III-175 TEMPERATURE EFFECTS ON MECHANICAL PROPERTIES OF BENTONITE

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INTRODUCTION

A number of studies have shown that temperature variations can significantly influence some mechanical properties of clay soils. The mechanical properties which have been proved to be affected by temperature variations are: deformation, shear strength, pore water pressure development and creep behaviors. Knowledge of these behaviors as a function of temperature not only provides very useful information for field application but also gives some basic understanding of soil behaviors.

This paper presents some results of the preliminary stage of a research program carried out to study the effects of the temperature variations on the mechanical properties of bentonite. In this stage the study is focused on how the temperature affects the mechanical properties of the bentonite, i.e. it changes material properties of bentonite powder or it affects interaction between the bentonite and pore water or it influences both.

EFFECTS OF HEATING ON PROPERTIES OF BENTONITE POWDER

Air dried bentonite powder was heated in ovens at temperatures of 200, 110 and 60°C for 5 days. The heated powder then was cooled down to a room temperature in desiccators. Unconfined compression test and free swelling test were conducted using this cooled powder.

The unconfined compression tests were carried out on specimens of compacted powder. The compaction was carried out at room temperature by static pressing. Water content at compaction was 13 %. Lubricated ends were used in loading of the specimens. Fig. 1 shows relationships between unconfined compressive strength and dry density of non-heated powder and the powder heated at 200°C. No significant difference between the relationships can be observed.

A free swelling test was conducted by pouring 5 cc. of the powder slowly into a measuring cylinder filled with 100 cc. of distilled water. Then the volume of the settled solid was measured. A free swelling value was defined as the change in volume of dry powder as its original volume. The free swelling values of the powder heated at 200, 110 and 60°C are shown in Fig. 2. There is no significant difference among the free swelling values.

TEMPERATURE EFFECTS ON INTERACTION BETWEEN BENTONITE AND WATER

Swelling properties of bentonite under high temperature were studied. Swelling pressures of non-heated compacted bentonite specimens when submerged in water at room temperature and at 90°C temperature were carried out using consolidometer. The specimens were compacted statically in the consolidometer rings with a water content of 13 %. Dry density of the specimens was 1.62 g/cc. The swelling pressure tests in 90°C water were carried out in a box containing water whose temperature was controlled by electric heaters and a thermostat. The tests were done according to the procedures suggested by Head (1980).

Fig. 3 presents the swelling pressure versus square root of time curves of both specimens submerged in room temperature water and in 90°C water. The curves show that the equilibrium swelling pressure at

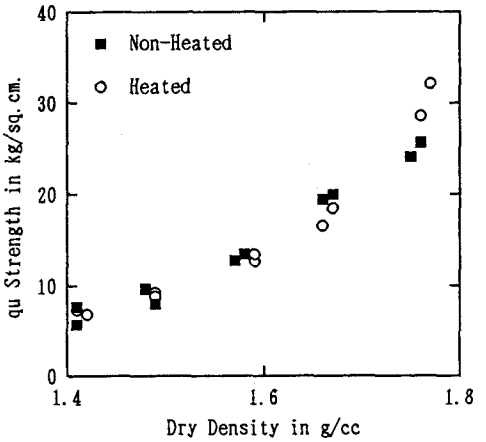

Fig. 1 Unconfined compressive strength - dry densities plots.

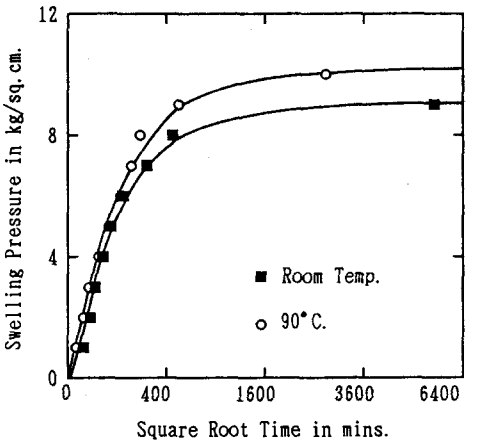

Fig. 3 Swelling pressure versus square root of time curve.

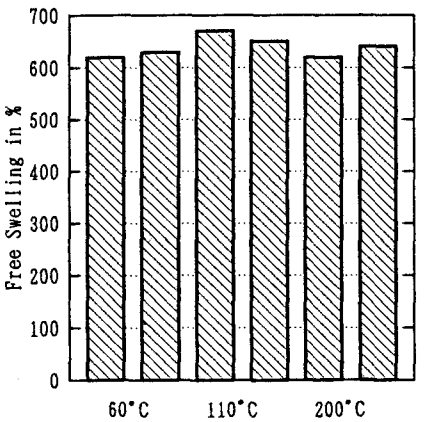

Fig. 2 Free swelling test results.

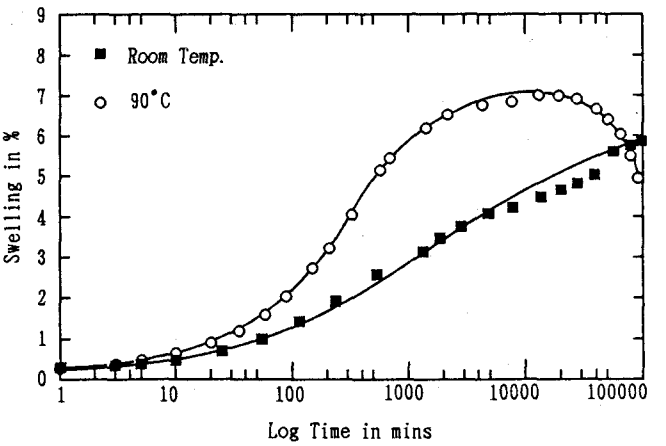

Fig. 4 Swelling - log time curve.

high temperature is slightly higher than that at room temperature.

After the equilibrium swelling pressures were obtained, the applied pressures were decreased to 4 kg/sq.cm. and the specimens were allowed to swell. The magnitudes of the swelling are plotted against logarithmic of time in Fig. 4. The figure shows that the rate of swelling in 90°C water is higher than that in room temperature water. Unfortunately, since the magnitude of maximum swelling in water at room temperature has not been obtained yet, the comparison of the magnitudes of swelling can not be done. It should be noted that creep rate of the specimen in 90°C water is quite high.

CONCLUSION

Heating up to 200°C has no significant effect on material properties of bentonite powder. But it affects interaction between bentonite and pore water. Swelling pressure of compacted bentonite submerged in 90°C water is slightly higher than that in room temperature. Rate of swelling in hot water is higher than that in cold water.

REFERENCE

Head, K.H. (1980), Manual of Soil Laboratory Testing, Pentech Press, London.