay soils undergo large amounts of heave and shrinkage due to seasonal moisture changes. These movements lead to cracking and buckling of the infrastructure built on the expansive soils and result in billions of dollars of damage annually (Nelson and Miller 1992). A difficult problem in civil engineering works exists when the sub-grade is found to be clay soil. Soils having high clay content have the tendency to swell when their moisture content is allowed to increase. Many studies have been done on the subject of soil stabilization using various additives, the most common methods of soil stabilization of clay soils supporting pavement work are by adding cement and lime. The hazards posed by expansive soils with regard to the civil engineering structures (buildings, roads, pavements, slab-on-grade, and other lightly loaded structures) have been documented around the world. (Al-Rawas, 2005).

3. Materials and Testing Method:

A field CH soil was selected for this study. The properties of soil used in this study are summarized in Table 1. Water soluble polymer solution was added in varying amounts to modify the soil used in this investigation.

Table 1. Index and Compacted Properties of Selected Soil

Soil Type, USCS,	% Passing Sieve #200	Specific Gravity	LL %	PI %	OMC %	Max. Dry Density (gm/cm^3)
CH	97.1	2.74	79	35	22	1.42

4. Results and Analysis

Based on the experimental results the index properties (LL% and PI%) of CH soil were decreased with the addition of 20% amount polymer solution by 29% and 80% respectively, fig (1). Compressive strength and maximum dry density of the modified CH soil were increased at 10% of polymer solution by 18% and 4% respectively, fig (2 &3,b).Also the optimum moisture content of the soil was decreased at 10% of polymer solution by 5%,fig.(3,a). Based on the test data, second order nonlinear relationship is proposed as follows***:***

$$Y-Yo=Ax^2+Bx \text{ ..... } (1)$$

Where:

Y= Index properties or compaction properties or compressive strength, UCS.

Yo= Index properties or compaction properties or compressive strength, UCS at 0% polymer solution.

A & B=Constant. , X =Polymer solution content (%).

Table 2. Model Parameters for the Modified Soil

Y	LL%	PI%	OMC%	$\gamma_{dmax.}$	UCS
Yo	79	34.40	22	1.4	49.6
A	0.06	0.031	0.007	-0.0002	-0.067
B	-2	-1.5	-0.173	0.007	1.5
R^2	0.96	0.98	0.96	0.86	0.95

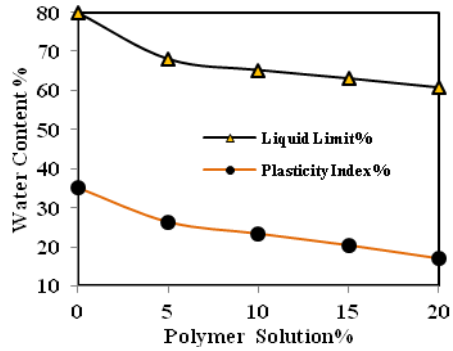

Figure 1 Variations of Index Properties with different Polymer %

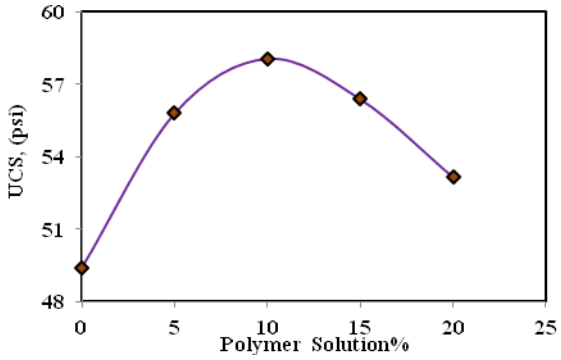

Figure 2Variation of Compressive Strength of Soil with Different percentage of polymer

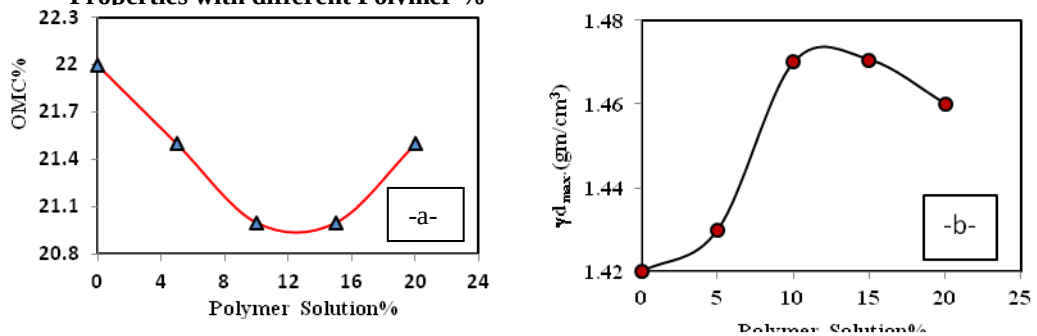

Figure 3Compaction Characteristics of Soil with Different Acrylamide polymer % (a) Optimum Moisture Content% (b) Max. Dry Density

5. Conclusions

Based on this study on a CH soil treated using a polymer solution, the index properties were reduced with increasing polymer content .The compressive strength and maximum dry density had optimum values with the addition of 10% polymer solution.

6. Acknowledgements

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7. References:

1. Abdullah, W.S., Alshibli, K.A. and Al-Zoubi, M.S. (1999). Influence of Pore Water Chemistry on the Swelling Behavior of Compacted Clays, Applied Clay Science, 15: 447-462.
2. Nelson, D. and Miller, W. (1992). Expansive Soils: Problems and Practice in Foundation and Pavement Engineering. New York: Wiley.
3. Al-Rawas, A.A., Hagoa, A.W. and Al-Sarmib, H. (2005). Effect of Lime, Cement and Sarooj (Artificial Pozzolan) on the Swelling Potential of an Expansive Soil from Oman. Building and Environment, 40: 681-687.