Soil Tank Tests and Numerical Analysis for the Prediction of Solute Transport in Porous Media

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1. INTRODUCTION

Since surplus soils are generated in large quantities every year from excavation operations, utilization of these soils would be beneficial especially in countries with limited space, such as Japan. Even though such surplus soils sometimes contain heavy metals by natural origin, their concentration levels are not so high compared with artificial contaminations. Therefore, these soils have potential to be reused in the construction works, such as embankment and backfill. However, fate and transport of substances must be assessed properly on the occasion of the application, since dissolved substances could reach the groundwater through infiltration and dispersion as shown in Figure 1. In this study, the solute transport behavior affected by compaction degree in the aquifer was evaluated and predicted analytically and experimentally.

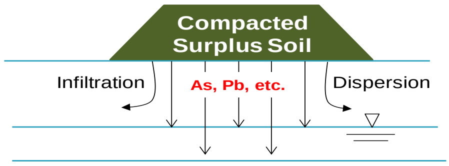

Fig 1. Solute transport in porous media

2. METHODOLOGIES

Soil tank test was conducted to evaluate the actual phenomenon focusing on the effect of compaction degree of tracer part on the solute transport. The dimension of the tank was 800 × 380 × 225 cm and it had 2 tracer parts with different compaction degree of 90% and 95% (see Figure 2). The tracer part consists of sand mixed with NaCl (2% of soil wet weight), which was used to simulate the solute. The soil tank test started as soon as tracer part was put in. Chloride concentration was monitored for 16 days.

Software, Dtransu-2D.EL, was used for numerical analysis in this study. Some parameters were determined from the experimental results and others, from the literature. A mesh model was built using the same size as the soil tank test. The analysis was started from the moment when the tracer part setup was finished. The water flow behavior, add up to the solute transport path and the concentration fate can be obtained from both experiment and analysis. A comparison of these results would verify the validity of the numerical analysis and help optimizing the initial parameter settings.

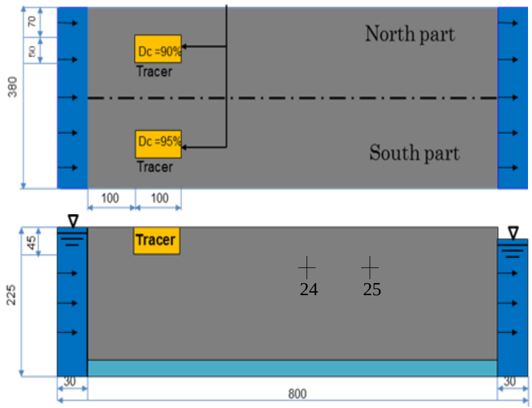

Fig 2. Detail of soil tank test (24, 25: sampling point)

3. RESULTS AND DISCUSSIONS

As a result of soil tank test, the concentration variation by the lower compacted tracer was larger than that by the higher compacted tracer as shown in Figure 3. Transport zone from the lower compacted tracer was larger than that from the higher compacted tracer. From these observations, a higher compaction of source zone could inhibit the release of solute for longer time.

The analysis results of both compaction degrees of tracer parts were almost same with the experimental results in water head fluctuation. However, there were differences in Cl^- concentration variation due to the parameters and conditions setting. The differences between soil tank test and numerical analysis in concentration variation should be minimized. In the future, the inverse-analysis would provide accurate parameters settings.

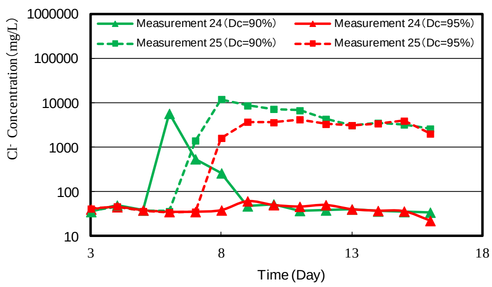

Fig 3. Cl^- concentration variation from soil tank test