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Experimental study for a long term behavior of near-field of HLW disposal hole by centrifuge model test

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The objective of this paper is to evaluate the long term behavior in the high level wastes geological disposal repository and the neighborhood (called "near-field") by the centrifuge model test. To clarify the long term phenomena in the near-field, the researches by the full-scale test and the numerical analysis have been carried out. However, it is difficult due to a place, time, and economic restraint and a verification of the applicability of the model. If the experiment of the small model of near-field by the centrifugal equipment that can supplement these problem points becomes possible, a long term reliability of the disposal repository can be improved by acquiring the empirical laboratory data. The model specimen consists of rock mass (Tage tuff), bentonite buffer (Kunigel-V1) and model waste (SUS). A rock mass was cut into a core with a diameter of 180 mm and length of 180 mm. The borehole of 54 mm in a diameter and 127 mm in a height was opened at the center of the rock mass. These are the size of 1/30 of the HLW disposal hole proposed in the report of CRIEPI and FEPC (1999). After the bentonite buffer and model waste were enclosed in the borehole of rock mass, the rock mass was enclosed with the pressure vessel, and then, centrifuge model tests were conducted at 30 G of centrifugal force field with confining pressures and injection pressures. The confining pressure was loaded in the conditions of 2, 5 and 10 MPa under the isotropic hydraulic pressure. The injection pressure and back pressure for the permeability test was constantly controlled by half the confining pressure and 0.5 MPa, respectively. We measured the strains of rock mass, swelling pressure of bentonite and displacement of model waste in the tests. In the confining pressure condition of 2 MPa (TG-01), the swelling pressure of bentonite remarkably increased until about 30 hours passed and was nearly constant until about 160 hours passed. After that, the swelling pressure re-increased, and then, gradually decreased after 230 hours passed. The observed maximum swelling pressure showed approximately 1.7 MPa. Similarly trend was observed in the displacement of model waste though the displacement showed subsidence until 30 hours passed. The equivalent maximum subsidence showed approximately 1.5 mm. The values of strain increased until 30 hours passed, and then, were nearly constant. In the confining pressure condition of 5 MPa (TG-03), the swelling pressure of bentonite continuously increased until about 120 hours passed, and then, was nearly constant after about 150 hours passed. The displacement of model waste remarkably subsided until about 50 hours passed and then, was nearly constant after that. The maximum values were observed approximately 1.6 MPa for swelling pressure of the bentonite, approximately 1.5 mm for equivalent subsidence of the model waste. In the confining pressure condition of 10 MPa (TG-05), the swelling pressure showed a similar trend to TG-03, on the contrary, the value obviously large: approximately 3.0 MPa at peak, and finally approximately 2.1 MPa. The displacement of model waste remarkably rose until about 120 hours passed and then, was nearly constant after that. The equivalent maximum rise showed approximately 21 mm. The values of strain gauges attached to the side face of rock specimen showed the rapid increase until 60 hours passed, and then, were nearly constant. The values of strain gauges attached to the top-end face of rock specimen showed the rapid decrease until 60 hours passed, and then, were nearly constant.

Keywords: Centrifuge, High-level radioactive waste, Near-field, Long term behavior, Model test