8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

A New Control System for Saltwater Intrusion into Coastal Aquifers and its Numerical Experiments

***Rippei Makino[1)], Eri Hirasawa[1)] and Morito Kusabuka[1)]**

1) Department of Civil and Environmental Engineering, Faculty of Engineering, HOSEI University
Kajino-cho 3-7-2, Koganei-shi, Tokyo, 184-8584, JAPAN
E-mail address r_makino@hosei.ac.jp, m.kusa@hosei.ac.jp

Key Words: *Coastal Aquifer, Saltwater Intrusion, Experiment, Numerical Analysis.*

ABSTRACT

In global environment problems, such as protection of water resources and maintenance of an ecosystem, the preservation and sustainable exploitation of freshwater have been important subjects. Coastal aquifer constitutes a water resource that can be exploited without affecting inland natural environment. On the other hand, public works, domestic and industrial water supply, agriculture and future sea level rise will affect directly the quality and quantity of freshwater in coastal aquifer. Considering that the costal areas sustain most of human activity, the integrated management of coastal aquifer is very important, and has to include the technical problems to be solved. One of the technical problems is the control technology of groundwater in costal aquifer without disturbing groundwater systems and the environment of shore water in costal areas as much as possible.

Authors proposed the new system which controls saltwater intrusion into coastal aquifer. This system consists of impermeable wall with surging trench and monitoring system of fresh and salt water or fresh-salt water interface. The bottom of the cutoff structure is not in contact with an impermeable stratum, and an opening is prepared. This opening allows moderate out-in flow of freshwater or saltwater, and makes it possible to control the scale and form of saltwater wedge intrusion. The structure constructed in an aquifer consists of an impermeable wall of the downstream side, a permeable wall of the upstream side and a surging pit constructed between the walls. The water table in the surging pit can be controlled by a flow rate of fresh water supplied from ground surface or the upstream aquifer with a higher water head. In other words, by controlling the water head in the surging pit, the water head distribution and the flow velocity vector in vicinity to the structure can be controlled. For example, a downward flow field is formed by keeping the inside of the surging pit in the higher head, around the control structure. This flow field prevents saltwater wedge penetrating into the aquifer, and also assists the discharge of saltwater or stagnant contaminants in the bottom of the aquifer.

Demonstrating of the configuration of fresh and salt water flow around the surging trench is very important in order to develop the new control method for saltwater intrusion in coastal aquifers. The numerical flow analysis of the experimental models had performed, and it evaluated the validity of our basic policies. The computer program FEMWATER [1] using the analysis is a three dimensional finite element model for simulating density-dependent flow and transport in variably saturated porous

media. **Fig. 1** shows the distribution of the saltwater concentration in the natural aquifer. **Fig.2** shows the distribution in the aquifer which was constructed only the impermeable wall without surging pit. **Fig. 3** shows the distribution in the aquifer with the new system which sets the impermeable wall with surging pit keeping the higher water head between the surging pit and the saltwater boundary.

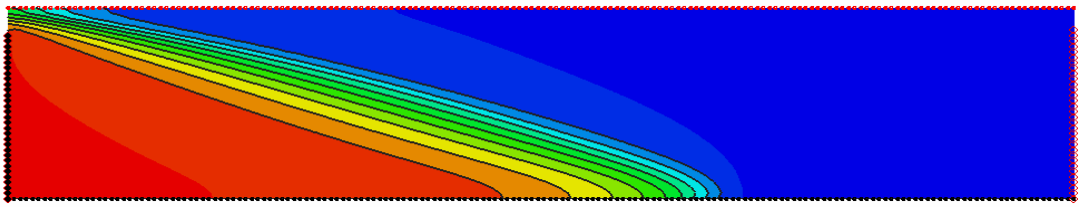

Fig.1 Distribution of saltwater concentration (without any barrier)

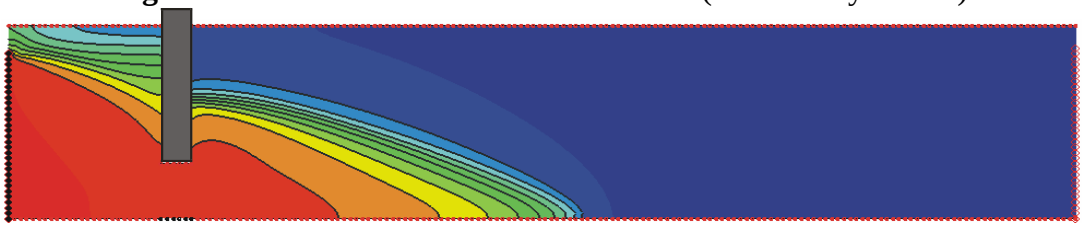

Fig.2 Distribution of saltwater concentration (with impermeable wall)

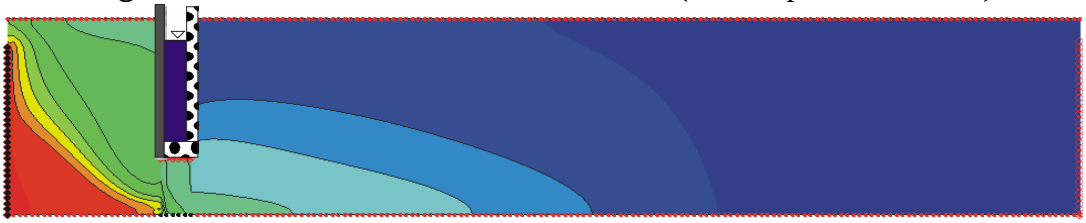

Fig.3 Distribution of saltwater concentration (with impermeable wall and surging pit)

Conclusions: Authors have proposed a new control system of saltwater intrusion into coastal aquifer and have assessed the effects of the control system as follows:

(1) The impermeable wall with the surging pit can reinforce both the amount and the increasing region of the downward component of the flow velocity by high water head in the surging pit. These two may easily controlled by adjusting water head in the surging pit.
(2) The opening section under the bottom of the surging pit can be closed by the saltwater wage controlled by the water head in the surging pit. This function has a significant meaning on the development of the technique to control the discharge of freshwater and the storage of freshwater in the aquifer.
(3) The above mentioned remarks guarantee that the proposed system can be applied to an aquifer in which the impermeable boundary under porous stratum is in a relative depth.

The surging pit has not only the effect of decreasing the scale of the penetrating saltwater wedge but also the effect which depresses deeply the salt-freshwater interface formed in an aquifer. As a result, we could increase the amount of storage of the freshwater.

REFERENCES

[1] Hsin-Chi J. Lin, etc., FEMWATER Version 3.0 Manuals.