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EXTENDED ABSTRACT

Impact of Initial pH Change of Kaolinite on Its Microstructure and Consolidation Characteristics

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1. Introduction

Acidic agents are considered as one of the most prevalent contaminants on the earth. Several sites are exposed to acidic pollutants like Acetic acid (Olgun and Yildiz, 2012). According to previous researches, the causes of acidic contaminations in soil could be natural processes like weathering of pyrite in mudstone, or human activities like municipal waste storage, accidental spills or acidic rain (Gratchev and Towhata, 2013). On the other hand, changes of the chemical properties of the pore fluid have a considerable effect on the geotechnical characteristics of clay including the compressibility and the shear strength parameters all of which are important parameter on the strength and the stability of earth structures and constructions on the soil. Therefore, it seems to be necessary to recognize and analyze the effective factors on the engineering behavior of clay soils like pH.

In the most of available research, experiments have been conducted by adding acidic or alkaline agents to the soil-water mixture and adjusting its pH whereas it seems that the pH would have some variations by the time. Therefore, the effects of the changes of the initial pH of the soil are neglected in the previous studies. In this study the effect of the initial pH of the pore fluid of the kaolinite on its microstructural and consolidation characteristics have been investigated in the laboratory.

2. Methodology

In this research, at first the water the and soil were mixed with the portion of 1:10 (10 water and 1 soil) to initialize the stabilization process of the initial pH of the kaolinite. Then in order to prepare kaolinite samples with stabilized initial pHs of 2, 4, and 6, 1M Hydrochloric acid solution was added to the mixture of water and kaolinite while the suspension was mixed by a rotary mixer. Adding Hydrochloride acid solution to samples was continued daily until the pH of the mixture was reached to the desired pH. The process of mixing was repeated every day at least for 2 hours in successive cycles to keep the pH of the mixture in the desired range of PH for 96 hours.

Fig. 1 shows the changes of the pH in samples during adding the acidic agent to the soil-water mixture. As can be seen in Figure 1, the pH of the soil-water mixture had reached to a steady-state condition after several cycles of exposing to the acidic agent depending on the desired level of the pH. Higher values of the pH require more cycles of exposing to the acidic agent while lower steady-state pH values reached by a few cycles of exposing to acidic agent.

After stabilization of initial pH of samples, several tests have been conducted on the samples, including sedimentation, X-ray diffraction (XRD), laser gradation, and consolidation according to ASTM standard. The

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tests were repeated at least two time to ensure the reputability of the experiments and reducing the possible errors.

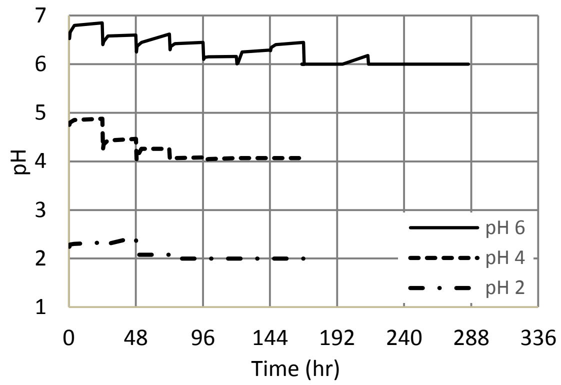

Fig. 1. PH variations in samples during adding acid to soil

3. Results and discussion

3.1. The investigation of changes in fabrics of kaolinite by changes of initial pH

Fig. 2 shows peak intensity variation of kaolinite by initial pH variations in XRD test. According to Fig. 2, the rate of kaolinite peak intensity reduction in samples with the pH of 2, 4 and 6 are 50%, 42% and 48% relatively compared to the main kaolinite sample. Generally, the results show a change in fabrics of kaolinite clay and the progress of soil fabrics from dispersed to flocculated with reduction in initial pH of soil.

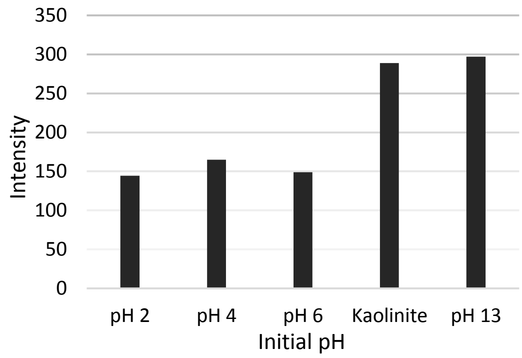

Fig. 2. Peak intensity variation of kaolinite by initial pH variations in XRD test

Fig.3 shows laser gradation plot of a pure kaolinite sample and kaolinite samples with stable initial pHs from laser measuring. As can be seen in Fig. 3, a reduction of initial pH and increasing the attraction between the clay particles, caused a kind of flocculation that increased the average particles size measured in the tests.

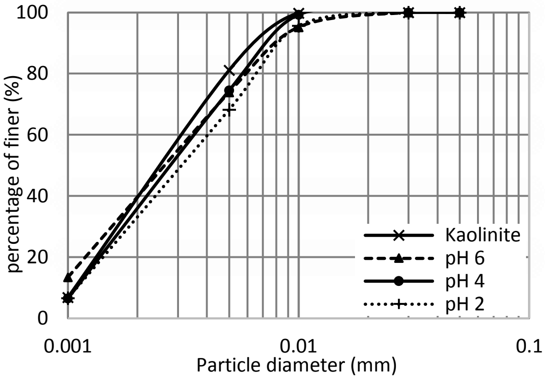

Fig. 3. Laser gradation plot of a pure kaolinite sample and kaolinite samples with stable initial pHs

3.2. The investigation of variations of consolidation characteristics of kaolinite soil by changes in initial pH

To investigate the effects of initial pH variations on compressibility behavior of kaolinite, the odometer test has been done on the samples. The outcomes are shown in Fig. 4.

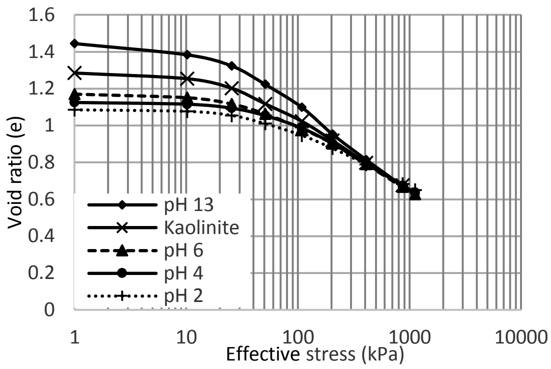

Fig. 4. Consolidation performance of kaolinite samples with stable initial pHs

Availability of Hydrogen ion from Hydrochloride acid solution with the purpose of reducing soil initial pH, leads to an increase in inter particle pure repulsive. According to previous studies the effective tension among soil particles has been increased and the soil gets denser under pre consolidation tension.

4. Conclusions

Investigating the results presented in three sections of X-ray diffraction, sedimentation and laser granulation indicates an appropriate overlap between the results. In general, these results indicate a change in the structure of the kaolinite and the progression of the soil structure from dispersed to the folliculated structure, and ultimately increasing the measured size of clay particles by reducing the initial soil pH.

The results of the one-dimensional consolidation show that the structure of the specimens has become denser under an initial constant stress by decreasing the initial pH of the kaolinite. Also, regarding the changes in compression index of samples, the results indicate that with decreasing the initial pH of the samples, their compression index was decreased.

4. References

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