Measurement of strain of bentonite-sand mixture in suction cycles

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Introduction

Compacted bentonite is accepted as high potential barrier material that has strong expansive phenomena. On repository concepts, very slow water conductiv-ity of dense compacted bentonite is effective to establish safety design at term of long time. As relevant engineered barrier properties, dry density, swelling pressure and water retention capacity had been investigated in previous experiences. The stress-strain behavior of compacted bentonite was interpreted in unsaturated soil mechanics using two effective stress variables that some constitutive models were developed to compare between experi-ence works and the confirmed tendencies. (Blatz et al., 2002, Cui et al., 2013). On concerning the interaction between repository and barrier phase for suc-tion cyclic such as wetting-drying paths induce accumulation of strains (Alonso et al., 2005).This study measured soil water characteristic curve (SWCC) of compacted, bentonite-sand mixture with total suction using vapor pressure technique. The specimen was applied suction without artificially confining pressure. The controlled suction had a range from 2.8 MPa to 296 MPa, which cor-responded from 98 % to 11 % in RH.

Test procedure

This testing programs majority consisted of soil-water characteristic curve measurement test, which had a high suction ranges due to vapor pressure technique. All of specimens were prepared in statically compaction process. The different salt solutions were selected for applying various high suctions. The relative humidity induced by salt solution was directly measured using RH & temperature sensor using modified air circulation system. Measurement of RH connected to confirm controlling of suction for specimens on vapor pressure technique. The testiong program used two soil materials that sodium bentonite and silica sand were called as Kunigru V1 and Iitoyo sand. Silica sand had uniformity grain size ditribution. The specimens with differnt sizes were prepared for SWCC tests, and each size was mentioned in Table 1. Actually, specification of specimen size was not yet established, and the results obained from this testing leaded meaningful tendency.

Table 1: Summary of specimens.

Specimen symbol	Sand mixture	Specimen di-ameter mm	Specimen height mm	Salt water	Initial condi-tion at SWCC test	Compaction
A	No	No	No	No	Powder	No
B	No	6	2	No	Saturation	Statically
C	No	6	2	Yes	Saturation	Statically
D	Yes	2	0.75	No	Unsaturation	Statically
E	Yes	6	2	No	Unsaturation	Statically
F	Yes	6	2	No	Saturation	Statically

Commonly information exception specimen symbol A: Initial water content 17.0 %, Dry density 1.600 g/cm^3

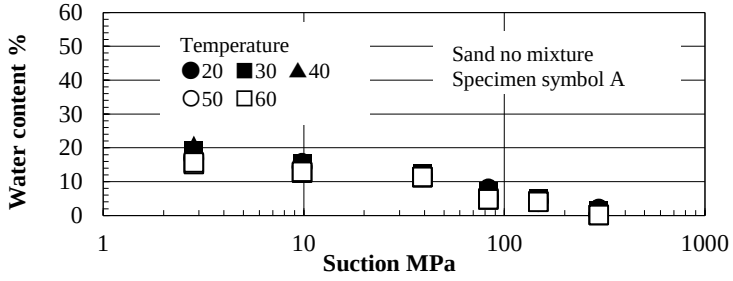

Fig. 1: Investigation of temperature on SWCC of bentonite.

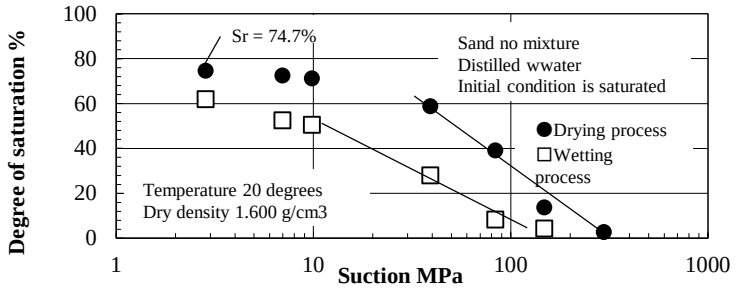

Fig. 2: Soil-watter characteristic curve for specimen symbol B.

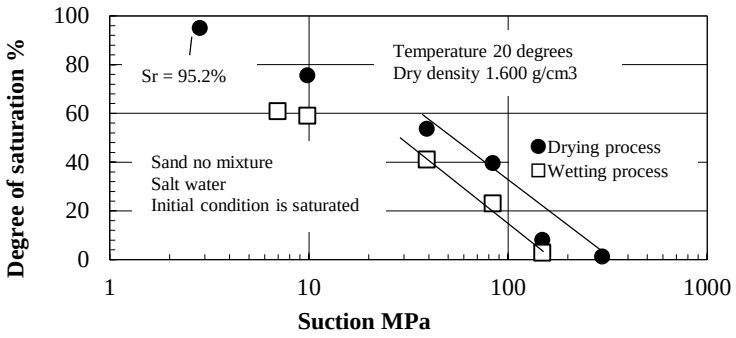

Fig. 3: Soil-watter characteristic curve for specimen sybmol C.

Test result

Figure 1 shows relationship between water content and suction with various temperatures. A general tendency was evidenced that water content decreased with suction, and the SWCCs were not depedent on temperature each of together. Water contents corresponding to suctions seemed to be similar that there was not inflencement of temperature on water retension capacity.

Figure 2 shows that degree of saturation indicated few decrement till suction was 9.8 MPa. Well, dry density mentioned in figure was of initial condition. Degree of saturation was 71.2 % at suction was 9.8 MPa. Over suction was 9.8 MPa, reduction was clear, and degree of saturation was on decrease (i.e. dry density changed). The decrement of degree of saturation was considerable, and had a relation with straight line. End of drying process, a very small amount of soil mositure remained in the void structure that degree of saturation described less than 3.0 %. On wetting process soil moisture increased due to decrement of suction (i.e. increment of RH). While suction was less than 83.4 MPa, degree of saturation indicated much increment, and was well recovering. At suction of 9.8 MPa its value was almost 50 %. It was identified what called hystersis between drying process and wetting process. Saturated specimen (specimen symbol C) swelled by salt water indicated the change of degree of saturation as shown in Fig. 3. It was similar with results as shown in Fig. 2 concerning mechanical properties to degree of saturation due to both increment and decrement with suction. of degree of saturation as shown in Fig. 3. It was similar with results as shown in Fig. 2 concerning mechanical properties to degree of saturation due to both increment and decrement with suction.

References

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