A numerical modelling of elastic fluid-structure interaction for aquaculture floater applications

Sungsoo Lim(sungsool@stud.ntnu.no), Tobias Martin, Hans Bihs

Norwegian University of Science and Technology

Abstract

More and more aquaculture structures are installed in open water and further offshore due to a variety of conflicts with coastal water, eco-system, and inhabitants who live nearby. They can additionally benefit from a high energy environment, for example, strong currents and waves could disperse fish farm waste. However, an open water environment accompanies longer and steeper waves and harsher weather conditions where the structures could be exerted by higher environmental loading and damaged by larger displacements or motions. Therefore, non- linear interaction between wave and structure needs to be investigated to get a better understanding of a phenomenon which might happen. The floater or collar structure above net, shaped in torus, consists of either single or double pipes, usually made of high-density polyethylene. Considering its slenderness the structure should be regarded as a flexible body and treated so in the structural analysis. In order to study its non-linearity, in addition, the coupling between structure and fluid surrounding the structure should be taken into account. For this project, a 3-dimensional beam model was used for the floater structure model and Newmark method was adopted for the time integration of the structural dynamic analysis. To compare the displacement calculated by this structure solver, which is developed in MATLAB by the author, the structural solver is integrated into the open-source CFD (Computational Fluid Dynamics) solver REEF3D. The fluid solver is capable of solving the Navier-Stokes equations for both water and air. The resulting fluid-structure interaction model demonstrats its possibility to be applied for complex wave-structure situations.

Keywords: *Aquaculture structure, Fluid-structure interaction, Finite Element Method, Computaional Fluid Dynamics*

References

[1] Kristiansen T. and Faltinsen O. M., 2015, Experimental and numerical study of an aquaculture net cage with floater in waves and current, Journal of Fluids and Structures 54 (2015), pp. 1-26

[2] Zienkiewicz O. C., Taylor R. L. and Zhu J. Z., 2005, The Finite Element Method: Its Basis and Fundamentals (Sixth edition), Elsevier Butterworth-Heinemann Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Burlington, MA 01803

[3] Bathe K., 1982, Finite Element Procedures in Engineering Analysis, PRENTICE-HALL, INC., Englewood Cliffs, New Jersey 07632

[4] Xu T., Hou H., Dong G., Zhao Y. and Guo W., 2017, Structural Analysis of Float Collar for Metal Fish Cage in Waves, Turkish Journal of Fisheries and Aquatic Science 17: 257-268

[5] Kristiansen D. and Faltinsen O. M., 2009, Non-linear wave-induced motions of cylinderical-shaped floaters of fish farms, Journal of Engineering for the Maritime Environment Proc. IMechE Vol.223 Part M

[6] Peter Kohnke, 1999, ANSYS Theory Reference Release 5.6 Eleventh edition

Biography

Sungsoo Lim received B.S. degree in naval architecture and ocean engineering from Seoul National University, South Korea, in 2008. He participated in a Erasmus Mundus Master program where he studied his master study, Coastal and Marine Engineering and Management since 2017.

In 2008, he joined Daewoo Shipbuilding and Marine Engineering Co.,Ltd. as a naval architect. He moved to Lloyds Register Asia in 2014 and has worked as a techincal safety consultant.