SPH Simulation of Irregular Wave Motion Using Flap Wavemaker

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ABSTRACT

Ocean surface waves generally cause periodic pressure loads on floating or fixed marine structures; therefore, it is vital to understand the time-dependent behavior of these loads acting on the offshore bodies. Moreover, the nature of oceanic waves is mostly random or irregular, and it requires the implementation of wave spectrum analyses into variable frequency domains. In this context, the main focus of the present study is to investigate the physical characteristics of irregular wave systems through a Lagrangian, particle-based numerical scheme, namely, Smoothed Particle Hydrodynamics (SPH) method. A numerical wave generator tank, which can generate desired irregular waves, is modeled by the SPH method. The fluid motion is governed by continuity and Navier-Stokes equations while Weakly Compressible SPH (WCSPH) approximation is employed for the numerical discretization of the problem domain. To generate the irregular wave spectrum in a more realistic manner, a flap type wave generator is adopted into the computational domain which yields to the modeling of moving boundary conditions on the problem domain. As benchmark studies, Jonswap and Pierson-Moskowitz wave spectrums are simulated to validate the obtained wave characteristics with the theoretical results [1]. The performances of the wave maker are tested under different peak wave frequencies. Fast Fourier Transformation (FFT) analysis is conducted to investigate the distribution of wave energy spectrum in the frequency domain. In the light of sufficiently long-term simulation results, it can be said that a good agreement is obtained between the numerical and analytical results, which indicates that the presented SPH scheme can be used in further free surface hydrodynamics studies related to the irregular wave regimes.

REFERENCES

[1] Stansberg, C., et al., The specialist committee on waves final report and recommendations to the 23rd ITTC. Proceedings of the 23rd ITTC, 2002. 2: p. 505-551.