The 18th International Conference on Finite Elements in Flow Problems (FEF2015)
16-18 March 2015, Taipei, Taiwan

FLUID-STRUCTURE INTERACTION ANALYSIS WITH FINITE COVER METHOD

Shinsuke Takase[1], Takuma Kotani[1], Shuji Moriguchi[1], Kenjiro Terada[1], Kazuo Kashiyama[2], Mitsuteru Asai[3] and Mao Kurumatani[4]

[1] International Research Institute of Disaster Science, Tohoku University, Sendai 9800845, Japan
[2] Department of Civil Engineering, Chuo University, Kasuga 1-13-27, Bunkyo-ku, Tokyo 112-8521, Japan
[3] Department of Civil Engineering, Kyushu University, Motooka 744, Nishi-ku, Fukuoka, 819-0391, Japan
[4] Department of Urban and Civil Engineering, Ibaraki University, Nakanaruswa 4-12-1, Hitachi, Ibaraki 316-8511, Japan

Key words: *Finite cover method, Fluid-structures interactions, Tsunami.*

The finite cover method[1, 2, 3], which has been known as a tool for stress analysis, is applied to simulate fluid-structure interactions. While the Navier-Stokes equations are solved with the stabilized finite element method (FEM)[4] and with a spatially fixed finite element mesh, the Lagrangian meshes of structures, which can be either rigid or deformable bodies, are placed on the same mesh. The continuity conditions of velocity and stress vectors at the interface are imposed with the penalty method. The proposed analysis method is carried out according to the following procedure:

First, the domains of structures that can be of arbitrary shape are defined and generate their finite element meshes. Second, the meshes are superimposed onto a mathematical mesh, which is spatially fixed and is independent of the domains of structures. Third, the level set functions are introduced to determine the outer and inner sides of the domains of structures. Fourth, the elements located on the boundaries of structures, which is the interfaces between fluids and structures, are extracted. Fifth, by using the level-set functions, we determine the location of the interface inside each of the extracted elements and re-generate the meshes for the fluid domain.

After simple verification analyses are carried out in comparison with experimental data, several representative numerical examples are presented to demonstrate the promise and performance of the proposed method. In particular, we conduct a fluid-structure simulation of tsunami runup behavior, in which a structure is destroyed and swayed by the fluid; see Fig. 1.

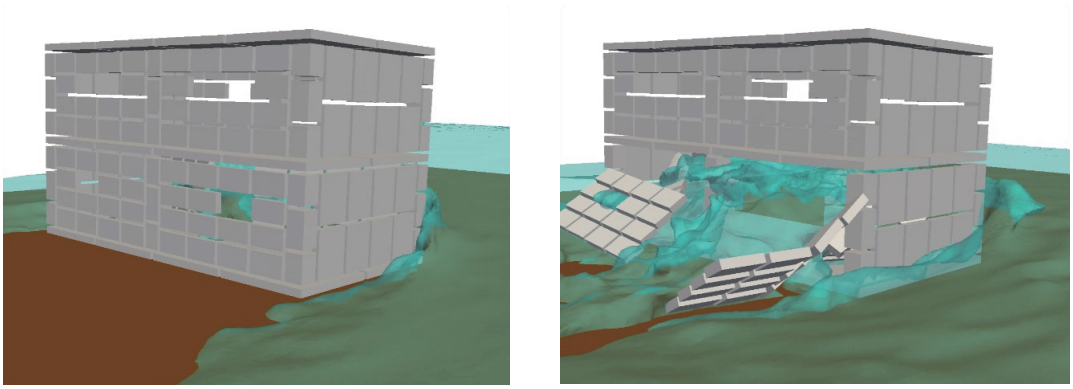

Figure 1: Building destroyed by fluid force.

REFERENCES

[1] Terada K, Asai M, Yamagishi M (2003) Finite cover method for linear and nonlinear analyses of heterogeneous solids *Int. J. Numer. Meth. Engrg.*, **58**: 1321–1346.

[2] Terada K, Maruyama A, Kurumatani M (2007) Eulerian finite cover method for quasi-static equilibrium problems of hyperelastic bodies, *Comm. Numer. Meth. Engrg.* **23**: 1081–1094.

[3] Okazawa S, Terasawa H, Kurumatani M, Terada K, Kashiyama K (2010) Eulerian finite cover method for solid dynamics, *Int. J. Comput. Meth.*, **7**: 33–54.

[4] Aliadabi S, Tezduyer TE (2000) Stabilized-finite-element/interface-capturing technique for parallel computation of unsteady cows with interfaces, *Comput. Meth. Appl. Mech. Engrg.*, **190**: 243–261.