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# Evaluation of the MDPSA Code's Performance : Prediction of a Pressure Distribution and a Groundwater Flow around a Vertical Fault in 2D Geometry

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## 1. Introduction

As a part of the mid- and long-term nuclear research and development program in Korea[1], KAERI is developing a new probability safety assessment program. The newly developed program(MDPSA code) is designed to be capable of probabilistic assessment of radio nuclide transport in multi-dimensional regions both of a fracture network and of a porous medium such as a top soil, buffer and backfill layers.

MDPSA code is developed on the basis of finite volume method assuming steady and transient state constant density groundwater flow. The numerical scheme can be found in the preceding references[2-4].

Through a series of previous comparisons between code predictions and analytical solutions[5-6] MDPSA code was found to provide a reasonable solution. However the performance of MDPSA code for the simulation of multi-dimensional advection and diffusion transport phenomena should be evaluated before the code is applied to a groundwater flow analysis for total system performance assessment of a HLW repository as well. One of the valid ways to evaluate the performance of the newly developed code is to compare code's predictions with those from other reliable codes.

There are many well-known programs for the prediction of a groundwater flow analysis. NAMMU code [7] is one of them and has been applied to various practical analyses. It is capable of describing fracture with continuum porous medium model and has basis on Finite Element Method, which is a different method from that of MDPSA code.

In this research performance of MDPSA code in multi-dimensional geometry is assessed by comparison with the prediction of NAMMU code. A vertical fault, halo region and topography are modeled and pressure distribution and groundwater flow are predicted with two different codes and the solutions from them are compared.

Based on the calculation results that were in good agreement with each other, it can be said that the numerical results of MDPSA code are physically reliable for prediction of pressure distribution and groundwater flow in multi-dimensional medium.

## 2. Methods and Results

### *2.1 Geometry Modeling*

The calculated geometry is presented in Fig. 1. The geometry is composed of rock, halo and a fault.

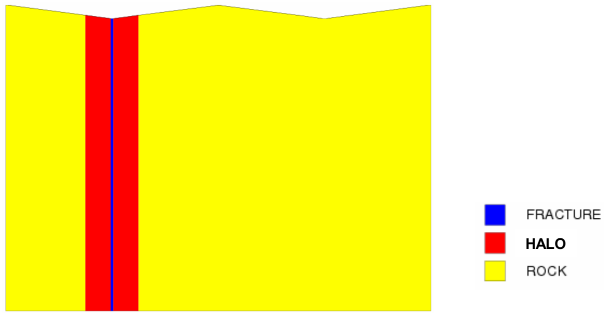



**Fig. 1 Geometry**

The size of domain is 1600m in width and -1000m in depth. The height of the peak and valley is 150m and 100m respectively. In MDPSA code the prescribed geometry is modeled with $x \times z = 88 \times 61$ and non-uniform grid system is applied. Finally generated grid system is presented in Fig. 2.

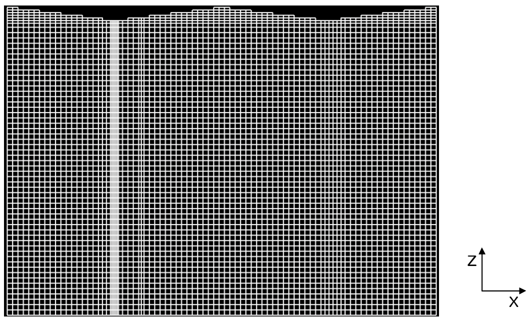



**Fig. 2 Grid System**

No flow boundary condition is given to the left, right and bottom sides. With the assumption of a fully saturated flow condition Dirichelet boundary condition is given to top side based on the following equation.

$$P = \rho_f g z \qquad (1)$$

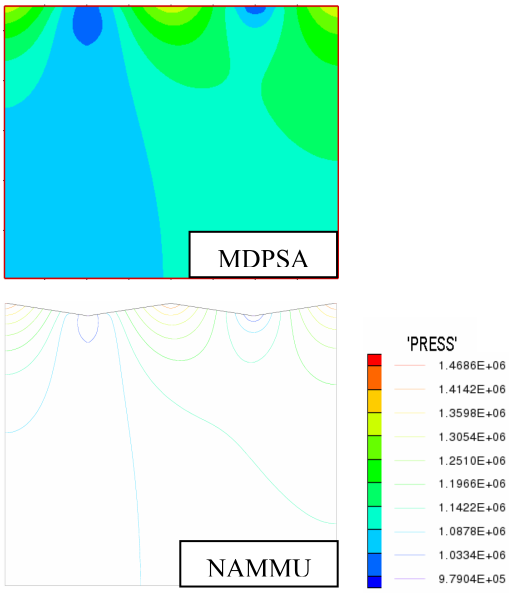
where $P$ is the residual pressure, $\rho_f$ is the fluid density, $g$ is the gravitational force and $z$ is the height. The related properties of the rock are presented in Table 1.

**Table 1 Properties of Rock**

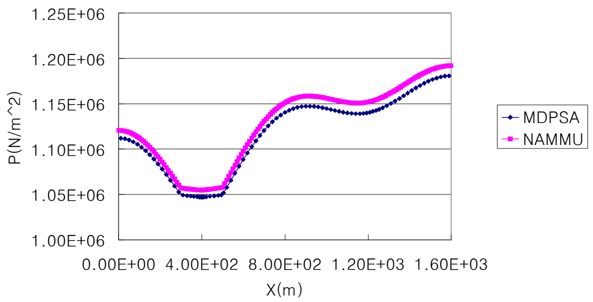
| | Permeability(m2) | Porosity | Aperture(m) |
|---|---|---|---|
| Rock | 1.0E-15 | 0.03 | - |
| Halo | 1.0E-14 | 0.03 | - |
| Fracture | 1.0E-13 | 0.03 | 10 |

*2.2 Pressure Distribution*

In order to assess the performance of MDPSA code predicted pressure distribution is compared with that from NAMMU code. Fig. 3 (a) and (b) shows the overall pressure distribution and pressure profiles at z=-500m respectively. Even though the numerical methodology of MDPSA code and NAMMU code is different we can see that finally calculated pressure distribution from them shows little differences within a reasonable range from Fig. 3.




(a) Pressure Distribution

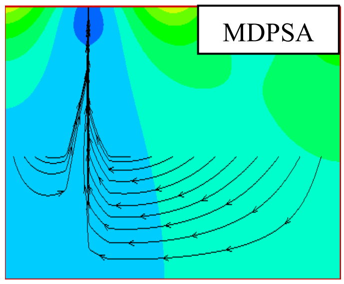



(b) Pressure Profile at z = -200(m)

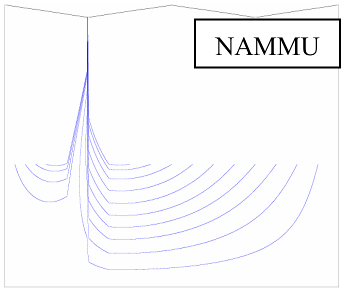
**Fig. 3 Comparison of Pressure Profiles**

*2.3 Flow Path*

In order to investigate the groundwater flow around a vertical fault, the flow path is predicted from MDPSA code and the results from NAMMU code are presented as a reference. Imaginary repository facility is assumed to be located at z=-500m in depth and the distance between facility and fault is varied from x=200m to 1100m. As shown in Fig. 4 we can see that it shows a good agreement for the flow path prediction.




(a) MDPSA




(b) NAMMU

**Fig. 4 Comparison of Flow Path**

## 3. Conclusion

In this study a series of calculations and comparisons with other commercial codes have been implemented for the verification of MDPSA codes' performance in multi-dimensional geometry. Pressure distribution and groundwater flow predicted by MDPSA code showed a good agreement with those by NAMMU. From these results MDPSA code can be said to predict a multi-dimensional groundwater movement reasonably well.

## REFERENCES

[1] C. H. Kang, et al., Geological Disposal System Development, Korea Atomic Energy Research Institute, KAERI/RR-2336/2002, 2002.
[2] J. W. Han, Y. S. Hwang and C. H. Kang, An Algorithm for Fracture Network Construction using Discrete Fracture Model, Proceedings of Korean Radioactive Waste Society, Vol.2, p. 129, 2004.
[3] J. W. Han, Y. S. Hwang and C. H. Kang, A Study on the Groundwater Flow in Fractured-Porous Media by Flow Resistance Theory, Proceedings of Korean Radioactive Waste Society, Vol.3, p. 231, 2005.
[4] Muhammad Sahimi, Flow and Transport in Porous Media and Fractured Rock, VCH, 1995.
[5] J. W. Han, Y. S. Hwang and C. H. Kang, MDPSA code verification for advective-dispersive mass transport in Porous Media, Proceedings of Korean Nuclear Society, 2005
[6] J. W. Han, Y. S. Hwang and C. H. Kang, Examination of MDPSA code performance in predicting advective-dispersive mass transport phenomena within fractured rock, Proceedings of Korean Radioactive Waste Society, Vol.4, p. 140, 2006.
[7] http://www.sercoassurance.com/ea-old/groundwater/nammu.htm