NUMERICAL MODELLING OF FLOW WITHIN POROUS MEDIA USING OpenFOAM®

The numerical modeling of the interaction of water waves with porous structures has been identified as one of the key challenges in coastal engineering research. Most coastal structures have a porous portion, and hence, a clear understanding of the porous media flow is highly significant in designing and investigating the stability of these porous coastal structures within the ocean environment. The simulation of multi-phase flow (water and air) through the porous media is a highly multifaceted process. In this study, a case study of the porous dam-break problem, conducted by Liu et al.,1999 as illustrated in Jafari et al., 2021 was simulated in two-dimension. The modified Volume Averaged Navier–Stokes Equations, including the effect of the porosity, are solved. The model, governing porosity, is formulated for the intrinsic velocity inside the porous structure. The numerical method was based on a finite volume discretization on a collocated grid arrangement. The interface tracking is conducted using a volume of fluid approach (VOF). For the CFD modelling, the finite-volume-based open source code OpenFOAM® (foam-extend 3.1) is used in combination with the porousWaveFoam solver (Jensen et al., 2014) developed within Waves2Foam (Jacobsen et al., 2021) toolbox. The performance of the porousWaveFoam solver is evaluated by comparing the results from the numerical simulation with those of experimental data. The results imply the use of a porous solver in investigating the fluid interaction with porous structures.

References

[1] P. L.-F. Liu, P. Lin, K.-A. Chang, and T. Sakakiyama, (1999), "Numerical modelling of wave interaction with porous structures," Journal of Waterway, Port, Coastal and Ocean Engineering, vol.125 No.6, pp. 322-330.

[2] E. Jafari, M. M. Namin, and P. Badiei,(2021), "Numerical simulation of wave interaction with porous structures," Applied Ocean Research, vol. 108, p. 102522.

[3] B. Jensen, N. G. Jacobsen, and E. D. Christensen,(2014), "Investigations on the porous media equations and resistance coefficients for coastal structures," Coastal Engineering, vol. 84, pp. 56-72.

[4] N. G. Jacobsen, D. R. Fuhrman, and J. Fredsøe, (2012),"A wave generation toolbox for the open-source CFD library: Openfoam®," International Journal for numerical methods in fluids, vol. 70, no. 9, pp. 1073–1088.