# Numerical Analysis of In-situ Flow Tests for Locally Variable Hydraulic Property on a Borehole

Nak-Youl Ko* and Sung-Hoon Ji

Korea Atomic Energy Research Institute, 111, Daedeok-daero 989beon-gil, Yuseong-gu, Daejeon, Republic of Korea

*nyko@kaeri.re.kr

## 1. Introduction

If deposition holes for high-level wastes in the deep geological disposal are damaged by excavation of the holes, flow and transport resistance at the near-field can be degraded. In this study, numerical analysis for in-situ flow with a double chamber (dipole) structure in single borehole was conducted [1].

## 2. Method

Numerical simulations for dipole flow tests were performed in discretized subsurface medium with hydraulic properties observed at KURT Research Gallery #6. First of all, the effect of anisotropic hydraulic conductivity on groundwater flow was examined. Then, a locally variable hydraulic conductivity, which represents local flow structures or damaged zone, was applied between the upper and lower chamber.

### *2.1 Modeling Domain for Numerical Simulations*

For numerical simulations, discretized modeling domain was constructed (Fig. 1). Hydraulic conductivities were applied as the estimations obtained by field tests in KURT (Fig.2)

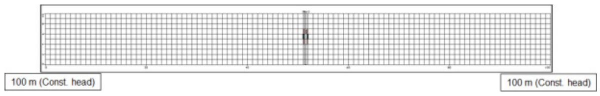



Fig. 1. Discretized modeling domain.

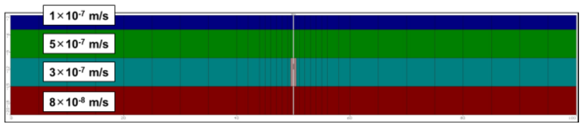
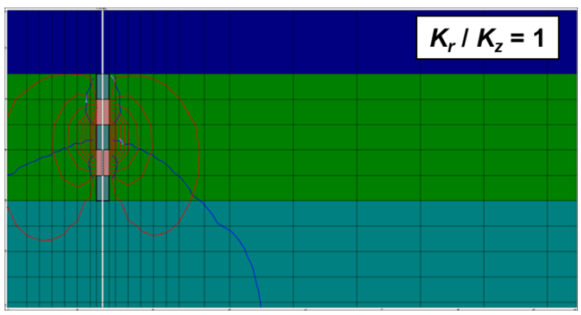



Fig. 2. Distribution of Hydraulic conductivity in the modeling domain.

## 3. Results

### *3.1 Effect of Anisotropy*

Anisotropic hydraulic conductivity ($K_x$ / $K_z$ = 10.0) was applied and the simulation results were compared with that of isotropic case ($K_x$ / $K_z$ = 1.0). In the anisotropic case, groundwater flow path was extended more laterally than that of isotropic case. Therefore, travel time of groundwater also increased. If high anisotropy is observed or expected in test area, enough test time will be required to analyze groundwater flow conditions more accurately.



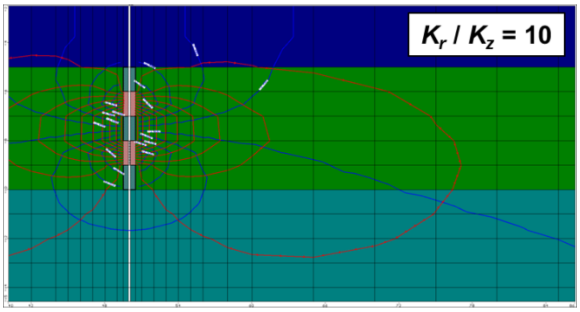



Fig. 3. Difference of groundwater flow path by anisotropy of hydraulic conductivity.

*3.2 Effect of Local Structure*

A high hydraulic conductivity zone between the upper and lower chamber was assumed and groundwater flow was simulated under anisotropic condition (Fig. 4). From the results, groundwater flow path became smaller and more than 50% of injected water at the lower chamber reached upper chamber throughout the high conductivity zone, which had 10-100 times higher hydraulic conductivity than other part of modeling domain.

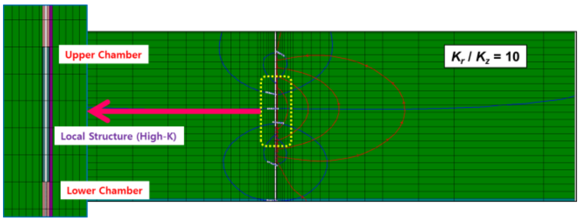



Fig. 4. Changes of groundwater flow path by local structure.

## 4. Conclusions

To investigate an effect of locally variable hydraulic conductivity on groundwater flow, numerical simulations were performed. The simulation results show that anisotropic distribution of hydraulic conductivity and locally variable hydraulic conductivity have much influence on groundwater flow path and travel time. These results and analysis can be helpful to design in-situ field test of dipole tracer test, which may shows directly an effect of short-cut transport via local damaged zone.

## ACKNOWLEDGEMENT

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## REFERENCES

[1] Z.J. Kabala, "The dipole-flow test: a new single-borehole tests for aquifer characterization," Water Resources Research, 29(1), 99–107 (1993).