ASI-ISPH Partitioned Coupling Analysis for Fluid-Structure Interaction

Hiroyuki Omura[1], Naoto Mitsume[2], Mitsuteru Asai[3] and Daigoro Isobe[4]

[1] Graduate School of Science and Technology, University of Tsukuba
1-1-1 Tennodai, Tsukuba-shi, Ibaraki 305-8573, JAPAN
s2030186@s.tsukuba.ac.jp

[2, 4]Division of Engineering Mechanics and Energy, University of Tsukuba
1-1-1 Tennodai, Tsukuba-shi, Ibaraki 305-8573, JAPAN
mitsume@kz.tsukuba.ac.jp[2], isobe@kz.tsukuba.ac.jp[4]

[3]Department of Civil Engineering, Kyushu University
744 Motooka, Nishi-ku, Fukuoka 819-0395, JAPAN
asai@doc.kyushu-u.ac.jp

In order to evaluate robustness of a building against tsunamis, it is necessary to consider the interaction between building and tsunami. The Fluid-Structure Interaction (FSI) analysis is appropriate for this purpose. Most existing FSI methods are based on the finite element method (FEM) and formulated with presupposition that the structure models are discretized with the solid elements. Therefore, there are few applications for large-scale cases such as tsunami-building interaction problems because of the huge computational cost.

In this research, we propose a partitioned FSI method based on the FEM using the beam element that is effective for analyses of framed structures such as buildings. The ASI-Gauss technique [1], which can efficiently compute yielding and fracture, is applied for the FEM. The particle method is used as a fluid analysis scheme. Especially, the ISPH [2], which can obtain accurate pressure values and can conserve volumes well, is applied for the particle method. Besides, the Explicit Represented Polygon wall boundary model (ERP model) [3] is introduced into ISPH to evaluate fluid forces exerting on the boundary. We extend the ERP model to the implicit particle method and the SPH because the original model was formulated for the Explicit MPS. In addition, the representation of the Dirichlet condition for velocity by the ERP model is generalized to be applied to the moving boundary problems. The boundary shape of the beam member is interpolated by using the coordinates of the nodes on both ends of the element, the predefined sectional shape of the beam and the deformation computed by the structural analysis. As described above, the fluid forces exerting on the beam elements are obtained from the fluid analysis. These forces are converted into external forces for the structural analysis.

A hydrostatic pressure problem and a dam break problem with an elastic obstacle were solved to verify. The numerical result showed that the proposed method can solve the fluid-structure interaction problem with sufficient precision.

References

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