D14

Modelling Internal Erosion with the Finite Different Method

〇Tanawat TANGJARUSRITARATORN, 宮崎祐輔, 澤村康生, 岸田潔

INTRODUCTION

According to the widely utilized underground infrastructure, the shallow under groundwater is sometimes unavoidable for geotechnical construction which could be leading to the need for the dewatering process. The seepage flow is generally occurred and stimulating an erosion process in accordance with the dewatering. Eventually, the severe erosion behind retaining wall even in embankment structure might be a collapse following the soil strength changed.

In order to identify the erosion, three mechanisms are generally defined; 1) Suffusion, 2) Contact erosion, and 3) Concentrated leak erosion (Molinder, G., 2016) as in Figure 1. This study is going to aim at the internal erosion or suffusion type.

METHODOLOGY

To approach erosion behavior by using numerical, analysis conventional numerical analysis might not be able to illustrate erosion behavior, therefore, the calculation scheme of erosion must be added into the main calculation scheme. Besides, the mechanical calculation and water flow calculation will be calculated by Finite Different method operated in FLAC3D. Hence, coupling simulation of mechanical behavior and flow simulation from FLAC3D together with erosion simulation will be used as following **Figure 2**.

Besides, the erosion calculation, which is standing for particle transported and detachment of particle from the soil mass, will be executed by either Finite Different method or Finite Volume method. Finally, the numerical simulation will be taken into comparison with an experimental model test for calibration in erosion modeling.

Currently, this research is still working on the erosion simulation part which concerns the erodible transport through porous media.

Erosion simulation

According to the suffusion or internal erosion type, the soil mass has been divided for 4 main parts, as shown in **Figure 3.**, which is quite different from the conventional concept. The fluidized particle will be added into the soil model for representing an erosion particle in the fluid state which is ready to move due to the seepage flow. In addition, the erodible part is needed as well to store the limitation of the erodible particle. The convective form is used to govern erosion transportation as follow in **Equation 1** (Liang, Y., 2017). According to the particle transport inside porous media, the erodible soil must be moving while the drag force is enough to move the fine particle. Therefore, the shear stress is used to define an initiation of erosion and rate of erodible particle detachment as follows **Equation 2** and **Equation 3** (Wan and Fell, 2004; Reddi et al., 2000).

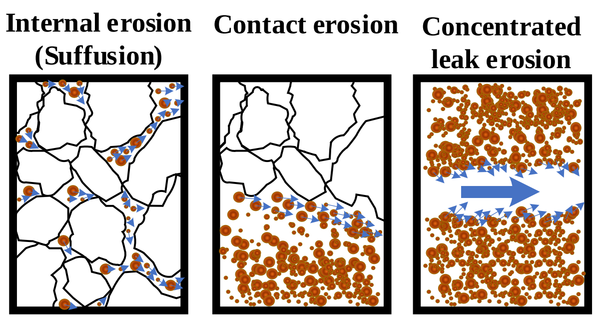

Figure 1. Erosion mechanism

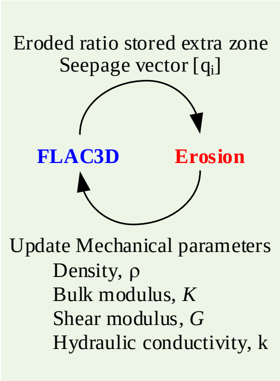

Figure 2. Calculation scheme

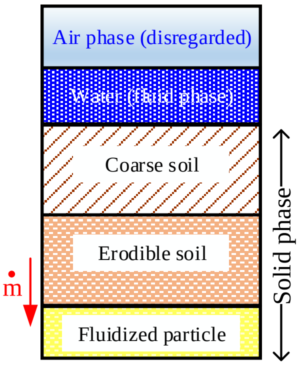

Figure 3. soil model concept

$$\frac{\partial C}{\partial t} + \nabla \cdot (Cu) = S_\varphi = \dot{m}$$ Equation 1.

$$\dot{m} = k_d(\tau - \tau_c)$$ Equation 2.

$$\tau = \rho f v$$ Equation 3.

RESULT AND DISCUSSION

Currently, the simple simulation has been calculated to test the source term propagation due to the seepage as in Figure 4. The fluid flow is simulated inside FLAC3D which will continue for 20,000 steps to show steady state. Besides, the erosion simulation is calculated at each step of flow simulation to define a zone that will be changed in skeleton mass to fluidized particle phase. From the simulation, the mass change is observed at several steps of flow simulation. For the first 100 steps, high seepage flow zones are located near to the left boundary, therefore, the source term is starting to generate from the left side boundary as well. Furthermore, the seepage velocity or shear flow is distributed uniformly all over the domain, therefore, the source term is produced linearly at a steady state.

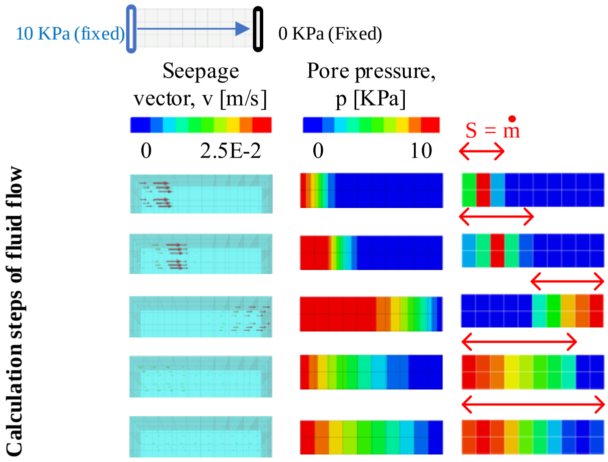

Figure 4. Seepage flow vectors, pore pressure and source term contour.

REFERENCE

- Reddi, L. N., Lee, I., and Bonala, M. V. S. (2000). Comparison of internal and surface erosion using flow pump test on a sand-kaolinite mixture. J. ASTM Geotech, 23(1), 116–122.
- Reddi, L., Lee, I.-M., & Bonala, M. (2000). Comparison of Internal and Surface Erosion Using Flow Pump Tests on a Sand-Kaolinite Mixture. Geotechnical Testing Journal, 23(1), 116. doi: 10.1520/gtj11129j
- Molinder, G. (2016). Internal erosion in the pervious foundation of an embankment dam: A case study on the Lossen dam.
- Liang, Y., Yeh, T.-C. J., Wang, Y.-L., Liu, M., Wang, J., & Hao, Y. (2017). Numerical simulation of backward erosion piping in heterogeneous fields. *Water Resources Research*, 53(4), 3246–3261. doi: 10.1002/2017wr020425