A Coupling Method using FEM of 2D Shallow Water Flow

and 3D Gas-Liquid Two-Phase Flow

*J. Matsumoto[1] and K. Kashiyama[2]

[1]Research Center for Ubiquitous MEMS & Micro Engineering,
National Institute of Advanced Industrial Science and Technology (AIST), Japan
[2]Department of Civil and Environmental Engineering, Chuo University, Japan

*Corresponding author: matsumoto-junichi@aist.go.jp

A coupling method based on an implicit mixed finite element method of two-dimensional shallow water long wave equations and three-dimensional Navier-Stokes equations is proposed in this paper. A stabilized MINI element, bubble function element/linear element, with an implicit scheme in time is used to solve the shallow water long wave equations and the Navier-Stokes equations. The stabilized MINI element means bubble function element stabilization method for triangular element and tetrahedral element. The estimation of gas-liquid interface for three-dimensional Navier-Stokes equations is employed an interface-capturing method based on a phase-field model (PFM). Cahn-Hilliard equation in PFM is applied to estimate the interface of gas and liquid. The stabilized MINI element is used to solve Cahn-Hilliard equation. Compatibility condition and equilibrium condition are considered for connecting the two-dimensional shallow water long wave equations and three-dimensional Navier-Stokes equations. A solitary wave problem is analyzed to verify presented coupling method as a computational example.

Keywords: Coupling method, 2D Shallow water flow, 3D Gas-liquid two-phase flow, Finite element method, MINI element