Stabilization of an Expansive Soil by Lime Pile and Lime Precipitation Techniques – A Comparative Study

K. S. R. Kumar[1*], T. Thyagaraj[2]

[1]Research scholar, Department of Civil Engineering, IIT Madras. (**srkumark88@gmail.com)**

[2] Associate Professor, Department of Civil Engineering, IIT Madras (**ttraj@iitm.ac.in)**

BACKGROUND

Lime columns (LCs), lime piles (LPs), and lime slurry pressure injection (LSPI) is adopted for stabilizing expansive soils extending for greater depths. However, LCs are mostly suitable for soft clays due to difficulties in mixing lime with stiff to very stiff expansive clays. Lime pressure injection will depends on extent of shrinkage cracks in terms of depth and radial distance (Thyagaraj and Zodinsanga 2015 ; Thyagaraj et al., 2016).

- In view of challenges in implementing LCs, LSPI for stabilizing deep expansive soils Thyagaraj et al. (2012), Thyagaraj and Zodinsanga (2015) and Thyagaraj et al. (2016) proposed a new method called as Lime Precipitation Technique (LPT) by sequential permeation of laboratory grade $CaCl_2$ and NaOH solutions to precipitate lime in compacted expansive soil and it has given good results. Implementation of this technique in the field is possible only with the use of commercial grade chemicals ($CaCl_2$ and NaOH salts) owing to cost implications and material feasibility.
- However, the behaviour of lime precipitation is not known using commercial grade $CaCl_2$ and NaOH solutions. Hence in the present paper, an attempt is made to stabilize the compacted expansive soil using commercially available $CaCl_2$ and NaOH solutions for permeation of lime and compare the results with lime pile technique.

METHODOLOGY

Materials

Soil : Expansive soil collected from Trichy

Stabilizer : commercial grade $CaCl_2$, NaOH salts and $Ca(OH)_2$

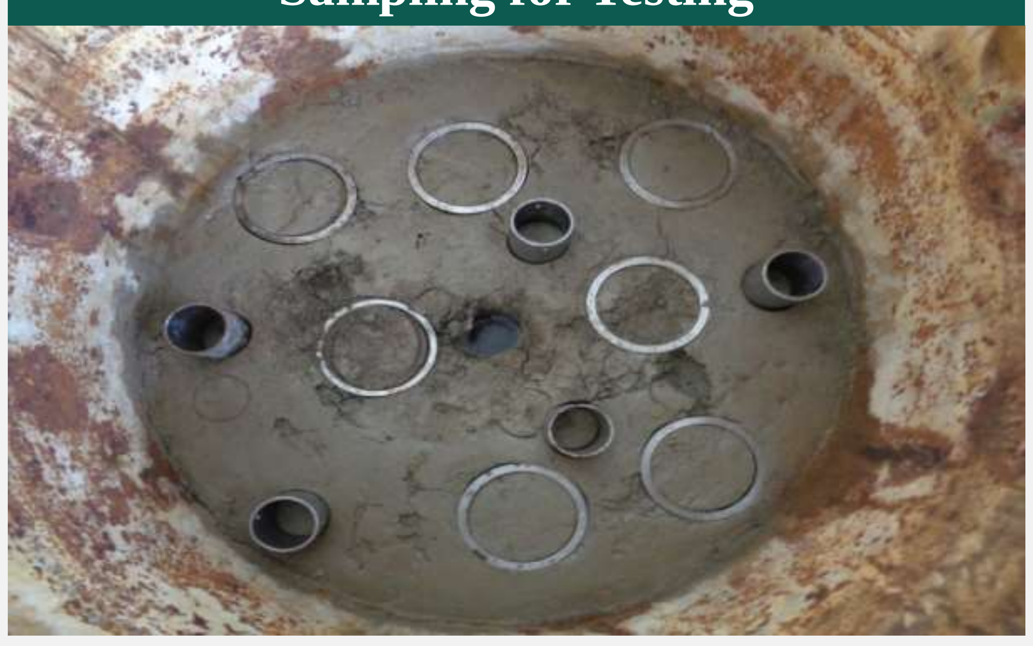
Circular tank of 500 mm dia

Preparation of test tank

Lime Precipitation

Lime pile Curing

Sampling for Testing



Experiments done

Preliminary Tests : pH, conductivity, Consistency limits, optimum lime content by Eades and Grim method, grain size distribution (GSD), Swell potential, unconfined compressive strength (UCS)

RESULTS

Table 1. Comparison of Physico-chemical, grain size distribution (GSD), and index properties of LP and LPT treated and untreated specimens of expansive soil

Specimen designation	Radial distance (d)	pH	Pore salinity (mg/l)	GSD Silt (%)	GSD Clay (%)	Liquid limit (%)	Plastic limit (%)	Shrinkage limit (%)
Untreated	-	8.52	321	18	49	92	22	8
Lime pile treated	0.8	10.06	769	26	41	84	28	10
	1.5	8.95	603	20	47	92	25	9
	2.0	8.54	417	19	48	93	22	8
Lime precipitation treated	1.7	10.94	6298	27	40	68	30	25
	2.5	10.53	5324	22	45	72	27	20
	4.0	10.16	4220	20	47	74	25	15

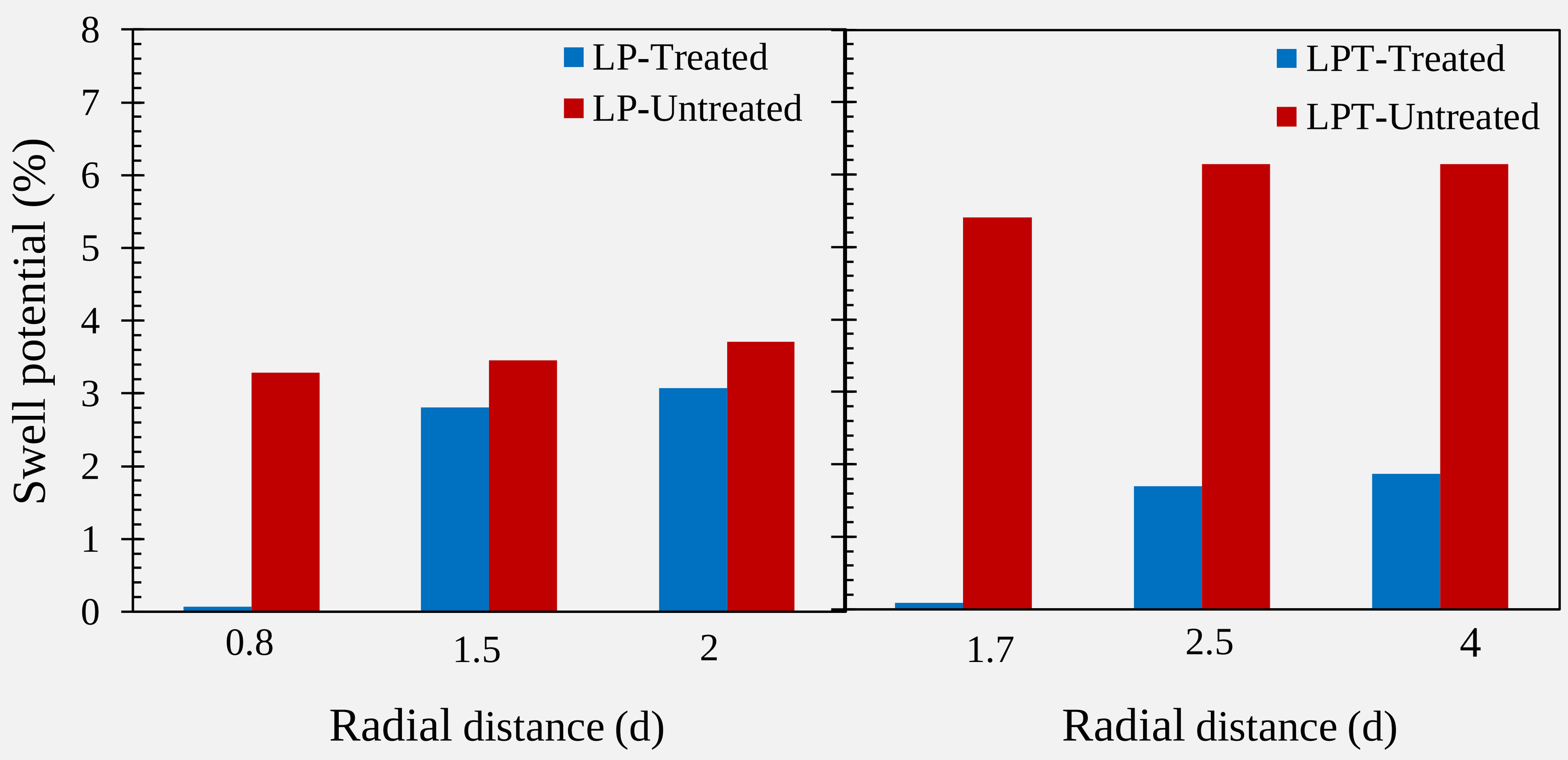


Fig. 1: Comparison of swell potential of untreated and treated specimens sampled at different radial distances

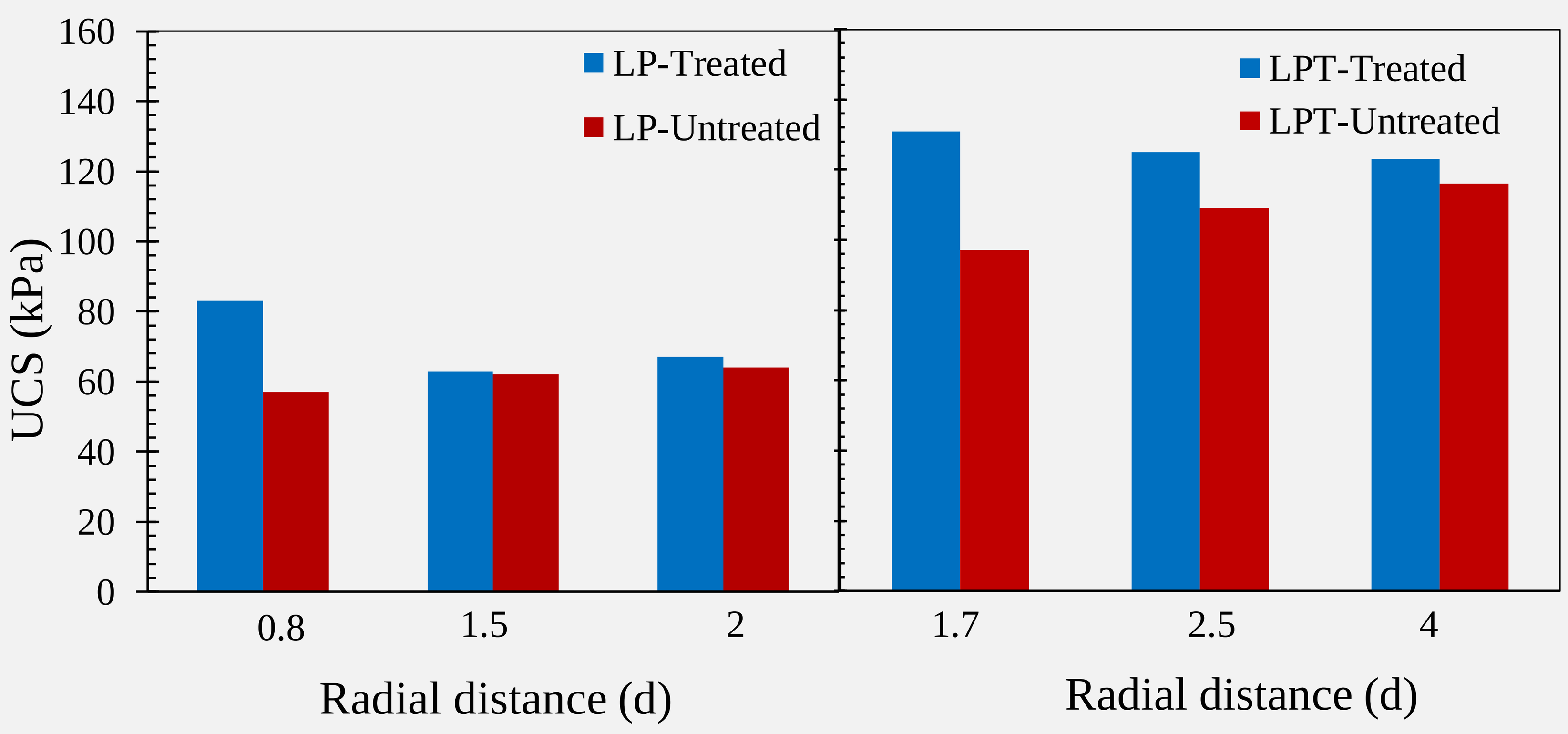


Fig. 2: Comparison of UCS of untreated and treated specimens sampled at different radial distances

Treatment	SEM Fig. No	Al	Si	K	Ca	O	C	Cl	Na
		Elemental weight percentage (%)							
Natural Soil	1(a)	9.14	39.44	0.94	0.75	38.60	2.35	0	0.41
Lime Pile	1(b)	3.32	20.42	0.31	14.83	34.25	20.25	0	0.29
LPT	1(c)	5.37	12.44	0.03	32.92	9.71	0.01	11.08	1.28

Fig. 3: SEM and EDAX of untreated, lime pile and LPT treated samples

CONCLUSIONS

A comparative study on lime pile and lime precipitation treated specimens was carried out in the present paper.

- The study shows that lime precipitation treated specimens showed decrease in clay content, plasticity index and swell potential. Further it shows a decrease in shrinkage and an increase strength up to a radial distance of 2.5d.
- In case of lime pile treated samples, the influence is up to 0.8d. This is because of less solubility of lime in water and low permeability of expansive soil. The reduction in plasticity properties and swell potential is due to the decrease in diffuse double layer thickness and repulsive forces between the clay particles.
- The micro level studies using SEM shows that morphology of untreated soil changes from dispersed state to flocculated state in both lime precipitated and lime pile treated samples. EDAX analysis shows that the calcium counts of lime precipitated specimens are much higher when compared to lime pile and untreated specimens.
- This proves that lime precipitation technique is much effective when compared to lime pile stabilization in stabilizing the expansive soil.

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