EFFECT OF SALT LEACHING ON SEDIMENTATION AND SELF WEIGHT CONSOLIDATION

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ABSTRACT

The soil washing treatment was carried on Ariake washed by cylinder test method, to investigate the sedimentation process and final water content change. A water-soil dilute were allowed to settling under salinity condition ranging from 30 to 2 g/L. We adjust the suspension for each sample in initial water content range from 500% to 6000%. Then let the sedimentation and self weight consolidation process occur for 14 days. After the final process, we measured the final water content and maximum settling rate. Leaching of salt decreases the liquid limit, consequently increasing the normalized water content w defined as the ratio normal water content over liquid limit (Hong and Tsuchida.2000). They also found that the value of* I_w *increases lineary with the increases in w*.*

Key words: salt leaching, sedimentation, self weight consolidation, water quality, settling rate, final water content.

1. Introduction

The Ariake creek becomes one of the most canals used for distributing the water sources from Ariake sea to the paddy farming and the needs of water surrounding that area. It is widely known that the sensitivity ratio of Ariake marine clay increases, if the clay is leached.

The Ariake clay deposits vary in thickness from 15 to 42 m. Based on the fossil assemblages investigated, it is surmised that the clay layers in the top 10-11 m were deposited under marine environment while the lower layers were formed under brackish conditions (Ohtsubo *et al.*, 1988). Smectite is the predominant mineral which exists along with vermiculite, illite and kaolinite, in the clays. The liquid limit and the plasticity index vary in the ranges 60-125 and 25-80 respectively. The natural water content ranging between 80-140 is higher than the liquid limit. Liquidity index value could be high as 2.5. The sensitivity of the soil is less than 100 in the top 10 m but could be as high as 500 or more at depths below 10 m. Thus, the clays can be classified as quick or extra quick according to Rosenquist's (1953) classification and salt leaching is identified as the primary cause for the sensitivity of the clays. The salt concentration in the pore water ranges between 0.05-1.08 g l"1 for extra quick clays and 1.02-10.4 g 1 for quick clays. Egashira and Ohtsubo (1984) and Ohtsubo et al. (1999) examined the clay mineralogy of the deposit samples collected from the different sites in Japan, and found the smectite is a main clay mineral. Predominance of smectite is reflected in the geotechnical properties of Japanese marine clays such as rather high liquid limit and activity (tanaka et al. 2001. Fujikawa and Takayama 1980).

Excess salts keep the clay in saline soils in a flocculated state so that these soils generally have good physical properties. Structure is generally good and tillage characteristics and permeability to water are even better than those of non-saline soils. However, when leached with a low salt water, some saline soils tend to disperse resulting in low permeability to water and air, particularly when the soils are heavy clays. Leaching may also result in a slight increase in soil pH due to lowering of salt concentration but saline soils, as will be shown later, rarely become strongly sodic upon leaching if there is an adequate drainage system.

2. Materials and Methods

Materials

Ariake clay sediment samples were collected in Higashi Youka in the intertidal zone at low tide on latitude 33°12'57.65. Longitude 130°18'13.44 (Fig. 1).

Methodologies

Density Testing

Soil particle density is a measure of the mass per unit volume of the soil solids only. Particle mass obtained from dried soil, its volume is calculated by measuring the mass of the water mass for picnometer. The constituents of soil organic matter has a limestone and silicate minerals and minerals. Most soil particles are composed of inorganic minerals. Mineral density of common minerals 2.5 ~ 2.8g / cm 3 because, soil particle density of 2.5 ~ 2.8g / cm 3 tend to be value. Soil particle density of organic matter consisting of 1.4 ~ 2.3 g / cm 3 will be much lower. The ignition loss between the density of soil particles and has a clear negative correlation, so that it can be determined whether a certain mineral or organic soil is composed from the partial density of soil particles. For Ariake clay the soil particle density is 2.54.

Cation Exchange Capacity (CEC)

Cation exchange capacity can be a representation of how to hold cations in clay and how to configure the surface of the soil humus, per 100g dry soil .The measurement method for all groups of soil cation exchange ion exchange Ca, saturate. Saturated Ca Na ions in ion exchange, extraction cleaning. Extracted and quantified Ca ions were calculated. The number CEC of Ariake clay is 33.63 meq/100g.

Grain Size Test

The state grain size distribution of soil particles to configure the soil, represented by the grain size accumulation curve showing the relationship between the mass percentage of particles smaller particle size and particle size distribution of soil particle state. Granularity, it is closely related to physical properties and mechanical properties of the soil. Actual soil particles of various shapes have been not spherical, its diameter is shown by the following values. We carried out both hydro-meter method and pipette method.

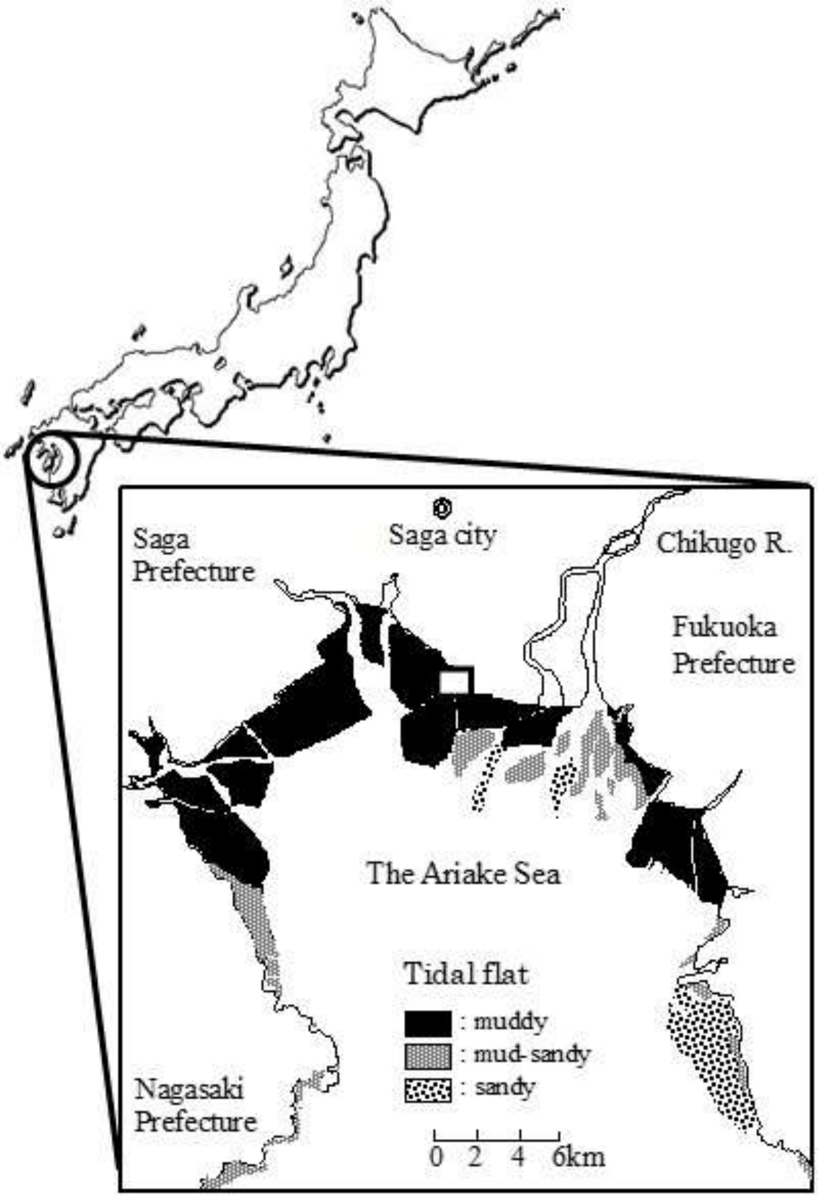

Fig. 1. Interior Parts of The Ariake Sea. Sampling site is indicated by an open square

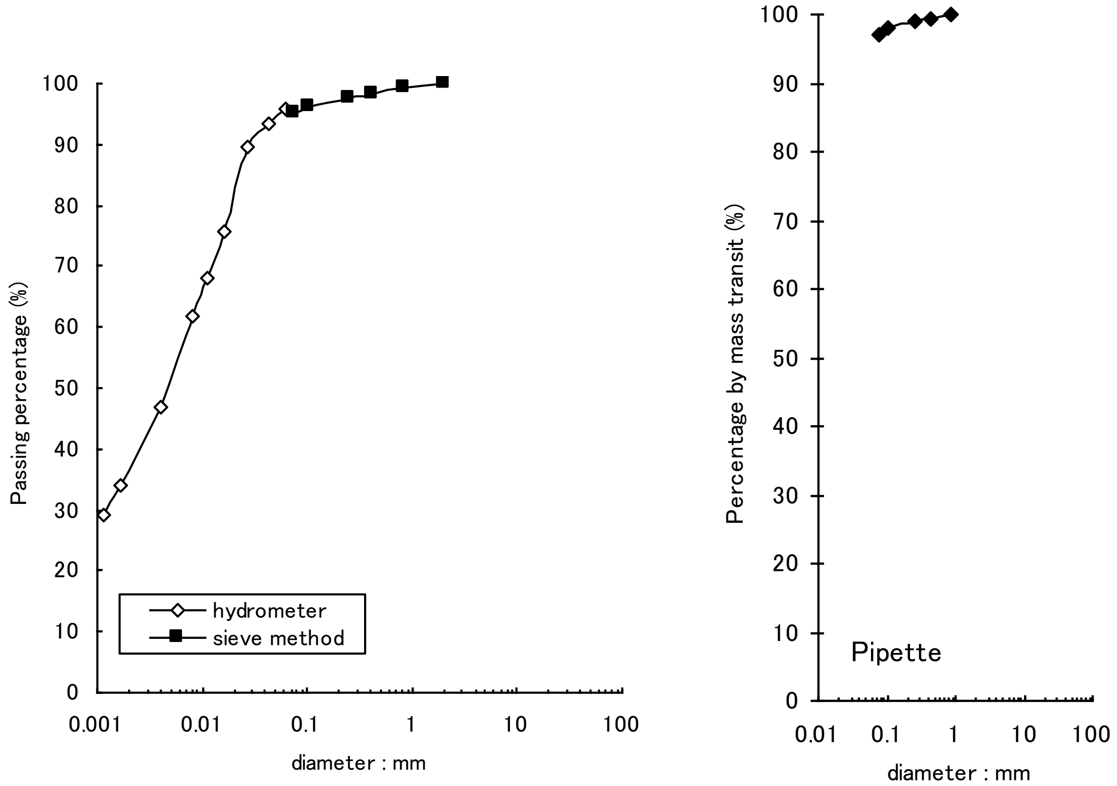

Fig. 2. Grain Size Distribution Curves

Water Content

Muddy soil condition and juicy, to be less smooth state. The major changes in the hardness and compressibility of the pore size and loose condition. ω is the water content of the mass representation of the percentage of water contained in the gap to the mass of soil particles. Measuring method by determined how evaporate the water in the oven dried under temperature 110 °C± 5°C. Ariake clay soil water content of about 200 to 150 percent.

Plastic Limt (PL) and Liquid Limit (LL)

The plastic limit (PL) is the water content where soil starts to exhibit plastic behavior. A thread of soil is at its plastic limit when it is rolled to a diameter of 3 mm or begins to crumble. To improve consistency, a 3 mm diameter rod is often used to gauge the thickness of the thread when conducting the test. The liquid limit (LL) is the water content where a soil changes from plastic to liquid behavior. In our laboratory we were measure the LL by using casagrande method and fall cone (cone penetration test). The number for PL and LL for Ariake clay were w_P = 53,1% and w_L = 106,2 % respectively.

Settling Experiment

The preparation of sedimentation experiment was conducted using a 1 L plastic bottle for each test series with the appropriate initial water content (w_0) which range from 500, 750, 1000, 1500, 2000, 2500, 3000, 4000, to 6000 % . We adjust the salinity of a water-soil dilute was 30g/L the former. Then, these suspensions were left for a day, the soil was removed into a 6 cm diameter and 26 cm high acrylic cylinder which was then filled to 20 cm with the appropriate suspensions. For each test condition, the sedimentation processes were monitored for 14 days, and data was recorded to the 1 cm graph paper which was pasted into the cylinder, and we measure the elapsed time record to interface between clear water and solid move on the cylinder. After the sedimentation process attained, we remove a half water volume from the suspension. Then replace by pure water. We assumed that the salt content has reduced a half. Repeated this procedure, unless attained the suspension salinity state range from 15, 8, 4 to 2 g/L. Then repeat again for the sedimentation procedures.

3. Result and Discussion

Sedimentation Characteristics

Four settling types have classified (Imai 1980): 1) Dispersed Free Settling (DFS) defined, soil particles do not flocculate but disperse, and freely settle without mutual interactions. Coarser particles settle earlier than the finer; 2) Flocculated Free Settling (FFS), soil particles flocculate and form flocs of different sizes. They settle freely with the rates peculiar to their sizes, therefore, no sharp interface is formed; 3) Zone Settling (ZS), flocs are formed due to flocculation and they settle wth the strong mutual interaction among them. Therefore, they settle uniformly in the aggregate forming a sharp interface, of which settling rate is constant during the settling stage; 4) Consolidation Settling (CS), visibles flocs cannot be formed. A mixture settle as a whole mainly due to the consolidation.

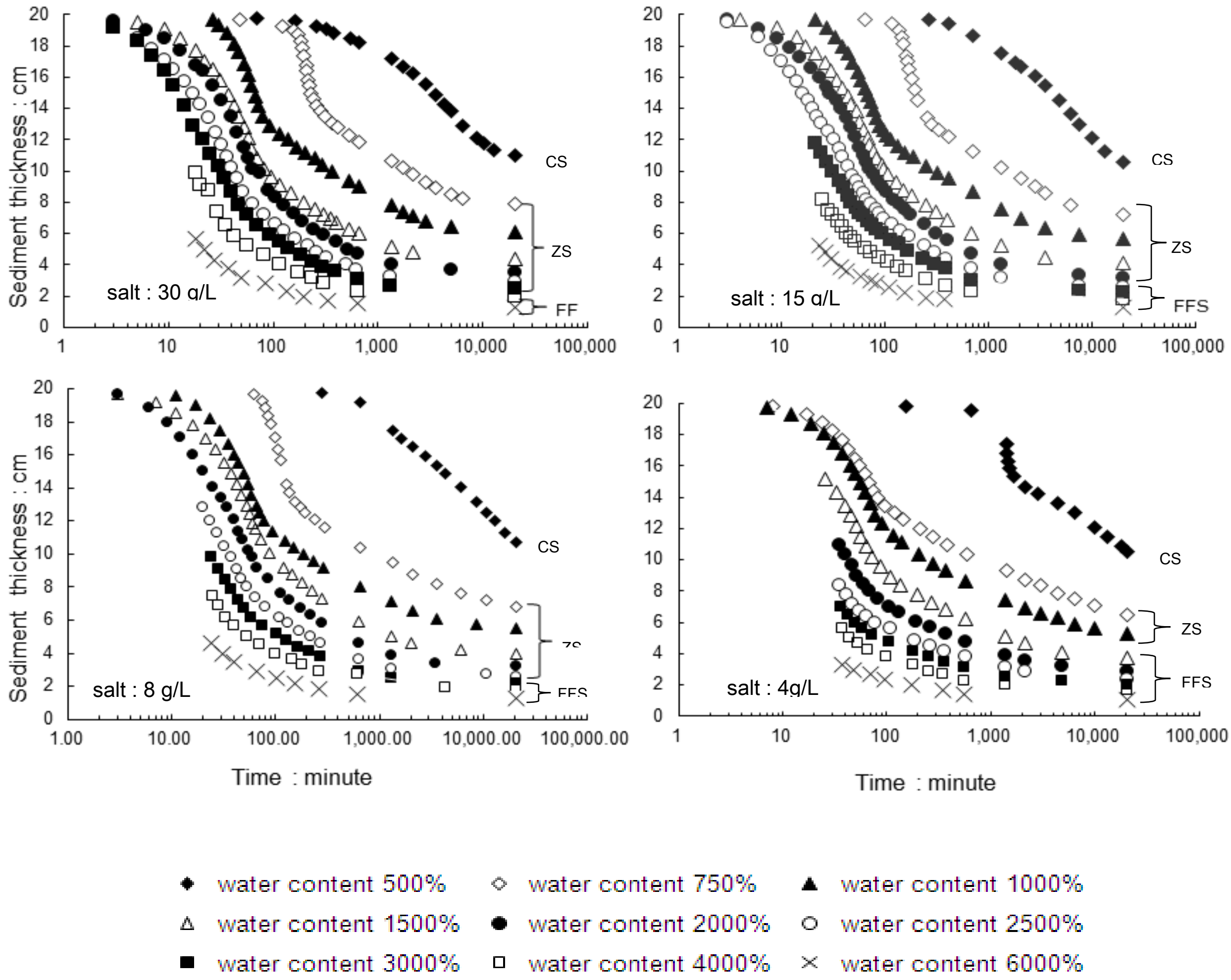

Fig. 3. Sediment Thicknes vs. Time according to Settling Types

Change of sediment pattern strongly influenced by 1) degree of flocculation which is depent on concentration and kind of addition material in soil water mixture and 2), degree of particle in which depent on concentration of solid in dilute (Mitchell 1993). According the graph, result of that sedimentation procces shown the settling pattern as shown in Fig. 4 and Fig 5.

Ariake Washed untreated the graph shown three types of settling pattern. They are CS (w= 500%), ZS (w = 750%, 1000%, 1500%, 2000% and w = 3000%), and FFS (w = 4000% and 6000%). Two factors dominate the settling pattern are water content and salinity. The sample with NaCl (30g / L), the graph shown, CS (w = 500%), ZS (w = 750% - 3000%), FFS (w = 4000 and 6000%). Settling pattern is not too different than the conditions that occurred in Ariake washed untreated, even though NaCl is highly cohesive which can increase binding force between soil particles. Ariake clay with CaSO4 (5%), the graph shown the settling pattern similar with two graph before. Namely CS for w = 500%, ZS for water content 750 – 4000%, and FFS for water content 6000%. In consolidation settling , initial water content 4000% could not be seen on untreated sample and with NaCl, however included in CaSO4 treatment. Ariake clay with 5% charcoal water hyacinth, the graph shown, CS for initial water content 500 – 750%, ZS for initial water content 1000 – 2500 %, and FFS for initial water content 3000 – 6000%. Compared with no treatment, there were many more free-settling cohesive surface subsidence. However, CaSO4 clear interface than when the addition is not seen because it does not appear to have changed the composition of the solid grain. Then, for the sample with 10% charcoal water hyacinth, the graph was shown the settling pattern similar. CS (w = 500 – 750%), ZS (1000% - 2500%), FFS (3000% - 6000%). Changed much coal and water hyacinth 5% when added was observed. Ariake clay with 20% citric acid, the graph shown CS for w = 500% , ZS for initial water content 750 - 2500% initial water content, and FFS for initial water content 3000 - 6000%. Comparing with the experiment before the 750% of the initial moisture content from consolidation settling has occurred. In case initial moisture content 4000 %, the interface could not see clearly, SS might accelerate the rate of sedimentation can be removed.

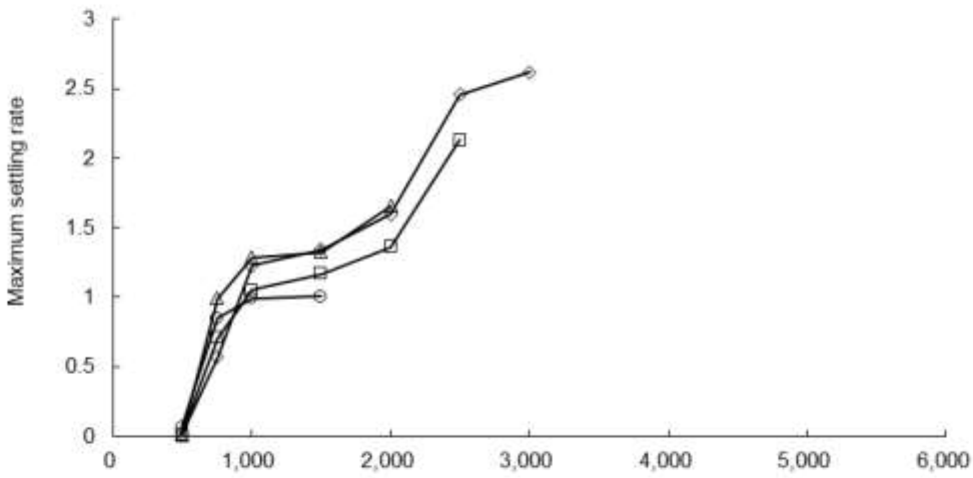

Fig. 4. Maximum Settling Rate vs Water Content

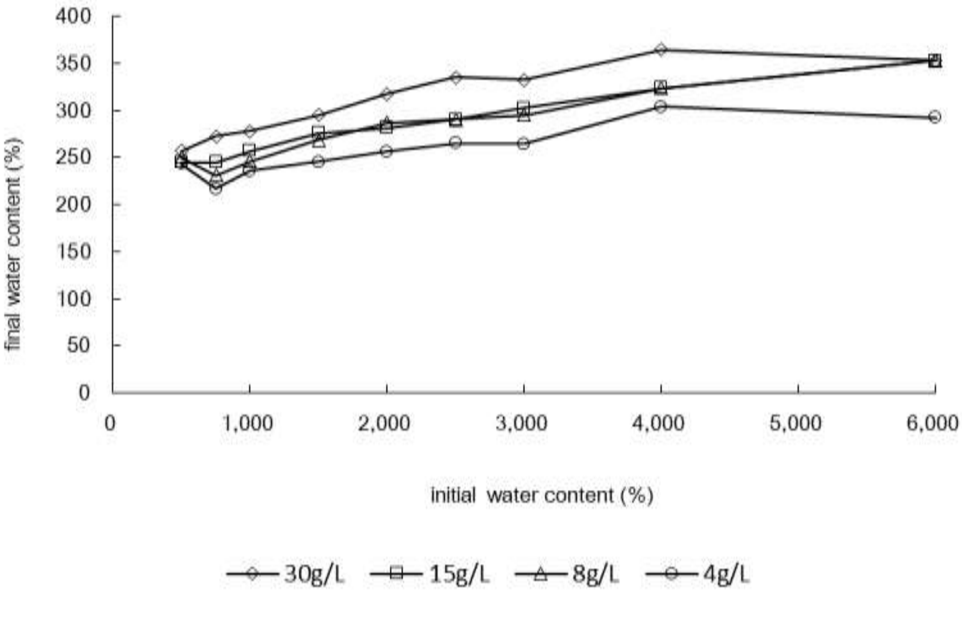

Fig. 4. Final Water Content vs Initial Water Content

4. Conclusions

The higher the solid content, and the lower the water content accompanied by the content of salt, organic matter and the containment in the dilute soil water will be higher. The higher the water content, and the higher the sedimentation pattern characteristics. The level names of sedimentation characteristics pattern according to definition of sedimentation characteristics pattern by Imai Goro (Goro 1980). Namely Consolidation settling (CS) grade I, which is occurred under the higher water content condition. The second grade is zone settling (ZS), occur under about 750 – 3000 % initial water content. For higher water content condition the sedimentation characteristics will be flocculation free settling and dispersion free settling respectively.

The ability of a soil to release salt to solution, thereby maintaining sufficient salt for flocculation, may be involved. The settling rate increased with increasing concentration of NaCl. The settling rate tended to decrease with increasing salt concentration and was directly related with average floc diameter. The settling rates increased with increasing floc diameter. This relationship was clearly observed with untreated bentonite in NaCl solutions. The variations in settling rates and floc diameters with salt concentrations were significant with untreated bentonite, but were insignificant in the organically-treated samples. The volume of settled particles (sediment volumes, Table 3) decreased as the salt concentration increased. This is probably due to more double layer compression in solutions of greater salt concentration. NaCl concentration can decrease the viscosity of the solution. In NaCl solutions, all bentonite suspensions were unstable (flocculated). The settling rate increased with increasing concentrations of NaCl. The settling rate is directly related to average floc diameter. The settling rates also increased with increasing floc diameter, although the sedimentation volume decreased with increasing NaCl concentrations. This is due to more double-layer compression caused by increased ionic strength.

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