EFFECT OF LEACHING ON SHEAR STRENGTH OF MARINE CLAY IN CAN GIO

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ABSTRACT

Effect of leaching on shear strength of marine clay at Can Gio, Ho Chi Minh City is investigated in laboratory tests. Soil specimens were collected from three sites with different soil salinity. Testing includes shear strength and initial soil salinity. Leaching process is performed by modified equipment in laboratory with fresh water, then specimen is subjected to direct shear test to determine shear strength of leached and unleached soil. It is indicated that leaching affects the shear strength as reducing cohesion value (c, kPa) from 30% – 70% and internal friction angle (φ,°) from 8% - 20%.

Keyword: Salinity, cohesion, internal friction angle.

1. INTRODUCTION

Recently, the sea level increases and salt exists in soil due to climate change in short time, especially in long coastal area. Thus, a large area has salt concentration in soil, affecting not only agriculture products but also other industrial works. Can Gio province is one of new industrial zones. In this area, high salt concentration is investigated.

Marine clays deposited along a coastal area usually contain an amount of soluble salt in the pore of soil skeleton. The soil salinity depends on the salt concentration of water or seawater environmental deposition. The salinity of seawater from which the marine clays are sedimented is of the order 35g/l (Sverdrup et al. 1942). Leaching effects on the properties of clay were also researched by many authors through a series of leaching and consolidation experiments. In the decade of 1950s, Rosenqvist (1953), Skempton and Northey (1952), and Bjerrum (1954) investigated leaching effects on physical properties of Norwegian clay. They demonstrated in Norwegian clay that when the soil salinity was reduced to very low values by leaching action of fresh water, it was transformed into quick clay. The decrease of soil salinity caused an increase in soil compressibility (Torrance 1976 and Moore 1977).

The objective of this study is to investigate the effect of leaching on the shear strength of marine clay in Can Gio. The leached specimens were obtained from leaching procedure with distilled water for a long period with modified leaching equipment. The direct shear tests were performed on the samples to compare the shear strength between the leached and the unleached marine clays.

2. MATERIAL AND SALINITY EQUIPMENT

Undisturbed samples using thin-walled tube were taken from three sites in Can Gio named as Ba Dong bridge,

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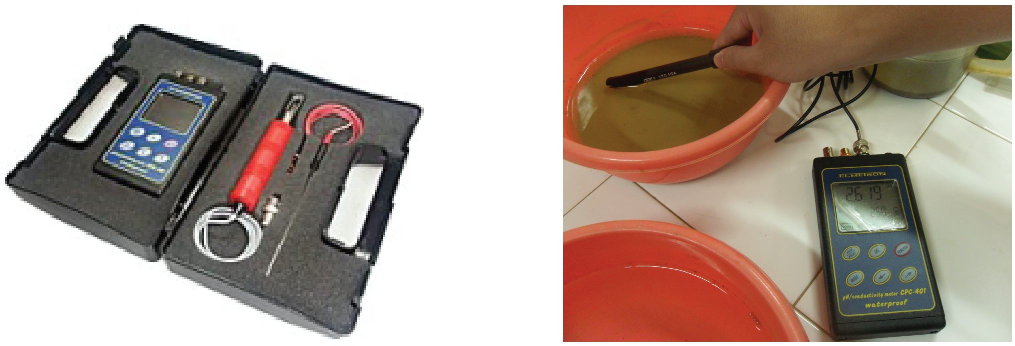
Ky Nam and 30/4. Soil specimens were collected with different soil salinity. Testing includes shear strength and initial soil salinity.

Soil salinity and water salinity were determined by salinity meter CPC-401, which measured the value in g/l of sodium chloride (NaCl) concentration. Figure 1 shows the photos of salinity meter CPC-401.

Figure 1. Salinity meter CPC-401



3. MODIFIED LEACHING EQUIPMENT

Leached sample of undisturbed clay is obtained in the conventional leaching method, which was simulated in the procedure by setting a specimen in the testing apparatus and by percolating distilled water in the specimen for a long time, until the salinity was decreased to the target value.

A modified leaching equipment at first as schematically shown in Fig 2. A reservoir of water was regulated to allow water to flow through the sample as shown in the photos of Figure 3. The leachate was collected at regular intervals for measuring the electrical conductivity (EC). In addition, the water flow (leaching fluid) was terminated when the EC measurement showed no further decrease. In this method, leached clay obtained after leaching. The advantages of this equipment are the obtain of 6 leached samples in the same time, then these undisturbed samples with the corrected dimension are subjected to direct shear test.

Figure 2. Leaching equipment diagram

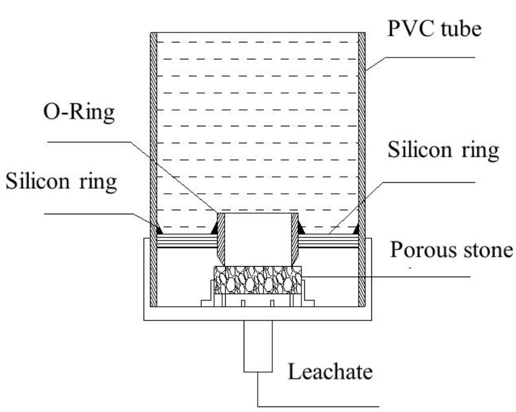


Figure 3. Modified leaching equipment

The method most frequently used to achieve salt removal from a soil sample in an CRS leaching test is how to collect the water and measure the water salinity. The leaching diagram was shown in Fig 4. This procedure presents several difficulties, especially if it is intended to carry out the leaching at pressures as low as those existing in the field. The sample is either loaded or unloaded, depending on the direction of the gradient, when the gradient is applied. Large gradients are required to achieve salt removal from a low permeability material in a reasonable period of time. The period of leaching is prolonged by the fact that the salt concentration gradient opposes the hydraulic gradient, i.e. back –diffusion occurs.

Figure 4. Leaching diagram

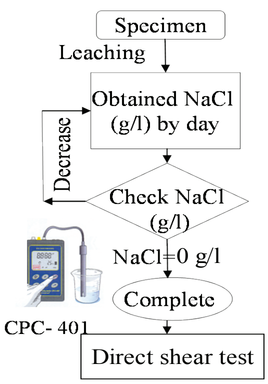


Figure 5. Direct shear test

Direct shear test is simple and faster to operate, as shown in Fig 5. The specimens with 6cm diameter and 2 cm high are used in shear box, they facilitate drainage of pore water from a saturated sample in less time. Direct shear test is used to predict these parameters quickly. The laboratory report covers the laboratory procedures for determining these values for cohesion soils. Strain controlled direct shear machine consists of shear box, soil container, loading unit, proving ring, dial gauge to measure shear deformation.

4. EXPERIMENTAL RESULTS

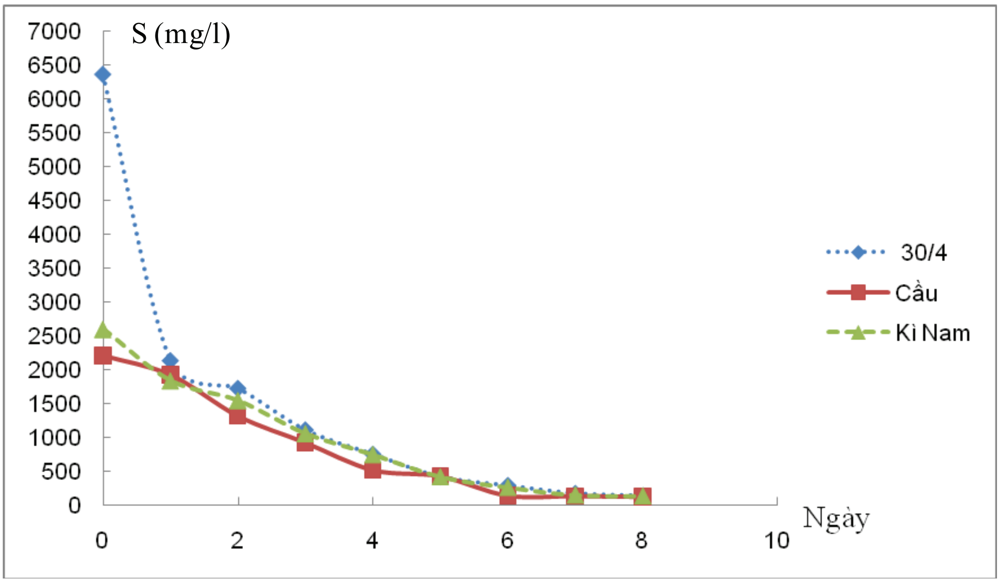
4.1. Change of soil salinity with time

Initial soil salinity of marine clay in Can Gio of three sites is measured with the value of 2,6 g/l in average. In this procedure, the distilled water of 0g/l salinity flows from the top to the bottom of the sample. Figure 6 shows the variation of soil salinity with the cumulative of collecting water.

As expected, the salinity decreased with time because of permeating distilled water. Finally, the target value of water salinity reached to about 0 g/l for 8 days of three specimens.

After finishing leaching procedure, a series of direct shear tests were carried out with the strain rate as 1mm/min on the leached and unleached specimens to investigate the shear strength characteristics of these specimens.

Figure 6. Variation of soil salinity with time



4.2. Change of shear strength after leaching

Data series from the direct shear test were collected in the same time to compare the shear strength. Figure 7, 8 and 9 show the results of three sites named as 30/4, Ba Dong bridge and Ky Nam, respectively. It is indicated that the shear strength reduces due to leaching in comparison of unleached and leached specimens. This phenomenon can be explained due to the removal of salt in soil, then result indicated that leaching process resulted in the bond weakness of soil skeleton, consequently the decrease in shear strength.

Figure 7. Shear strength changes for the site named 30/4

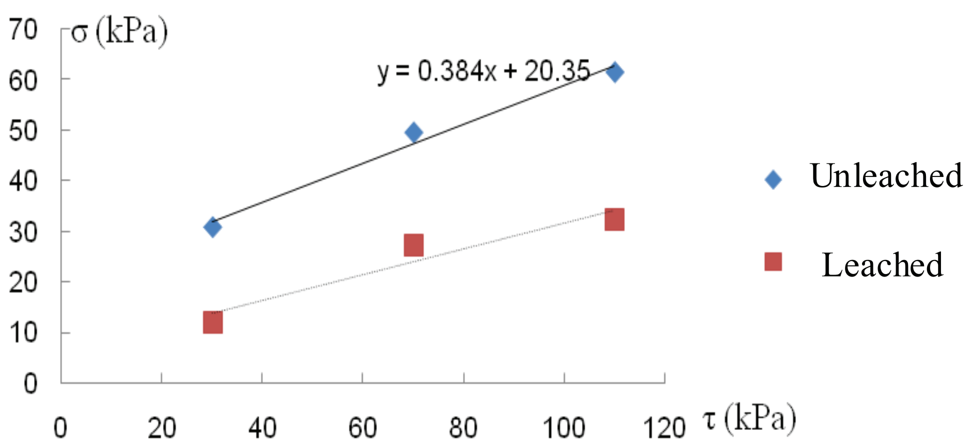


Figure 8. Shear strength changes for the site named Ba Dong bridge

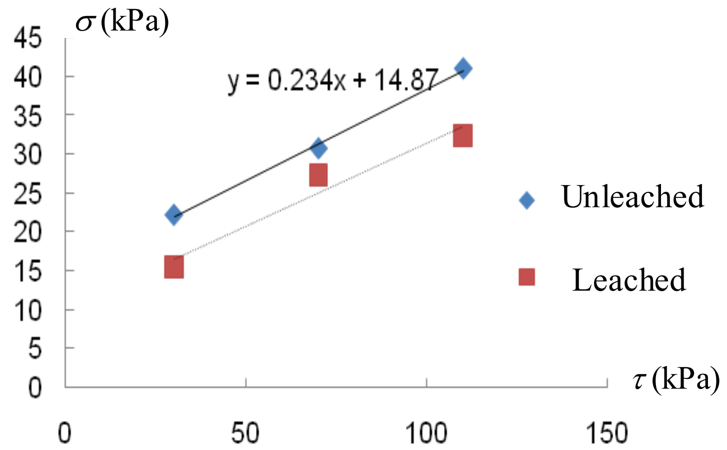
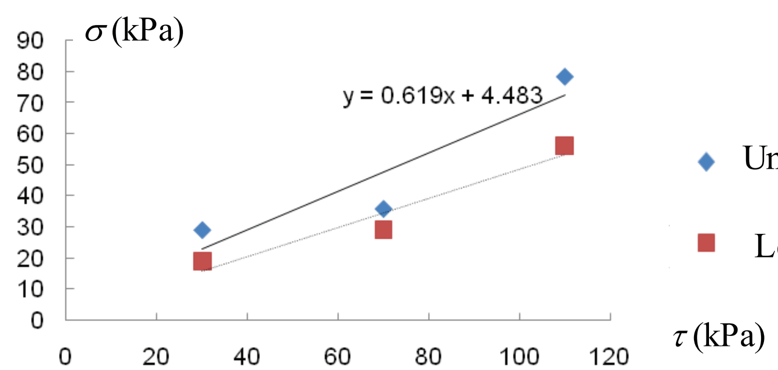


Figure 9. Shear strength changes for the site named Ky Nam



In order to know the change of shear strength in details, the analysis of these components that concludes cohesion (c) and internal friction angle (φ) is done as shown in Table 1. It is shown that the cohesion and internal friction decrease due to leaching.

Table 1: Comparison c and φ of unleached and leached specimens

Site	c (kPa)			φ (°)		
	Unleached	Leached	Decrease	Unleached	Leached	Decrease
30/4	20,31	5,98	70,63%	21,02	14,37	31,64%
Ba Dong bridge	14,87	10,11	32,06%	13,22	12,05	8,81%
Ky Nam	4,48	1,85	58,73%	31,76	25,16	20,79%

5. CONCLUSION

The leaching procedure was taken almost 8 days for the natural samples of marine clays in Can Gio to reduce gradually the soil salinity from 2.6 g/l to about 0 g/l with distilled water.

Leaching process is performed by modified equipment in laboratory with fresh water, then specimen is subjected to direct shear test to determine shear strength of leached and unleached soil. It is indicated that leaching affects the shear strength as reducing cohesion value (c, kPa) from 30% – 70% and internal friction angle (φ,o) from 8% - 20%.

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