Numerical Simulation of Flexible Aquaculture Structures using Extended Position-Based Dynamic Method

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ABSTRACT

Marine aquaculture is one of the largest and fast-growing food sectors that plays a significant role in providing nutrition for the growing global population. As one of the leading seafood suppliers, Norway has developed innovative semi-submersible offshore aquaculture structures for farming in the sea, such as Ocean Farm 1 [1] and HavFarm 1 [2]. These offshore aquaculture structures are required to operate under more extreme environmental loads, compared to conventional Norwegian fish farms in near-shore areas. Operations in offshore areas are much more challenging than those in near-shore areas, due to fast-changing weather, limited operating window, and short time for decision-making. A digital twin method can be one of the solutions to support decision-making, based on fast and real-time simulation results.

A variety of commercial numerical software programs can be employed to study the hydrodynamic response of these offshore aquaculture structures under different environmental conditions. These software programs are usually solving the structural responses based on the traditional Finite Element Method (FEM). However, the traditional FEM can be very slow for these types of dynamic simulations, especially when many flexible and soft bodies are included in the simulations. Thus, the traditional FEM cannot be applied to fast real-time simulations to support decision-making.

This study presents a method proposed by Macklin et al. [3], the Extended Position-Based Dynamic (XPBD) Method, for the real-time simulations of flexible and soft bodies. We implemented this method to simulate the dynamic response of the offshore aquaculture structures with a special focus on the mooring line response. Using the XPBD method, the effects of using different simulation run times, time steps, and segment lengths in the model are investigated. This study will be a baseline for the future research using the XPBD method for dynamic responses of flexible aquaculture structures.

REFERENCES

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