Offshore & Dredging Engineering

Technische Universiteit Delft

Numerical Modelling of Interconnected Floating Solar Energy Platforms

Land scarcity is increasing and therefore one of the main challenges for renewable energy in the future is 'physical space'. While renewables need a lot of space compared to conventional energy sources, and the competition for space is already increasing (food production, housing etc.), leading to higher land costs and opposition. Public resistance to new highly visible windfarms and onshore solar farms is hardening. Large land-based solar farms compete with agricultural use and can have negative effects on the ecosystem, by covering the soil from the solar light. A solution to the stated problems is by placing renewable energy production at sea, among which offshore floating solar energy.

One of the main challenges in offshore floating solar is the continuous wave-induced motion of floaters, and the forces that arise at the most critical points. Dynamically modelling multiple floaters in waves becomes very computationally and time intensive when the number of floaters increases. This research focused on creating and comparing a linear and a non-linear model that calculates motions of multiple floaters under first order wave forces. The aim is to perform these calculations with open-source software only.

The dynamic forces on the floaters are obtained by evaluating the radiation, diffraction and wave excitation potential in the open-source Boundary-Element-Method-Solver NEMOH and showed good resemblance with commercial software packages AQWA and DIFFRAC. The modelling of the motions is performed in time (linear and non-linear RK4-integration-scheme) and frequency domain (linear). The implementation of the dynamic forces in both cases showed to be the most critical for the behavior of the floaters. Especially the determination of the hydrodynamic coefficients: Infinite added mass and retardation function for the time domain simulation are key in getting the same result for the linear time domain and frequency domain. Suppressing non-realistic values of gap resonance between multiple floating bodies increases the efficiency of time-domain simulations. Small differences between the motions of the floaters can cause significant differences in the forcing, therefor it is rather advisable to perform the comparison between the linear and non-linear case in time domain.

A comparison of different wave directions and conditions showed that the results of the linear model are of the same order of magnitude as the non-linear model. For the determination of motions and forcing under first order wave forces this shows that both cases are similar. Nevertheless, other non-linear effects can be added in a follow-up study.

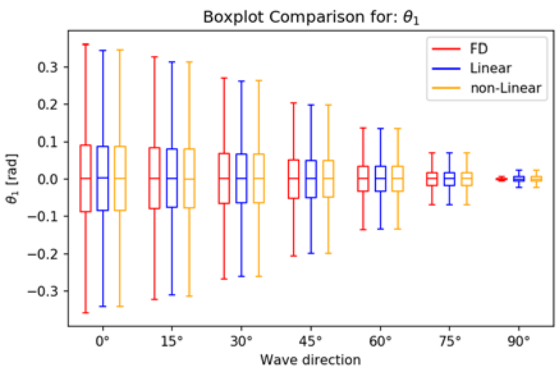

Figure 1: Motion in pitch of one of the floaters for different wave directions.

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