11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

MULTISCALE FLOW SIMULATIONS OF TSUNAMI RUNUP WITH LOCALLY-PERIODIC STRUCTURAL OBSTACLES

S. Takase[1], J. Kato[1], S. Moriguchi[1], K. Terada[1], T. Kyoya[2], M. Kurumatani[3], M. Asai[4] and K. Kashiyama [5]

[1] International Research Institute of Disaster Science, Tohoku University
6-6-11, Aoba, Aramaki, Aoba-ku, SENDAI 980-8579, JAPAN, takase@irides.tohoku.ac.jp
[2] Department of Civil Engineering, Tohoku University, JAPAN
[3] Department of Urban and Civil Engineering, Ibaraki University, JAPAN
[4] Department of Civil Engineering, Kyushu University, JAPAN
[5] Department of Civil and Environmental Engineering, Chuo University, JAPAN

Key words: *Homogenization, Multiscale flow simulations, Stabilized finite element method.*

We present a method of multiscale flow simulations of tsunami runup with locally-periodic structural obstacles such as a tide-prevention grove. The flow properties for upper-scale simulations of tsunami runup behavior are characterized by lower-scale flow simulations with structural obstacles that are arranged in a locally periodic manner. The latter analysis, which resembles homogenization-type process[1], can be regarded as the numerical fluids experiments for three-dimensional local domains, while the former analysis reflects the effect of the obstacles as resistance at global-scale. We employ the stabilized finite element method [2] for both local and global numerical analyses to solve the incompressible Navier-Stokes equation and apply the VOF method to represent free surfaces. The first step of the proposed multiscale analysis is to carry out the flow simulations of the local-scale domain with leaves and branches to derive the resistance properties of a tree for the middle-scale flow. The second step would be the evaluation of the effect of a tide-prevention grove against the tsunami runup by conducting the middle-scale flow simulations with the resistance by leaves and branches. With the fluid properties at hand, the final step is to perform the global-scale flow analysis of the tsunami runup in a wide region to estimate the flood area.

REFERENCES

[1] K. Terada, J. Kato, N. Hirayama, T. Inugai, K. Yamamoto : A method of two-scale analysis with micro-macro decoupling scheme: application to hyperelastic composite materials *Comput. Mech.*, **52**, 1199–1219, 2013.