VERIFICATION OF SEEPAGE FLOW CALCULATION BASED ON FLUID-GROUND WEAK COUPLING ANALYSIS MODEL

Riku OKAJIMA, Chuo University, a14.bhaa@g.chuo-u.ac.jp
Yuki OHKI, Chuo University, a12.he8n@g.chuo-u.ac.jp
Shinji TAENAKA, Shunsuke MORIYASU, Takeji DEJI, Hideki UEDA,
Nippon Steel and Sumitomo Metal Corporation, taenaka.2m2.shinji@jp.nssmc.com
Katsumi SEKI, Chuo University, seki-k.15e@g.chuo-u.ac.jp
Taro ARIKAWA, Chuo University, taro.arikawa.38d @g.chuo-u.ac.jp

INTRODUCTION

In order to evaluate destruction of coastal structure caused by tsunami, it is essential to establish coupling method of fluid and ground. Arikawa et. Al.(2009) developed the model using weak coupling method of fluid analysis and ground analysis (named as CADMAS-STR). It is performed by mutual communication between pressure on fluid side and displacement on structure side. Based on boundary pressure from the fluid side, the ground side calculates seepage flow analysis using Biot's equation. On the other hand, the fluid side converts the ground region to porosity and calculates the resistance force to calculate seepage on the fluid side.

In this study, based on Yoshioka's research, we applied Dupuit-Forchheimer's rule in CADMAS-STR's fluid resistance calculation, and verify its validity by comparing it with physical experiment. Furthermore, we compared pore water pressure

HYDRAULIC MODEL EXPERIMENT

We made a ground and caused a water level difference between front side and behind about the sheet pile. We installed four pore water pressure gauges on the sheet pile and investigated the change of pore water pressure. Also, in order to follow the streamline in the ground, dyes were placed on the ground surface.

NUMERICAL ANALYSIS

We used CADMAS-STR . As the analysis condition, the sheet pile was calculated as a structure (impermeable condition) and the ground was porous (permeability condition by porous). Fluid calculation was carried out by applying the porous resistance law.

COMPARING CALCULATION AND EXPERIMENT

Figure 1 shows the experimental results, the calculation results by the fluid side, and the calculated value by the ground side with respect to the permeation flow velocity generated directly under the sheet pile in the steady state 15 cm in the steady state. Calculated values on the fluid side are in good agreement with the experimental values with respect to the permeation flow velocity generated immediately below the sheet pile. Figure 2 compares fluid side, ground side, and experiment with respect to pore water pressure generated in the sheet pile. Three value on fluid side, ground side, and the experiment relatively well agree. By comparison with experiments, it was confirmed that by applying the Dupuit-Forchheimer's rule to the fluid side, the permeation flow velocity inside the ground can be reproduced. The results of calculation are also consistent with the experimental results with regard to the pore water pressure generated in the pile sheet, and it was confirmed that this method can evaluate.

CONCLUSION

In this research, we could obtain the following conclusion. (1) The permeation flow velocity under the sheet pile was reproduced. However, the streamline calculated on the fluid side became asymmetric with respect to the sheet pile. (2) It was confirmed that it is possible to evaluate the pore water pressure due to the rise of the water level. The pore water pressure on the fluid calculation side also showed good results in the experimental results. It was found that pore water pressure can be sufficiently evaluated by reproducing underground water flow. (3) Pressure mismatch occurred at the groundwater boundary, which affected the percolation flow analysis. In future it is necessary to study the method of treating the groundwater surface in the fluid-ground coupling model. (4) It was confirmed that the calculated value is different depending on the value of the coefficient of Dupuit-Forchheimer.

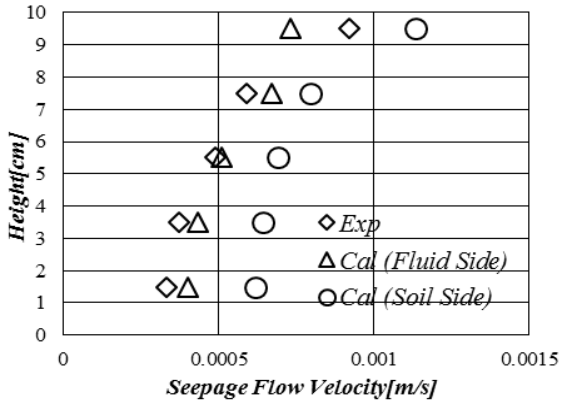

Figure1- Comparison of Seepage Flow Velocity

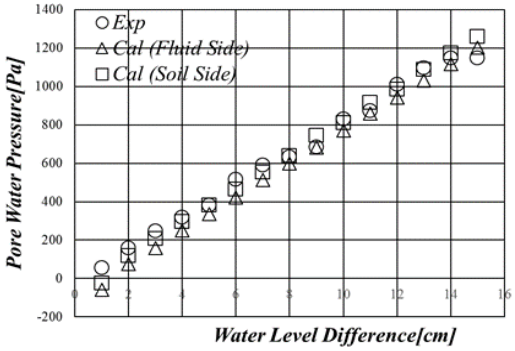

Figure2- Comparison of Results

REFERENCES

Arikawa.T et. al. (2009): Development of Numerical Wave Tank Coupled with Structure Analysis Based on FEM

Yoshioka.M et.al (2010): Review on non-Darcy flow in highly permeable flow porous media