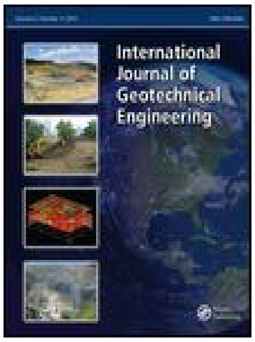

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In-situ stabilization of an expansive soil in desiccated state

ABSTRACT: This paper examines the efficiency of in-situ stabilization of expansive soil by lime slurry technique in desiccated state through laboratory and field experimental studies. The laboratory and field studies consists of permeating 34% hydrated lime slurry into the desiccated soil through vertical holes and measuring the physico-chemical, index and engineering properties before and after treatment at different radial distances. The distinct changes in the physico-chemical and index properties of the expansive soil indicate the occurrence of lime modification reactions and pozzolanic reactions on lime migration into the inter-connected shrinkage cracks. The lime slurry treatment increased the soil *pH* (≈ 12) to the levels that are conducive for the pozzolanic reactions to occur. The soil-lime reactions reduced the swelling potential and increased the unconfined compressive strength of lime slurry treated expansive soil. The test results encourage the application of lime slurry technique to expansive soil deposits during dry season upon development of shrinkage cracks..

KEYWORDS: expansive soil, lime treatment, soil improvement, swelling

1. INTRODUCTION

Expansive clay soils undergo large moisture-related volume changes and cause severe damages to the civil engineering structures founded on them. Several remedial techniques have been devised for stabilizing expansive soil deposits, and include soil replacement, surcharge loading, moisture control, chemical modification, stiffening of the super structure, sand cushion, cohesive non-swelling soil (CNS) cushion, under reamed pile foundations, and mat foundations (Katti, 1979; Chen, 1988; Nelson and Miller, 1992). Treatment of expansive soils by lime is widely adopted method for stabilizing the swell-shrink movements of the expansive soils (Bell, 1993).

Several investigations have demonstrated the successful use of lime by physical mixing to shallow depths in various civil engineering applications, such as improvement of sub-grade and sub-base, stabilization of expansive clay soils under footings and floor slabs of lightly loaded structures, and stabilization of canal linings (Herrin and Mitchell, 1961; Anderson and Thomson, 1969; Holtz, 1969; Uppal, 1969; Byers and Jack, 1980; Bell, 1988). Deep stabilization using lime has been mainly pioneered in Sweden, Japan and USA to improve the engineering properties of soft soils (Bell, 1988; Glendinning and Rogers, 1996; Porbaha, 1998; Rogers et al., 2000). Recently, deep stabilization using lime has been used to control the swell-shrink potentials of deep expansive soil layers (Tonoz et al., 2003; Hewayde et al., 2005; Puppala et al., 2008). Deep stabilization using lime can be broadly categorized into three main groups: lime piles, lime columns, and lime slurry injection (Glendinning and Rogers, 1996).

More recently, Rao and Venkataswamy (2002) conducted laboratory scale experiments to study the efficiency of the lime piles in altering the physico-chemical and engineering of properties of compacted expansive soil. Their study revealed that lime pile treatment could only promote short-term lime modification reactions, but not the soil-lime pozzolanic reactions. The results showed that the lime pile treatment did not increase soil *pH*, to the levels that are conducive for pozzolanic reactions to occur (≈12), owing to the impervious nature of the expansive soils, which impeded the migration of lime into the soil mass.

Hewayde et al. (2005) conducted a laboratory-scale experimental investigation on the efficiency of unreinforced and reinforced lime columns in controlling the swelling of

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expansive soils. The unreinforced and reinforced lime columns reduced the swelling potential of expansive soil by 33% and 69%, respectively, as compared to untreated expansive soil. The swelling reduction in reinforced lime column is attributed to both the physico-chemical changes occurring due to lime and development of resistive adhesive forces at the interfaces of lime column and surrounding soil, and the reinforcement and lime column. Puppalla et al. (2008) evaluated the effectiveness of lime-cement deep soil mixed (DSM) column in controlling the swelling of medium stiff expansive soils through pilot field studies at Haltom City, USA. The results showed that the swell-shrink movements and swell pressures in both vertical and lateral directions were remarkably lower in sections treated with DSM columns as compared to the untreated soil sections. However, construction of lime columns in unsaturated expansive soils by in-situ mixing of lime and expansive soil becomes difficult, owing to the stiff to very stiff nature of expansive soils.

Rao and Thyagaraj (2003) performed laboratory-scale experiments to evaluate the effectiveness of in-situ lime slurry stabilization technique in controlling the swell-shrink potentials of expansive soils in desiccated state. The study indicated that, desiccation induced extensive shrinkage cracks in the expansive soil and greatly assisted in the migration of lime slurry into the expansive soil mass. The migrated lime slurry promoted strong lime-modification and pozzolanic reactions to occur in the soil mass, which in turn reduced the swell potentials, and increased the unconfined compressive strength of the lime slurry treated specimens. However, the authors are not aware of any field studies reported in literature on the in-situ stabilization of expansive soils by lime slurry technique in desiccated sate. Hence, the present study examines the in-situ stabilization of expansive soil by lime slurry technique through laboratory and field investigations, during dry season in desiccated state. In this technique, 34% hydrated lime slurry is allowed to radially migrate through the vertical holes in the desiccated soil mass. The impact of hydrated lime slurry treatment in the desiccated state on the physico-chemical properties, index properties and engineering properties of expansive soil is evaluated.

2. MATERIALS AND TESTING

Expansive soil from NIT Warangal campus, India was used for the present investigation. The soil was air-dried and pulverized to pass 2 mm sieve. The soil passing 2 mm sieve was used for conducting standard Proctor compaction, oedometer swell potential and unconfined compressive strength tests. Soil fraction passing 2 mm sieve was also used in the lime slurry experiments. The standard Proctor compaction test was performed according to IS: 2720 (Part 7) -1980. The specific gravity (G_s) of the expansive soil specimen was determined as per IS: 2720 (Part 3) - 1980. The *pH* of the representative soil was obtained by standard method. Soil-water suspension with solids to water ratio of 1 : 2.5 was used for the determinations. The grain size distribution of the expansive soil specimen was determined as per IS: 2720 (Part 4) - 1985. Atterberg limits of the representative expansive soil was determined on the soil fraction passing 425 μm sieve as per IS: 2720 (Part 5) - 1985 and IS: 2720 (Part 6) -1972. The properties of the representative expansive soil are presented in Table 1. Commercial grade hydrated lime {$Ca(OH)_2$} was used in the present investigation. Initial consumption of lime (ICL) of the expansive soil was determined as per BS: 1924 -1990. The ICL value of expansive soil corresponded to 2.5%.

Table 1. Properties of expansive soil

Property	Value
pH	8.0
Specific gravity (G_S)	2.70
Liquid limit (%)	75
Plastic limit (%)	25
Plasticity index (%)	50
Shrinkage limit (%)	13
Grain size distribution: (%)	
• Sand	16
• Silt	28
• Clay	56
Unified soil classification symbol	CH
Compaction characteristics:	
Maximum dry density (Mg/m^3)	1.45
Optimum moisture content (%)	25
Oedometer swell potential at 6.25 kPa (%) (specimen compacted at optimum moisture content to maximum dry density)	4.95
Unconfined compressive strength (specimen compacted at optimum moisture content to maximum dry density) (kPa)	127

2.1. Laboratory Testing

Laboratory-scale in-situ stabilization of expansive soil by lime slurry technique was carried out in a cylindrical mould of 307 mm diameter and 310 mm height. Expansive soil for lime slurry experiments was compacted to a maximum dry density of 1.45 Mg/m^3 at optimum moisture content of 25%, to a thickness of 120 mm in two layers in a cylindrical mould. A reaction frame and hydraulic jack was used to statically compact the expansive soil to a thickness of 120 mm in the

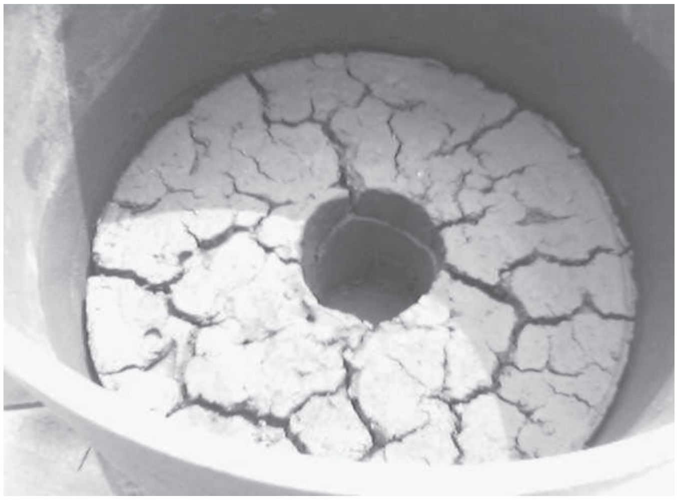

Figure 1. Shrinkage cracks in compacted expansive soil on desiccation.

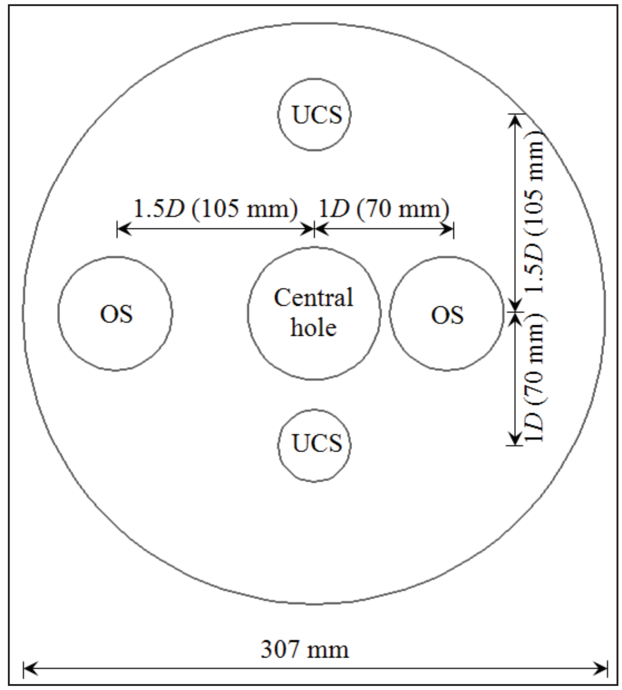

Figure 2 Sampling locations of lime slurry treated specimens in laboratory mould. OS: oedometer test specimen; UCS: UCS test specimen; *D* = diameter of central hole..

test mould. 12.88 kg of dry expansive soil mass was required for lime slurry experiment.

A central hole of 70 mm diameter was made in the compacted soil mass with the help of a hollow metal tube for permeation of lime slurry. Desiccation of soil was achieved by allowing the compacted soil to gradually air dry under a temperature of 30°C. At the end of the drying process, large shrinkage cracks were developed through the entire depth of soil (Figure 1). Air drying of the compacted soil reduced the water content to 10.8% and increased the dry density to 2.06 Mg/m^3.

A typical composition of lime slurry recommended for soil stabilization consists of 1 kg of lime to 2.5 liters of water which produces 34% of lime solution (Bell, 1993). Accordingly, 600 g of lime was mixed with 1500 ml of tap water. Lime slurry was poured into the central hole (70 mm diameter) until the hole were filled with lime slurry. Instantaneous migration of lime slurry occurred preferentially through the shrinkage cracks. After the lime slurry permeation, soil specimen was covered with wet burlap and cured for a period of 15 days.

After curing period of 15 days, specimens were collected at radial distances of 1*D* and 1.5*D* (where *D* = diameter of central hole) from the central hole for determination of physico-chemical, index and engineering properties (Figure 2). The oedometer specimens for swell potential determinations were obtained by pushing 60 mm diameter odeometer rings to a depth of 30-40 mm into the treated soil at radial distances of 1*D* and 1.5*D*. Thin walled sampling tubes of 38 mm diameter and 150 mm length were pushed into the treated soil at radial distances of 1*D* and 1.5*D*, for determination of unconfined compression strength (q_u). Representative soil samples were also collected at radial distances of 1*D* and 1.5*D* for determination of physico-chemical and index properties.

2.2 Field Testing

A pilot test site was selected to examine the effectiveness of in-situ stabilization of expansive soil by lime slurry technique in desiccated sate. The selected test site was behind STPI building (adjacent to International Students Hostel), NIT Warangal. The subsoil at the test site consists of expansive soil up to a depth of 2.4 m followed by murrum. The investigation was carried out after the formation of extensive shrinkage cracks in the expansive soil during dry season (June) from loss of moisture content. Shrinkage cracks are interconnected similar to the network of interconnected voids in the soil. Four boreholes of diameter (*D*) = 100 mm were made using hand auger up to a depth of 1 m, with centre to centre distance of 1 m in square pattern for lime slurry treatment (Figure 3). 34% hydrated lime slurry was also used in the field investigation, as adopted in laboratory investigation. Lime slurry was poured into the four boreholes simultaneously until all the boreholes were filled with lime slurry. Instantaneous migration of lime slurry occurred preferentially through the extensive network of shrinkage cracks developed in the expansive soil and resulted in closure of shrinkage cracks on lime slurry permeation. Lime slurry

Figure 3. Picture depicting auger boring at test site for lime slurry treatment.

treated test area was wetted with water by sprinkling, in order to facilitate soil-lime reactions to occur, and allowed to cure for 15 days. Further, diffusion of lime into the soil lumps, surrounded by the network of interconnected shrinkage cracks, occurs from all the directions (top, bottom and sides).

After 15 days of curing, lime slurry treated specimens were collected at radial distances of 1.5*D*, 5*D*, 7*D* and 10*D* for determination of physico-chemical, index and engineering properties (Figure 4). The oedometer rings of 60 mm diameter were pushed at a depth of 0.6 m into the treated soil at radial distances of 1.5*D*, 5*D*, 7*D* and 10*D*, for oedometer swell potential determination. Thin walled sampling tubes of 38 mm diameter and 150 mm length were pushed at a depth of 0.6 m into the treated soil at radial distances of 1.5*D*, 5*D*, 7*D* and 10*D*, for determining unconfined compression strength. Representative soil samples were also collected at the same radial distances for determination of physico-chemical and index properties. Sufficient quantity of expansive soil at the same site was also collected prior to lime slurry treatment. Samples collected from the field were tested in laboratory,

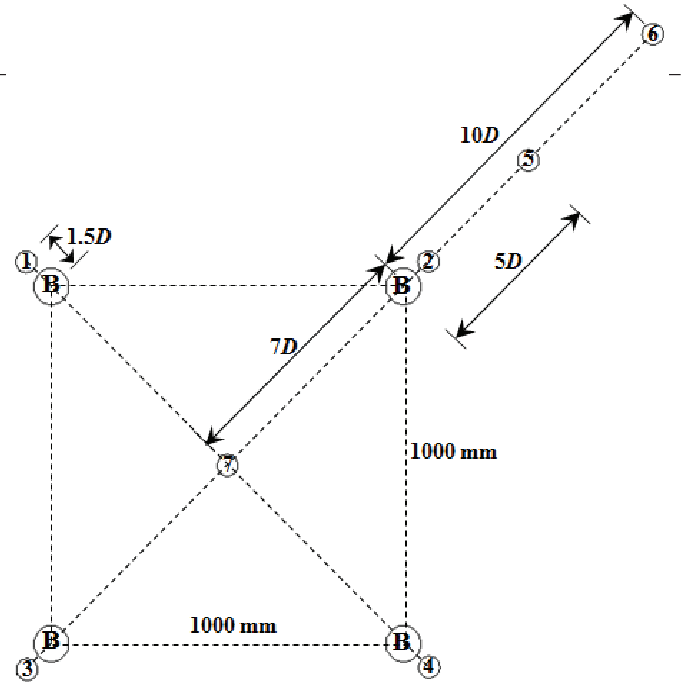

Figure 4. Field sampling locations of lime slurry treated specimens. B: Borehole; 1 to 7: Sampling locations; D = diameter of bore hole.

for determination of physico-chemical, index and engineering properties.

3. RESULTS AND DISCUSSION

3.1. Laboratory Test Results

3.1.1. Physico-Chemical and Index Properties

Table 2 compares the physico-chemical and index properties of expansive soil specimens before (untreated sample) and after in-situ lime slurry treatment in the laboratory mould. *pH* of lime slurry treated specimens increased from untreated value of 8.00 to 12.16 and 11.85 at radial distances of 1.0*D* and 1.5*D* respectively. The strong alkaline *pH* values indicate the migration of lime into the soil mass through the network of inter-connected shrinkage cracks, and are conducive for soil-lime pozzolanic reactions to occur. In addition to lime migration through shrinkage cracks, diffusion of lime into the soil lumps, surrounded by the network of interconnected shrinkage cracks, occurs from all the directions (top, bottom and sides). The hydroxyl ions released from the lime contribute to the increase in *pH* values (≈ 12), and cause the dissolution of silica and alumina from the clay lattice. The dissolved compounds in turn combine with calcium ions to form cementation compounds: calcium silicate hydrate (CSH) and calcium aluminate hydrate (CAH) (Eades and Grim, 1960; Wang et al., 1963; Diamond et al., 1963; Rajasekaran and Narasimha Rao, 1998).

The liquid limit (w_L) of the lime slurry treated specimens reduced to 53-58% from 75%. The plasticity index (I_p) of

Table 2. Comparison of physico-chemical and index properties of untreated and laboratory lime slurry treated expansive soil specimens

Specimen designation	Radial distance	pH	w_L (%)	w_P (%)	I_P (%)	w_S (%)	Free swell index (%)
Untreated	—	8.00	75	25	50	12	110
Lime slurry treated (laboratory)	1.0D	12.16	53	32	21	23	68
	1.5D	11.85	58	31	27	20	71

Abbreviations used: w_L: liquid limit; w_P: plastic limit; I_P: plasticity index; w_S: shrinkage limit

the lime slurry treated specimens reduced to 21- 27% from untreated value of 50%. The shrinkage limit (w_S) of the lime slurry treated samples notably increased to 20-23% from 12%. The free swell index of the lime slurry treated specimens also reduced to 68-71% from untreated value of 110%.

The distinct alterations in the physico-chemical and index properties of the expansive soil are attributed to strong lime modification reactions and pozzolanic reactions occurring between soil and lime. Reduction in liquid limit and plasticity index, and increase in plastic limit of expansive soil are apparently due to reduction in diffuse ion layer thickness from the increase in exchangeable calcium ion content and pore water salinity (Mitchell, 1993; Sridharan et al., 1986; Sridharan et al., 1992). The increase in shrinkage limit of the expansive soil upon lime slurry treatment is apparently due to increased particle flocculation brought about by the increase in particle attraction from reduction in diffuse ion layer thickness (van Olphen, 1963; Yong and Warkentin, 1975; Sridharan et al., 1992).

The reduction in free swell index of the lime slurry treated expansive soil indicate the reduction in diffuse ion layer thickness surrounding the clay particles as a result of increase pore salinity and exchangeable calcium ion content from lime migration (Rao and Thyagaraj, 2003).

3.1.2. Oedometer Swell Potential

Figures 5a and 5b compare the time-swell plots of untreated specimens and lime slurry treated specimen in the labora-

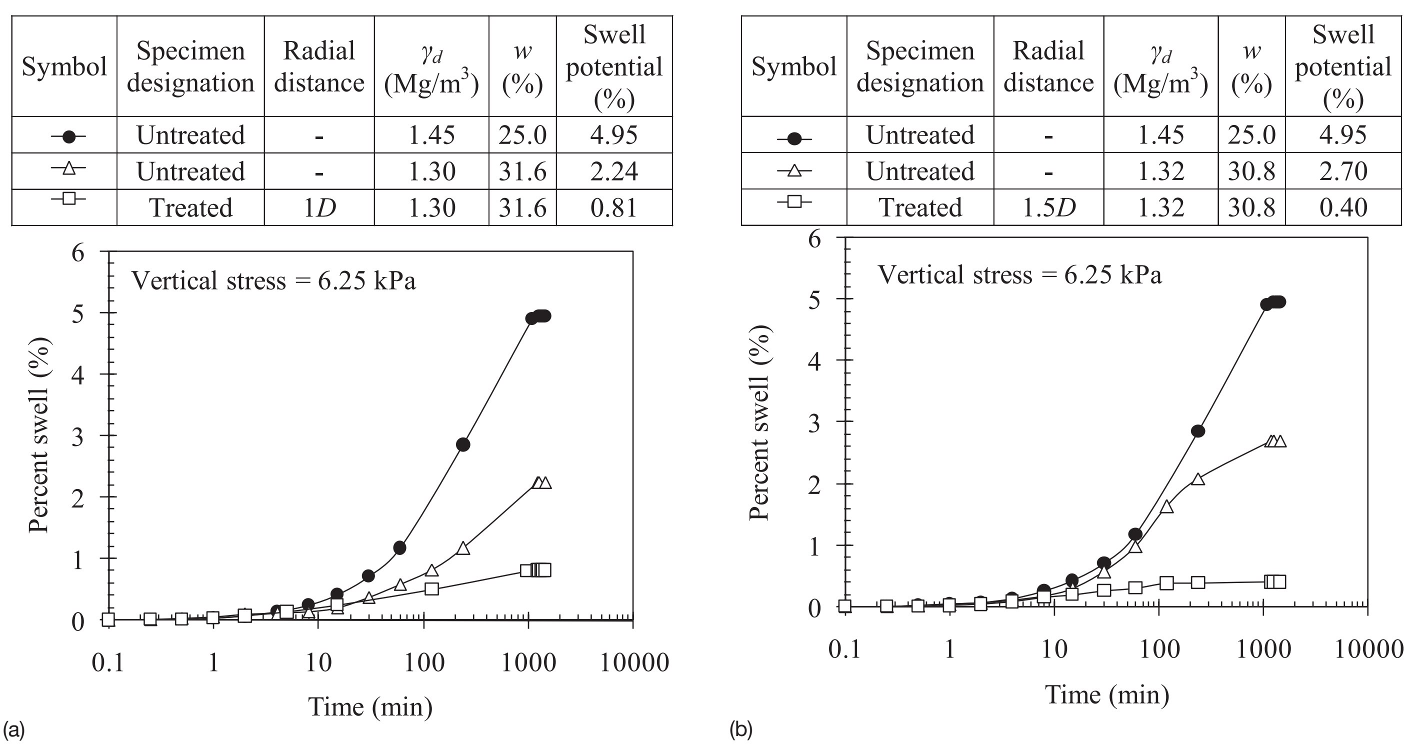

Figure 5. (a) Time-percent swell plots of untreated specimens, and lime slurry treated specimen in laboratory mould sampled at a radial distance of 1D. γ_d = dry density; w = water content. (b) Time-percent swell plots of untreated specimens, and lime slurry treated specimen in laboratory mould sampled at a radial distance or 1.5D.

Symbol	Specimen designation	Radial distance	γ_d (Mg/m^3)	w (%)	q_u (kPa)
—●—	Untreated	-	1.45	25.0	127
—△—	Untreated	-	1.30	31.6	57
—□—	Treated	1D	1.30	31.6	80

Symbol	Specimen designation	Radial distance	γ_d (Mg/m^3)	w (%)	q_u (kPa)
—●—	Untreated	-	1.45	25.0	127
—△—	Untreated	-	1.32	30.8	62
—□—	Treated	1.5D	1.32	30.8	120

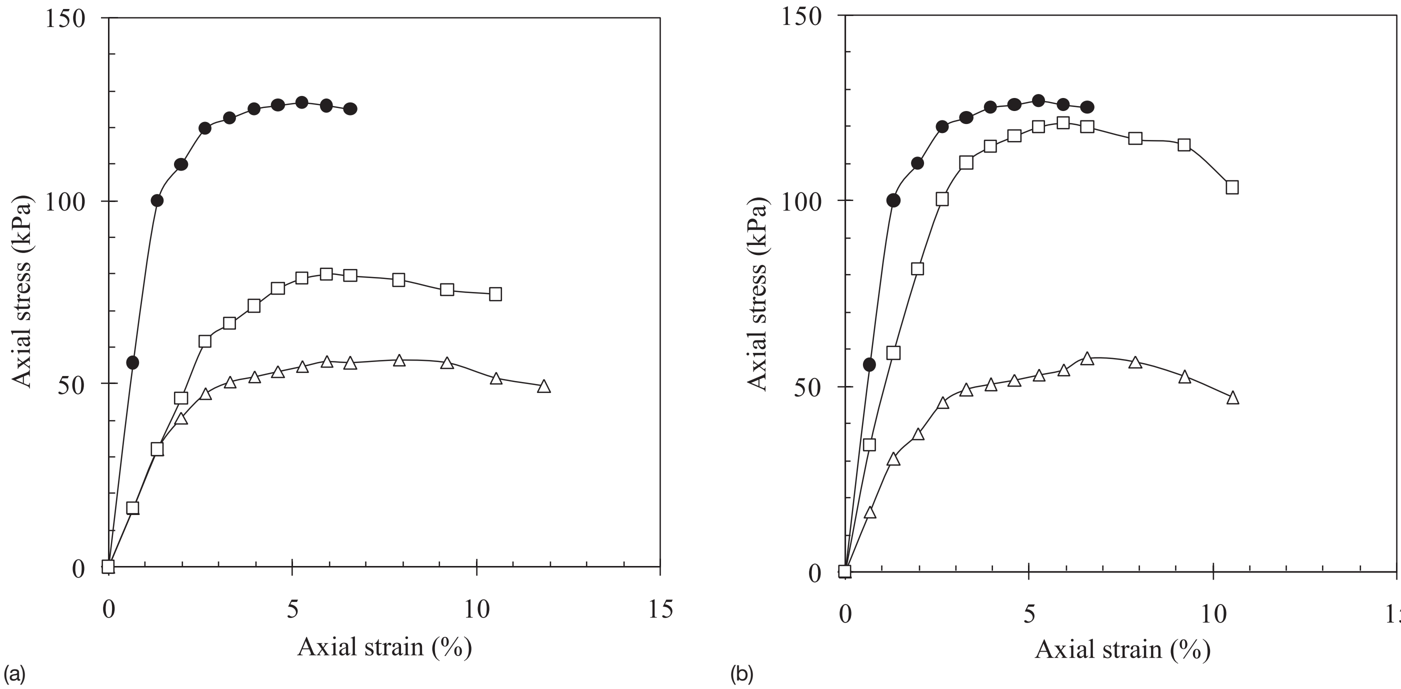

Figure 6. (a) Stress-strain plots of untreated specimens, and lime slurry treated specimen in laboratory mould sampled at a radial distance of 1D. γ_d = dry density; w = water content; q_u = unconfined compressive strength. (b) Stress-strain plots of untreated specimens, and lime slurry treated specimen in laboratory mould sampled at a radial distance of 1.5D.

tory mould sampled at a radial distance of 1.0D and 1.5D respectively. Permeation of lime slurry from the central hole into the surrounding soil mass closed the shrinkage cracks, increased the water content (w) to 30.8-31.6% and reduced the dry density (γ_d) to 1.30-1.32 Mg/m^3 on absorption of water from the permeating lime slurry. Swell potential of the lime slurry treated specimens reduced to 0.40-0.81% (Figures 5a and 5b).

It is well established in the literature that the swell potential of the expansive soil is controlled by the dry density and water content (Holtz and Gibbs, 1956; Seed et al., 1962). In order to know the role of dry density and water content, the swell potential of the untreated soil was determined at dry densities (1.30 Mg/m^3 to 1.32 Mg/m^3) and water contents (30.8 to 31.6 %) of the lime slurry treated specimens. At these densities and water content values, the untreated specimens swell potential ranged between 2.24% and 2.70%, which are higher than that of the lime slurry treated specimens (0.81% and 0.40%) (Figures 5a and 5b). The reduced swell potentials of the lime treated specimens are apparently attributed to the strong lime modification and soil-lime pozzolanic reactions occurred on lime migration, which is evidenced by the distinct alterations in the physico-chemical and index properties of the expansive soil.

3.1.3. Unconfined Compression Strength

Figures 6a and 6b compare the stress-strain plots of untreated specimen and lime slurry treated specimens in the laboratory mould sampled at a radial distance of 1.0D and 1.5D respectively. As mentioned earlier, the lime slurry permeated specimens are characterized by low densities (1.30-1.32 Mg/m^3) and high water contents (30.8-31.6%) on moisture absorption from the lime slurry. The lime-slurry treated specimens exhibited 1.4-1.9 times higher strengths (80-120 kPa) than the untreated soil specimens (57-62 kPa) at same dry densities and water contents. Increasing the curing period may further enhance the strength of the lime slurry treated specimens. The increase in strength of lime slurry treated specimens is attributed to the formation of cementation bonds from the soil-lime pozzolanic reactions as explained earlier.

Table 3. Comparison of physico-chemical and index properties of untreated and lime slurry treated specimens in the field at different radial distances

Specimen designation	Radial distance / Location	pH	w_L (%)	w_P (%)	I_P (%)	w_S (%)	Free swell index (%)
Untreated	-	7.47	69	22	47	8	120
Lime slurry treated (field)	1.5*D*/ 1	12.4	47	32	15	9	102
	1.5*D*/ 2	12.4	43	37	6	39	56
	1.5*D*/ 3	12.4	44	34	10	25	73
	1.5*D*/ 4	12.4	43	40	3	40	49
	5*D*/ 5	11.6	54	24	30	14	88
	10*D*/ 6	11.4	55	24	31	17	94
	7*D*/ 7	12.4	43	40	3	40	52

Abbreviations used: w_L: liquid limit; w_P: plastic limit; I_P: plasticity index; w_S: shrinkage limit

The laboratory test results presented here are in conformity with the results reported by Rao and Thyagaraj (2003).

3.2. Field Test Results

3.2.1. Physico-Chemical and Index Properties

Table 3 compares the physico-chemical and index properties of untreated (before treatment) and lime slurry treated specimens in the field, sampled at different radial distances. After the treatment, the lime slurry treated specimens are sampled at radial distances of 1.5*D*, 5*D*, 7*D* (mid point) and 10*D* from the boreholes (Figure 4). The results indicate that the lime slurry technique also had a significant impact on the physico-chemical and index properties of expansive soil treated in the field (Table 3). Lime slurry treatment in the field increased the soil *pH* to 12.40, 11.60, 12.40 and 11.40, from untreated value of 7.47, at radial distances of 1.5*D*, 5*D*, 7*D* and 10*D* respectively. The liquid limit of the lime slurry treated specimens reduced to 43-55% from an untreated value of 69%. The plastic limit of the lime slurry treated specimens increased to 24-40% from 22%. The shrinkage limit notably increased to 14-40% from 8% on lime slurry treatment except at one location. Free swell index of the lime slurry treated specimens also reduced from 120% to 49-102% on lime slurry treatment. Soil properties of locations 1 to 6 are influenced by lime slurry permeation from any one borehole, where as soil properties of location 7 are influenced by lime slurry permeation from four boreholes. Physico-chemical and index properties of expansive soil at location 7 (mid point) are significantly altered from lime slurry permeation in comparison to other locations. The distinct alterations in the physico-chemical and index properties of the expansive soil are attributed to strong lime-modification and pozzolanic reactions occurring between soil and lime.

The variations in the physico-chemical and index properties at different locations are primarily due to distribution of lime slurry into the shrinkage cracks according to the shrinkage patterns formed.

3.2.2. Oedometer Swell Potential

Figure 7 compares the time-swell plots of untreated specimen and lime slurry treated specimens in the field, sampled

Symbol	Specimen designation	Radial distance	γ_d (Mg/m^3)	w (%)	Swell potential (%)
○	Untreated	-	1.49	25.0	7.04
□	Treated	1.5*D*	1.48	24.0	0.19
△	Treated	5*D*	1.47	26.0	0.44
●	Treated	7*D*	1.49	25.0	0.16
+	Treated	10*D*	1.46	27.0	0.81

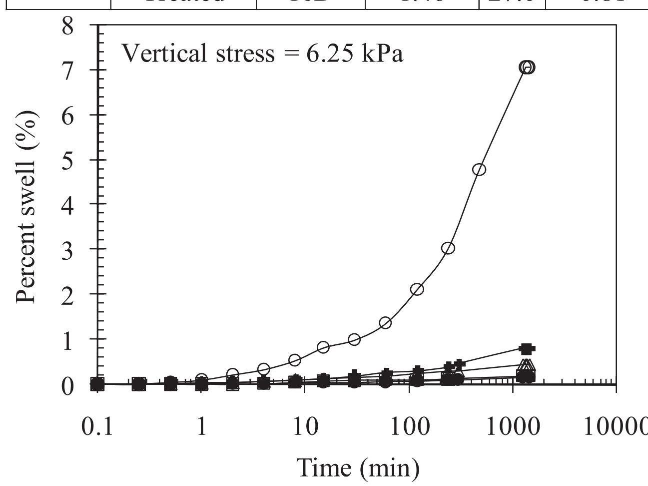

Figure 7. Time-percent swell plots of untreated specimen, and lime slurry treated specimens in the field sampled at different radial distances.

at different radial distances. Desiccation of expansive soil produced extensive inter-connected shrinkage cracks in the soil, and resulted in reduction in water content to 5.7% and increase in dry density to 2.06 Mg/m^3. Permeation of lime slurry through the boreholes to the desiccated soil increased the soil water contents to 24-27% from 5.7% (desiccated condition) and reduced its dry density to 1.46-1.49 Mg/m^3 on absorption of lime slurry. Swell potential of lime slurry treated specimens reduced to 0.16–0.81% from untreated value of 7.04%. Swell potentials of the lime slurry treated specimens reduced drastically from strong lime modification reactions and soil-lime pozzolanic reactions occurring in the lime slurry treated specimens as discussed earlier.

3.2.3. Unconfined Compression Strength

Figure 8 compares the stress-strain plots of lime slurry treated specimens in the field, sampled at different radial distances. The dry densities and water content of lime slurry treaded specimens ranged between 1.46 Mg/m^3 and 1.49 Mg/m^3, and 24% and 27%, on moisture absorption by the desiccated soil from the lime slurry. The lime slurry treated specimens exhibited 1.2-3.4 times higher strengths (146-413 kPa) than natural soil specimen (121 kPa). Increasing the curing period may further enhance the strength of the lime slurry treated specimens. The higher strengths exhibited by the lime slurry treated specimens is attributed to the formation of cementation bonds from the soil-lime pozzolanic reactions as explained earlier.

Symbol	Specimen designation	Radial distance	γ_d (Mg/m^3)	w (%)	q_u (kPa)
-○-	Untreated	-	1.47	27.0	121
-□-	Treated	1.5*D*	1.48	24.0	155
-△-	Treated	5*D*	1.47	26.0	167
-●-	Treated	7*D*	1.49	25.0	413
-✚-	Treated	10*D*	1.46	27.0	146

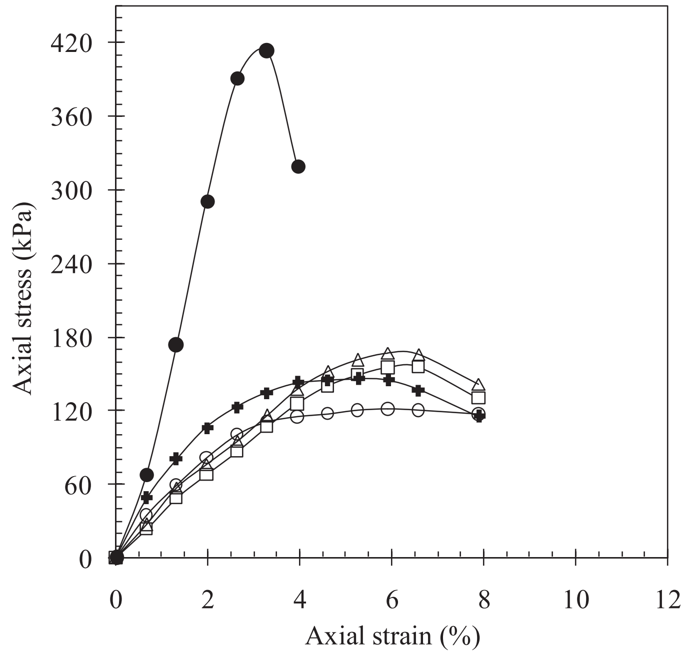

Figure 8. Stress-strain plots of untreated specimen, and lime slurry treated specimens in the field at different radial distances.

4. PRACTICAL SIGNIFICANCE

The laboratory and field test results of lime slurry technique indicate that this method could effectively control the swelling movements and increased the unconfined compressive strength of the expansive soil. The spacing of the boreholes in the field may be increased to 2-4 m for lime slurry application in expansive soils, since lime slurry permeates to a greater distance through the extensive network of inter-connected shrinkage cracks formed during dry season. Thus the cost of stabilization can be significantly reduced if the lime slurry technique is carried out in dry season. However, the spacing and depth of boreholes for lime slurry application is site-specific, and depends on the plasticity characteristics and the extent of shrinkage cracks formed at the time of lime slurry application.

The lime slurry technique may be effectively applied up to the depth of seasonal moisture fluctuation in dry season without any additional pressure. The efficiency of this technique may be further enhanced with lime slurry pressure injection application in desiccated state.

5. CONCLUSIONS

The in-situ stabilization of expansive soil by lime slurry technique in desiccated state is evaluated in this investigation. The experimental investigation consists of permeating lime slurry into the desiccated soil through vertical holes both in field and laboratory-scale test, and measuring the index and engineering properties before and after treatment. The following conclusions can be drawn from the laboratory and field investigations:

- Permeation of lime slurry in desiccated state eased the migration of lime through the interconnected shrinkage cracks to a greater distance, and thereby increasing the soil *pH* (≈12) to the levels that are conducive for soil-lime pozzolanic reactions to occur.
- The strong soil-lime modification reactions reduced the plasticity characteristics and swelling potentials of lime slurry treated specimens. The unconfined

compressive strength of the lime slurry treated specimens increased from cementation bonds developed by the soil-lime pozzolanic reactions.

- A borehole spacing of 1 m in both directions for lime slurry application proved to be very effective in controlling the swelling movements, and in increasing the unconfined compressive strength of the expansive soil. However, this spacing may not be the optimum spacing for the present test site.

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