Chemical and geotechnical properties of salt-leached Ariake clay

He Phanny*, Masami Ohstubo**,Takahiro Higashi**, and Motohei Kanayama**

Introduction

The soft clays of Ariake Bay are the sedimentation products accumulated in the sea water over the past 10,000 years. Ariake clay, because of softness, has posed several geotechnical problems such as failure of slopes and the settlement of earth structures. The sensitivity of Ariake clay varies mostly 8 to 40, but salt-leached clay exhibits the sensitivity greater than 40. In the present paper, we report the chemical and geotechnical properties determined on the salt-leached borehole samples of Ariake clay. We also assessed the effects of salt concentration in pore water on some geotechnical properties such as the consistency limits and remolded shear strength.

Materials and methods

The borehole samples with the depth of 3 to 17 m were taken at the Yamaashi site of Saga Prefecture, 10 m distant from the Rokkaku River. Clay minerals were identified by X-ray analysis. Pore water ion concentrations were determined by atomic adsorption spectroscopy and ion chromatography. Surface area was determined by ethylene glycol monoethyl ether. Remoded strength was measured by vane shear tests.

Results and discussions

Figure 1 shows the chemical properties of the clay profile. The Cl concentration was in the range of 1.3 to 1.8 cmolc/kg, which was much lower than that for the non-salt-leached Ariake clay (1.7-18 $cmol_c$/kg) (Ohtsubo et al., 1982), indicating that the clay sediment in Fig.1 has been subjected to salt leaching. The CEC and pH was in the range of 17.3 to 46.6 $cmol_c$/kg and 7.9 to 8.7, respectively. The organic matter was less than 1.54 %.

The geotechnical properties of the clay profile are shown in Fig. 2. The natural water content (w) was higher than the liquid limit (w_L) throughout the depth, which is reflected in the liquidity index greater than 1.0, defined as $(w - w_p)/(w_L - w_p)$. The liquidity index at the depths of 5.2, 6.2 and 6.3 m was greater than other depths. This would be the result of greater reduction in the liquid limit for the clays at three depths than other depths due to more intensive salt leaching. The more intensive salt leaching is indicated by the lower Na concentration at 5.2, 6.2 and 6.3 m (Fig.1). The clays at 5.3 and 5.5 m with the sensitivity of 25 is classified as medium high sensitivity

clay while the clays at 6.2 and 6.4 m with the sensitivity of 77 is classified as high sensitivity

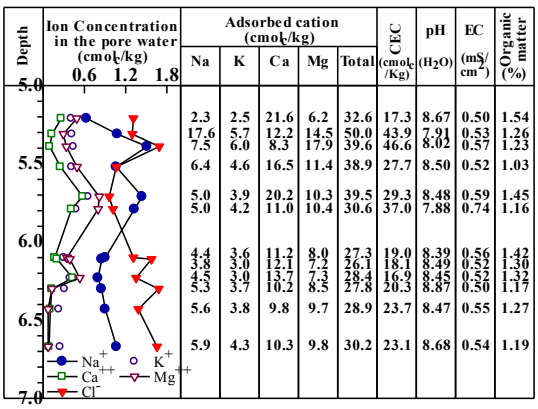

Fig.1. Chemistry of clay profile at Yamaashi

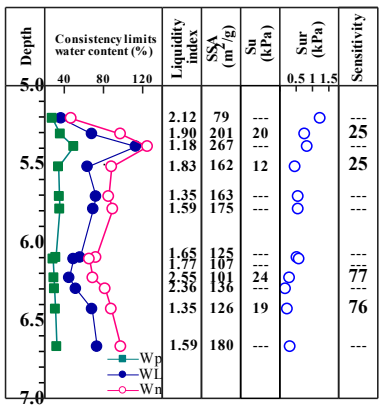

Fig.2. Geotechnical properties clay profile at Yamaashi

*Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University.

**Faculty of Agriculture, Kyushu University.

Key words: Consistency limits, soft ground, physic-chemical properties.

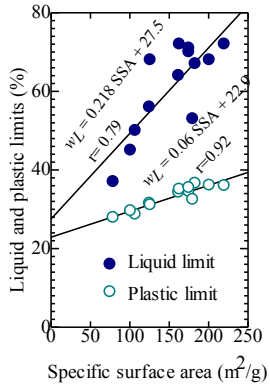

Fig.3. Relationship between consistency limits and specific surface area

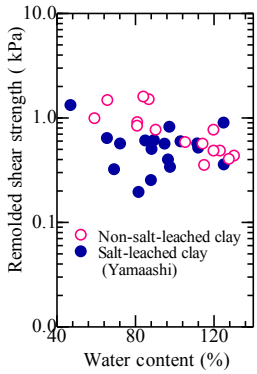

Fig.4. Remolded shear strength versus natural water content for salt-leached and non-salt leached clay

clay according to the scale by Norsk Geoteknisk Forening (Torrance, 1983). The clays at 6.2 and 6.4 m can be called quick clay since the S_{ur} at 6.2 and 6.4 m meets the definition of quick clay that remolded shear strength must be less than 0.5 kPa.

The liquid and plastic limits are influenced by several factors such as particle size, clay mineral, salinity and organic matter. Taking into account that the specific surface area reflects the particle size, clay mineral and organic matter, the correlation of the liquid and plastic limits versus specific surface area (SSA) was plotted (Fig.3). Significant correlation was found between the two parameters for both the liquid and plastic limits, but great variations in the limit values at the same SSA were found for the liquid limit. We assumed that these variations would be due to difference in pore water salinity, i.e. higher salinity enhances the liquid limit, but we could not prove this hypothesis. Further study is needed for this.

Figure 4 shows the remolded shear strengh versus water content for the salt-leached clay along

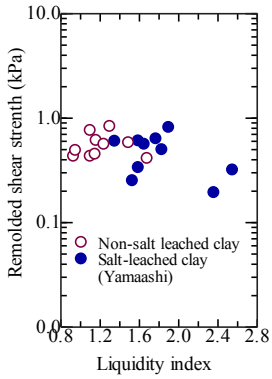

Fig.5. Remolded shear strength versus liquidity index for salt-leached and non-salt leached clay

with non-salt-leached clay (Ohtsubo et al., 1982). The remolded strength decreased with increasing the water content for the non-salt-leached clay while such trend was not observed for the salt-leached clay and remolded strength tended to be smaller than the strength of the non-salt-leached clay at given water contents. This is due to reduction in the remolded strength by salt leaching for the salt-leached clay.

The relationship between remolded strength and the liquidity index was plotted for both salt-leached and non-salt-leached clay in Fig.5. Significant correlation was not found between the two parameters. Some samples of the salt-leached clay exhibited lower remolded strength or higher liquidity index than the non-salt-leached clay. This is the result of the reduction in the remolded strength and liquid

Conclusions

(1) The salt concentration in pore water at Yamaashi was lower than non-salt leached clay.

(2) Quick clay was found at the depth of 6.2 and 6.4 m.

(3) Significant correlation was found between consistency limits and specific surface area

(4) The remolded shear strength of clay at Yamaashi tends to be smaller than the strength of non-salt leached clay.

References

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