THE EFFECT OF SALINITY ON THE SWELLING OF BENTONITE

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1.Introduction

Compacted bentonite and bentonite-sand mixtures are attracting greater attention as buffer and backfill materials for high radioactive waste disposal because its good sorption properties, micro porous structure and low hydraulic conductivity and plasticity to act as an effective barrier and restrict the movement of nuclides from the waste packages after canister failure.

Many experimental works have also been developed to study the behavior of buffer material under combined effect of water from surrounding rock and heat from canister. However, the experimental information on swelling property of compacted bentonite were mainly saturated with distilled water as test fluid. In reality, the underground water at very deep level is fossil brine formed several thousand years ago and consists of saline content such as water sample at 300 meters depth from Underground Research Laboratory site in Horonobe, Hokkaido has exchange amount of Na^+ 4300 mg/l (half of Na^+ amount in seawater) (Kikuchi et.al., 2005). To study the effects of salinity on the swelling characteristics of bentonite, a series of laboratory tests was performed.

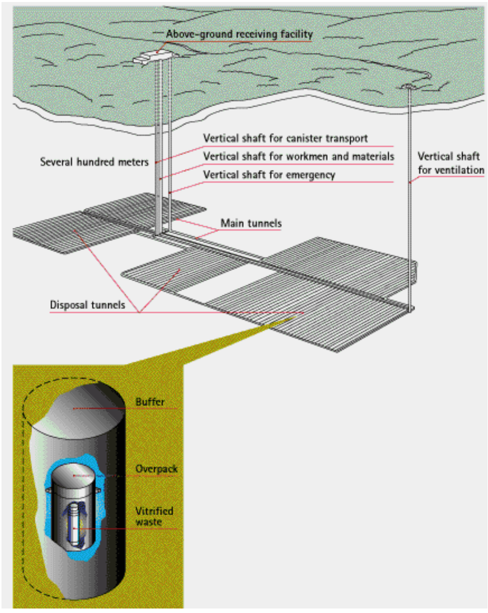

Figure 1 Graphical Conception of Underground Disposal of HLW

2. Materials and Methods

Powdered Kunigel bentonite was used in this study. Pure powdered bentonite compacted by a compaction device.The specimen height and desire density was maintained by the variation of specimen mass and compaction energy. Initial dry density of pure bentonite specimens vary from 1.30-1.95 g/cm^3. The concentrations of NaCl in saline solution vary from 0.5 ? 4.0 moles/l.

The vertical swelling deformation of compacted specimens under static load was measured by Oedometer test apparatus (See Figure 2 for schematic diagram of swelling deformation test apparatus). Saline solution applies to the specimen simultaneously

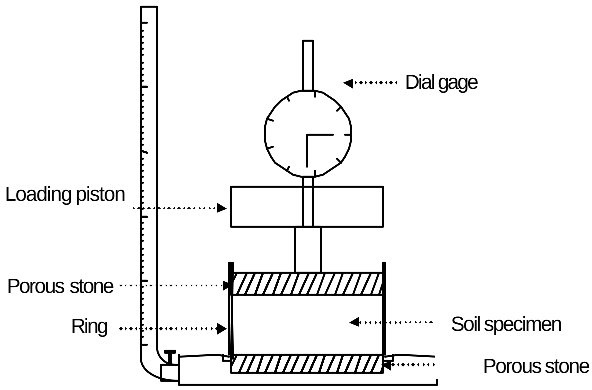

Figure 2 Schematic diagram of swelling deformation apparatus

with controlled 0.16 Mpa static load. Swelling rate was calculated by the following equation.

$$\text{Swelling rate} = \frac{\Delta s}{H_0} \times 100$$

3.Test result and dicussion

Swelling deformation test has been carried out at laboratory temperature for dry density of 1.30-1.95 g/cm³ under static load 0.16 MPa which were carried out by distilled water and different concentrations of sodium chloride solution. The specimens carried out by distilled water and compared with previous experiments by Shirazi 2005. The relationship between swelling rate and elapsed time for various initial dry densities are shown in Fig. 3. The percent swelling is defined as the change in the volume of the sample relative to the initial dry volume. The experiments which were saturated by different concentrations of sodium chloride have been carried out and the results are shown in Fig. 5.

From Fig.3 can be observed that for higher dry density specimens show higher maximum swelling rate. It is due to the monmorillonite content of sample. The result from this research shows lower swelling rate and lower maximum swelling rate than previous research by Shirazi 2005 (Show in Fig.4). It might be caused by the temperature different. In present research, the experiment has been carried out in winter while the previous were carried out in summer. Fig. 5 clearly showed that salinity strongly effect to the swelling rate of compacted bentonite. Higher concentration of sodium chloride solution show lower both swelling rate and maximum swelling rate

Anyway, the data is seem to be too less to conclude that with the high concentration of salinity, compacted bentonite will not swell like in this experiment. The experiment with higher initial dry densities is needed to be carry out.

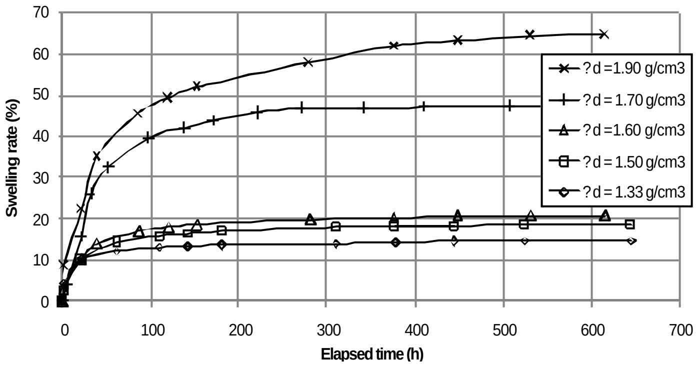

Figure 3 Swelling rate of Kunigel Bentonite under static load 0.16 Mpa saturated in distilled water

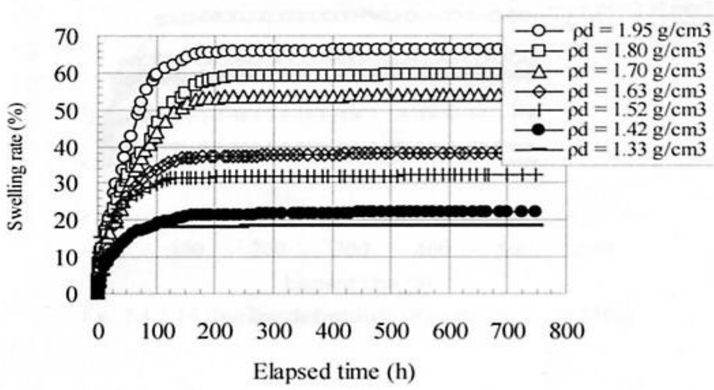

Figure 4 Swelling rate of Kunigel Bentonite under static load 0.16 Mpa saturated in distilled water by Dr.Shirazi (2005)

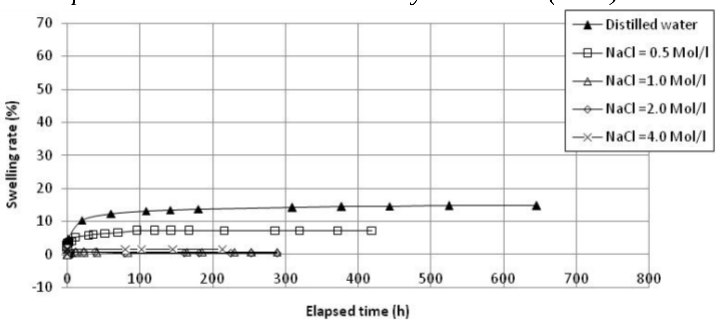

Figure 5 Swelling rate of Kunigel Bentonite with initial dry density 1.3 g/cm³ under static load 0.16 MPa saturated in different concentration of NaCl

4.References

Shirazi,S.M (2005), “Permeability and Swelling Characteristics of Bentonite for Waste Disposal”,Ph.D.Thesis,Saitama University,Japan.

Kikuchi Hirohito, Tanai Kenji and Yui Mikazu, “Database Development of Fundamental Properties for The Buffer Material in Japan” Proceedings of GLOBAL 2005, Tsukuba, Japan, Oct 9-13, 2005, Paper No. 238