GROUNDWATER FLOW UNDER THE EFFECTS OF FAULT AND SHEET WALL AT THE LANDFILL SITE

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Abstract: At the landfill site, the effects of the faults and sheet wall have not been analyzed yet. In the present paper, the authors attempted to simulate the scenarios to understand these effects on the mechanism of groundwater flow at the landfill site. The results show that when the permeability of the faults is higher, the groundwater takes place along these faults. Surface water may be contaminated due to the leakage of waste water at outside the landfill.

1. Introduction

In Japan the landfills have been constructed with high technology and good standard at present. The landfills used before 1970s when the incineration became popular, contain waste which did not undergo intermediate treatment. In other words, the landfill was just a dumping site[1]. From 1970 to 1980s, the landfills contain both intact waste and incineration residue [2]. Moreover, the first guidelines for the landfill facilities were published in 1979. The characteristics of waste depose at the landfill sites in Japan had been drastically changed, i.e. from unprocessed municipal solid waste (MSW) to incinerator residue and noncombustible MSW. In 1988, the new landfill guidelines were promulgated providing the standard values for facility and equipment as well as the new design criteria of leachate treatment facilities [3].

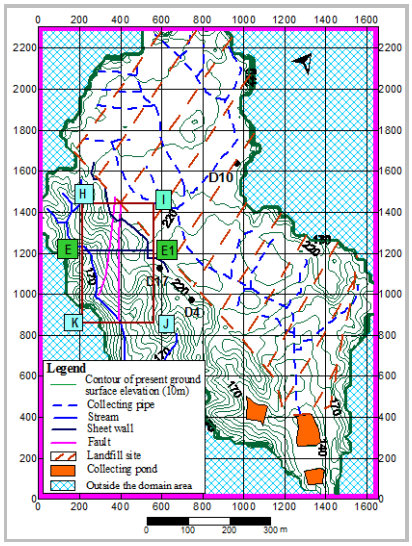

Fig.1 Geological conditions at cross section D-D1

Table 1. Model parameters of the $2D_h$

Model parameters	Value (unit)	Note
$K_{natural}$	$8.6x10^{-4}$ cm/s	Outside the landfill
K_{waste}	$5x10^{-3}$ cm/s	Waste material
K_{f1} (scenario 1)	$8.6x10^{-4}$ cm/s	Fault
K_{f2} (scenario 2)	$1.2x10^{-3}$ cm/s	Fault
K_{f3} (scenario 3)	$2.4x10^{-3}$ cm/s	Fault

Fig.1 shows A. landfill which is located in B. City, Japan and selected as case study. The function of this landfill is to dispose the final domestic waste such as domestic garbage, swept refuse from streets. Inside the domain area, there are three waste water collecting ponds which are regarded as the impermeable boundaries. A concrete sheet wall system was constructed in order to prevent the leakage of the leachate of the landfill. Understanding of the behavior of groundwater flow is the most important in order to make the landfill "safety" with the surrounding environment. At the study site, the contaminants have been found outside the landfill at some springs and also at the observed wells. Almost the contaminated locations concentrate outside the walls and along the faults. However, the effects of the faults and the sheet wall have not been considered yet. Therefore, the evaluation of the effects is indispensable. The present paper will discuss on domain HIJK and the cross-section E-E1 in **Fig.1**. The objectives of the paper are 1) to simulate the groundwater flow and 2) to evaluate the effects of the faults and sheet wall.

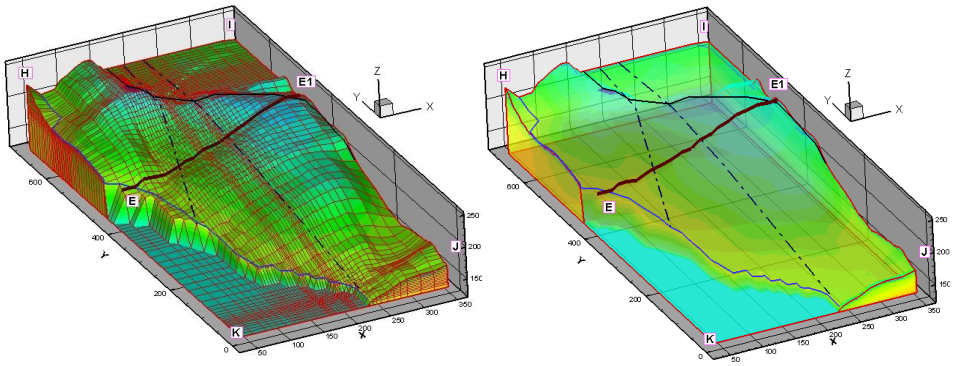

Fig.2 Discretization and pressure head

2. Methodology

Groundwater flow equation

Three dimensional groundwater flow equation assuming constant water density can be described as Eq.(1):

$$(C_w + \beta S_0)\frac{\partial p}{\partial t} = \frac{\partial}{\partial x}\left\{k(p)\frac{\partial p}{\partial x}\right\} + \frac{\partial}{\partial y}\left\{k(p)\frac{\partial p}{\partial y}\right\} + \frac{\partial}{\partial z}\left\{k(p)\left(\frac{\partial p}{\partial z}+1\right)\right\} \quad (1)$$

where $p(x,y,z,t)$[L]is pore pressure head (further it will be called as pressure head); k[LT^{-1}] is permeability in isotropic media, k is a function of the pressure head. In other words, k depends on water content of the porous media. S_0[L^{-1}] is specific storage coefficient. β is a switch number given by 0 or 1 for unsaturated or saturated condition.

Numerical solution

The transient groundwater flow by Eq.(1) is solved by an implicit finite difference method and over relaxation technique. The research concentrated on a small part at the landfill site. The model domain is divided into irregular discretized grid system for x and y direction which gradually changes from 2m to 40m. For the z direction, the constant grid size of 2.5m is used. The densest is closed to the sheet walls and faults to examine their effects on groundwater flow. The bedrock elevation is 80m above sea level. The time interval of model is 1 hour. **Fig.2** demonstrates the grid distribution and pressure head of the calculated domain HIJK. Three scenarios were carried out with different permeability of faults which was shown in Table 1.

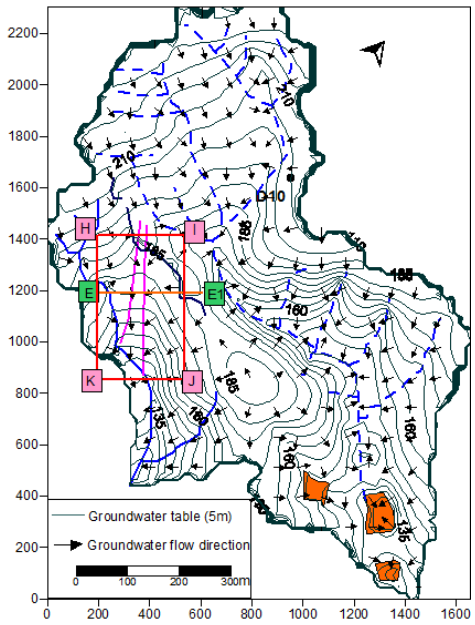

Fig.3 Groundwater table and direction

3. Discussion

The two dimensional groundwater simulation obtained groundwater table and direction by the authors [4]. In this section, the authors focus on the effects of the faults and the sheet wall on groundwater table. **Fig.3** shows the groundwater table and direction under the assumption that the collecting pipe functions to drain the leachate. The result demonstrates that groundwater flows along the faults. **Fig.4** illustrates more detail about groundwater table at cross-section E-E1. Three scenarios show that groundwater table is lower when the permeability is smaller. Therefore, the higher permeability of the faults the easier groundwater flows out. In other words, groundwater flow will take place perpendicularly to cross-section E-E1. The groundwater table inside the landfill does not change by the different permeability of the faults. Therefore, the contaminated groundwater may leak out along the faults and make the outside environment of the landfill polluted. The figure also shows that the groundwater table inside the landfill site is higher than that of outside. It is possible for groundwater to transport the waste water to the outside of the landfill when the sheet wall does not reach the bedrock. There is a seeping point close to the stream. Moreover, the groundwater discharges surface water. Hence the surface water is easily contaminated.

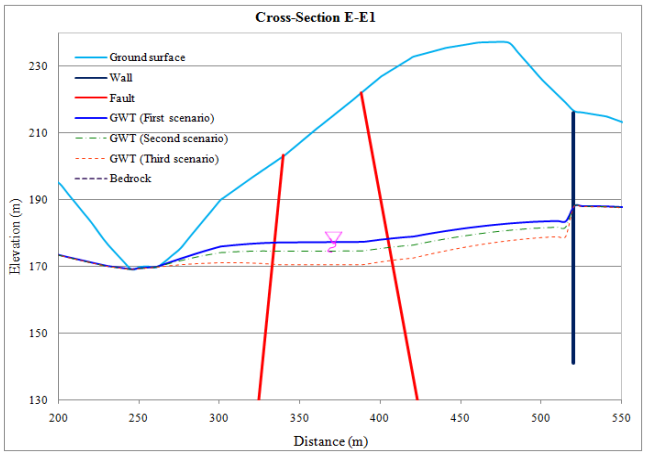

Fig.4 Scenarios of groundwater table

4. Conclusion

The result shows that there are significant effects of the faults and the sheet wall on groundwater movement. The waste water may take place to flow out and make the groundwater contaminated. The model results explain the reason why at outside the landfill site the contaminants have been found. Therefore, the authors recommend that at the study site the above mentioned effects should be carefully considered.

References

1) Matsufuji, Y., A road to semi-aerobic landfill experience of semi-aerobic landfills in Japan and Malaysia, The Third Intercontinental Landfill Research Symposium, Hokkaido, Japan, (2004).

2) Watanabe, T., Newsletter, Japanese society of waste management expert, No.50, pp.1-4, (2004), http://www.jswme.gr.jp/international/pdf/News50.pdf

3) Ikeguchi, T., Progress in sanitary landfill technology and regulations in Japan: a review, Waste Management & Research, Vol.12 (2), pp.109-127, (1994).

4) Dang, T.H., Jinno, K., Tstutsumi, A., Effect of landfill on local hydrogeological process. Journal of Hydraulic Engineering, JSCE, Vol.53, pp. 73-78, (2009).