Effect of sulfate content on compressibility of quicklime treated Ariake clay

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I INTRODUCTION

Disposal of surplus soils at construction sites has become a pressing problem as it is becoming increasingly difficult to secure dumping sites. Therefore, it is necessary to recycle the surplus soils by relatively simple treatment such as stabilization. Quicklime is one of effective chemicals for stabilization. Adding quicklime to soft clay improves its engineering properties such as index properties, strength and resistance to compressibility. The quicklime treated surplus clay is normally utilized as engineering materials for backfill and pavement. The strength development of quicklime treated clay is mainly obtained by forming cemented materials that were investigated by x-ray diffraction and scanning electron microscope (SEM) (Kamon and Nontananandh 1991; Rajasekaran et al. 1997). It is clearly shown that the cemented materials cause the strength of stabilized clay to increases. There are many factors such as differences in soil gradation, types of clay minerals, organic matter, pH and sulphate etc., (Mateos 1964;Thompson 1966) that significantly influence the ability of clay to react with lime to achieve a strength increase. The main factors that retarded the strength development of lime treated soil were reported such as clay mineral, organic matter, sulphate and pH (Sherwood 1962; Thompson 1966; Miura et al. 1988).

Ariake clay is a kind of very high sensitive clay that deposited at the coast of the Ariake Sea in Kyushu Island. The sulphates usually occur in Ariake clay that locates near river sites. From the previous researches, the retarding effect of sulphate is not clearly understood, then this study points out to investigate the effect of sulphate on the quicklime treated soft clay. This paper investigates the effect of sulphate on compressibility of quicklime treated soft clay. One-dimensional compression tests were performed on the quicklime treated soft clay that contained various sulphate contents.

II EXPERIMENTAL INVESTIGATION

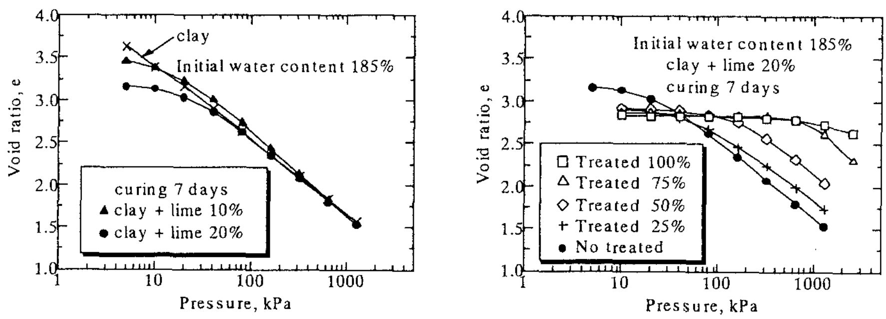
Ariake clay used in this study was obtained from Okawa, Fukuoka prefecture. The clay was sampled from 1.0 m depth from the bottom of the creek. Properties of the soft clay sample were showed in Table 1. Quicklime was applied for the stabilization. To investigate organic matter effect, the natural and the clay that was treated by Hydrogen peroxide (H_2O_2) and then washed several times with distilled water until the washings did not indicate acidity, were then mixed with 20% quicklime content at the same initial water content as about 185%. The specimens are 50 mm in diameter and 100 mm in height. They were cured at temperature about 20°c and humidity 90%. The unconfined compressive tests were carried out after the curing period of 28 days. To investigate the effect of sulphate, the treated soft clay free of sulphate was mixed in different proportions with initial soft clay to obtain specimen containing various sulphate contents. To eliminate the sulphides, the clay was treated by sulphuric acid (H_2SO_4) until no further evolution of hydrogen sulfide occurred, and then washed several times with hot distilled water until the washings did not indicate acidity (BS1377: Part 3:1990:3). A series of one-dimensional compression tests were carried out on the remolded soil using an oedometer apparatus. The specimens were performed on the soft clay treated with 20% quicklime content and contained different sulphate contents at the same initial water content as 185%. The tests were carried out after the curing period of 7 days.

Table 1. Properties of soil

Water content, %	Liquid limit, %	Plasticity index, %	pH	Organic matter, %	Particle size distribution, %		
					Sand	Silt	Clay
185	143	89	6	1	3	52	45

III RESULTS AND DISCUSSIONS

The clay sample was obtained from the bottom of the creek. It normally contains high sulphate content. The specimens of natural and treated clay with Hydrogen peroxide (H_2O_2) that were mixed with 20% lime and cured 28 days could not stand when they were taken from the molds. The strength of sample is too low to conduct unconfined compression tests as about 5 kPa. The quicklime fails to treat Ariake clay that contains organic matter more than 6 percent (Miura et al. 1988). As show in Table 1 this clay sample contains organic matter only 1 percent. And there are many kinds of organic matter that do not influence on the strength of the stabilized clay (H. Tremblay et al. 2000). It clearly showed that the organic matter has no effect on strength mobilize of this treated clay. Fig. 1 showed one dimensional compression curves for specimens containing different sulphate contents. The initial void ratios of different sulphate contents are different because of the water contents after stabilized. The sulphate content has the effect on dehydration reaction of quicklime treated soft clay. Fig. 1 (a) showed that the compression curve of the remolded soil is a strength line. After the clay was mixed with the 10 and 20% quicklime contents, it induced the yield stress 10 and 20 kPa, respectively. Fig. 1 (b) showed that the treated clay 0, 25, 50, 75 and 100 % induced yield stress 20, 80,100, 900 and 2000 kPa, respectively. The yield stress of non- sulphate clay is 200 times of sulphate clay. The sulphate content has the high effect on strength development of quicklime treated soft clay. The low sulphate content induces higher yield stress. This showed that the strength mobilization of quicklime treated soft clay is reduced when the sulphate content increases.



(a) (b)

Figure1 One-dimensional compression curves of clay treated with quicklime

IV CONCLUSIONS

The test results show that the sulphate content induces the high influence in quicklime treated soft clay. The low sulphate content induces higher yield stress. The sulphate has the influence on dehydration of lime treated soft clay. The observed data show that the sulfate is a major factor retarding the development of lime treated soft clay. The strength loss of treated clay is related directly to the sulphate contents increase.

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