The effect of humic acid on strength of lime and cement stabilized Ariake clays

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I INTRODUCTION

An extensively used method for the soft ground improvement is chemical stabilization by the use of lime and cement. The presence of the organic matter in the clay normally acts to the detriment of the strength of stabilized clays. The study focuses on the effect of humic acid, which is a kind of organic matter, on the strength of lime and cement stabilized Ariake clays. The tests were realized with inorganic clays mixed with the humic acid, which was extracted from the organic matter in natural clay. Finally, due to the retarding effect on the strength development of stabilized clays is not only controlled by humic acid, the study also investigated in the effect of salt concentration on this retarding effect.

II EXPERIMENTAL INVESTIGATION

The samples were obtained from Okawa area, Ashikari area and Isahaya Bay designated as Clay 1, Clay 2 and Clay 3, respectively. Clay 1 was sampled at 1.0 m depth under the bottom of the rivulet. Clay 2 and Clay 3 were sampled at 3.0 m depth from the ground surface. Properties of the soft Ariake clay samples are shown in Table 1.

The clays were mixed with various percent of lime and cement by mass of dry soil. In order to eliminate the effect of difference in water content, the samples were prepared to be the same water content of 185%. The unconfined compression tests were conducted at curing periods of 7, 14 and 28 days. In order to investigate the effect of organic matter, the clays were treated to eliminate the organic matter by the alkaline extraction method (Clare and Sherwood, 1956). The material obtained by the alkaline extraction of the natural soil can be divided into two parts as the humic and the fulvic acids. The humic acid is precipitated by acidification of the extract to pH 2.5, and filtered off. After extraction, the treated clay (the organic matter was removed from the clay by alkaline extraction method) was used in the preparation for the unconfined compression tests, using the mixture of clay with humic acid and 20% lime.

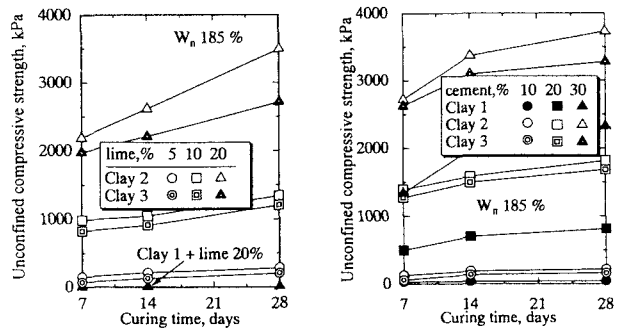
Finally, the study also investigated in the effect of salt concentration on strength retarding effect of humic acid. The treated clays were washed to obtain the clay samples containing different salt contents by the distilled water. The clay samples were then mixed with 20% lime at various humic acid contents, cured and tested at the age of 7 days.

Table 1. Properties of soil

	Water content, %	Liquid limit, %	Plasticity index	pH	Humic acid, %	Particle size distribution, %		
						Sand	Silt	Clay
Clay1	185	143	90	6.0	1.60	3	52	45
Clay2	150	133	71	7.6	0.25	1	44	55
Clay3	170	150	88	8.0	0.31	0	19	81

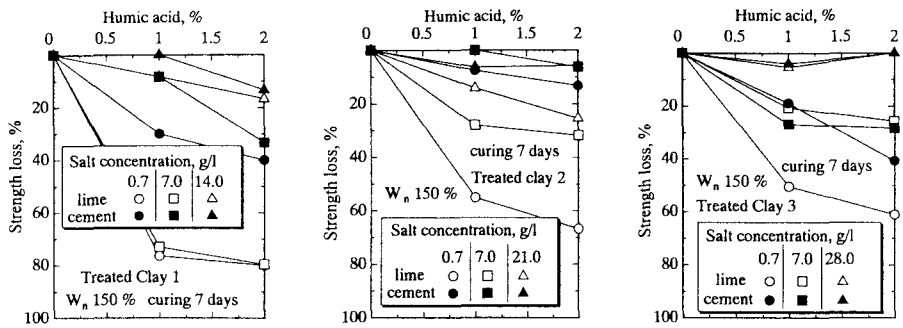
III RESULTS AND DISCUSSIONS

Fig. 1(a) shows the strength development of lime stabilized clays. The unconfined compressive strength of Clay 1, which was mixed with 20% lime at the curing time of 7 days, was found to be 5 kPa compared with corresponding values of 2200 kPa and 2000 kPa obtained in tests with similar mixture made with Clay 2 and Clay 3. It clearly shows that Clay 1 failed to be stabilized by lime. Fig.1 (b) also shows that the unconfined compressive strength of cement stabilized Clay 1 is also low compared with the others.



(a) (b)

Figs. 1(a) and (b) Strength development of lime and cement stabilized clays.



(a) (b) (c)

Figs. 2(a), (b) and (c) Effect of humic acid on strength of lime and cement stabilized clays at various salt concentrations.

Figs. 2(a), (b) and (c) show that the lower the salt concentration, the higher the percentage of strength loss with the same humic acid content. It can be stated that the retarding effect of the humic acid on the strength of lime and cement stabilized clays directly relates to the salt concentration. The increase in salt concentration induces to decrease in spaces between the aggregations and the increase in the cementation bond by chemical reactions. These induce a high level of bonding which is sustained to reduce the retarding effect of humic acid (Onitsuka et. al., 2002). At a low salt concentration of about 0.7 g/l, the humic acid content 1 % can reduce the strength of lime and cement stabilized Ariake clay by up to 50% and 20%, respectively. The percentage of strength loss of lime stabilized clays is higher than the value obtained from cement stabilized clays with the same humic acid and salt concentration.

IV CONCLUSION

The humic acid and the salt concentration are the dominant factors affecting the strength of lime and cement stabilized clay. The humic acid has a greater detrimental effect on the strength of lime stabilized clay than cement stabilized clay. However, the retarding effect of humic acid on the strength of stabilized clays decreases as the salt concentration increases.

V REFERFENCES

Clare, KE, and Sherwood, P.T. (1956). "Further studies on the effect of organic matter on the setting of soil-cement Mixtures", *Journal of applies chemistry*, pp. 317-324.

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