SMOOTHED PARTICLE HYDRODYNAMICS MODELLING OF WAVES, SHEARED CURRENTS AND LOADS

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MOTIVATION

Waves and currents coexist and interact with each other in a wide range of coastal locations. These currents are seldom uniform with depth and typically have vertical shear which adds complexity to the wave-current interaction problem [1]. It is this, potentially complex, combined environment which subsequently determines the loading on structures making it important to accurately model for the purpose of system design. However, there exist challenges in both the experimental and numerical (re)-creation of waves in sheared currents and hence the realistic combined wave-current environment is not routinely considered.

OUTLINE

This work focuses on the numerical modelling of wave-sheared current interaction and subsequent loading on a cylinder using a smoothed particle hydrodynamics (SPH) approach [3, 4]. The SPH method is used, taking advantage of its Lagrangian nature to deal with wave breaking and highly nonlinear deformation. The work uses the open-source DualSPHysics solver accelerated on GPUs [2].

Here, we use open boundaries and a modified damping zone to model wave-sheared current conditions [3]. The combined wave-current inlet conditions can be defined through theory e.g. [1], or from outputs of another numerical model, where both are demonstrated. Wave groups are generated on a variety of shear profiles and results are validated against analytical solutions and experiments.

Once the generation of conditions have been validated, we focus on loading on a cylinder in a range of wave-sheared current combinations (see Figure 1). Four-phase repeats are used to understand the harmonic structure of the loading and the SPH model outputs are validated against experimentally obtained harmonics for the first time. We subsequently explore breaking wave cases, and the influence of both wave phase and structural response on the peak loads experienced. Overall, we demonstrate a highly effective tool for the modelling of realistic extreme wave-current conditions and the associated loading on offshore systems, facilitating their effective design in these environments.

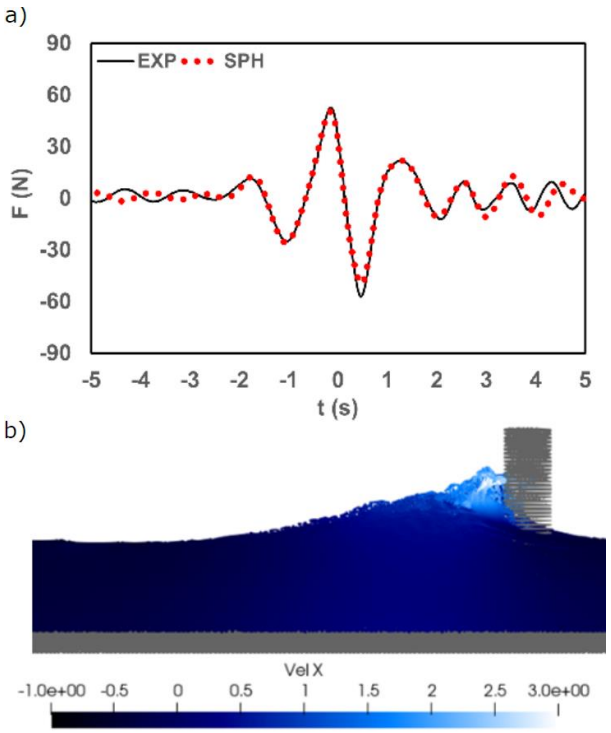

Figure 1 - SPH model outputs for cylinder loading in sheared currents and waves, showing (a) comparison of measured force between the SPH model and experiments and (b) breaking wave impact on a cylinder.

REFERENCES

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