INTRODUCTION

In recent years, growing concerns of human-induced global warming have fueled the R&D of novel technologies to harness renewable energy resources. Among these resources, marine renewable energies (MREs), and specifically ocean wave energy, show significant potential to contribute to the global energy supply (Falcão, 2010). The harsh ocean environment, in which wave energy converters (WECs) are deployed, poses challenges to the R&D of these devices. Although the energy resource is free, to be commercially viable, the price of the produced energy from a WEC, stemming from capital, operational, and maintenance costs, must be minimised.

To drive down the cost of the produced energy, optimisation of the WEC devices is required, for which numerical wave tanks (NWTs) are a valuable tool. Depending on the implemented equations for the solution of the wave–structure interaction (WSI) problem, different levels of fidelity, at different levels of computational cost, can be achieved (Penalba et al., 2017). Lower-fidelity models, implementing methods based on the Laplace equation and, thus, assuming inviscid and irrotational fluids, are associated with minimal computational cost and are valuable tools for parametric studies or optimisation algorithms. However, due to the required linearisation of the hydrodynamic equations, lower-fidelity models are only valid when considering linear conditions, i.e., small amplitude waves and device motions. Still assuming irrotational and inviscid fluid, non-linear free-surface deformations can be captured in fully non-linear potential flow solvers, such as OceanWave3D (Engsig-Karup et al., 2009). Furthermore, linear models can be extended to capture non-linear effects, such as viscous drag (Morison et al., 1950) or non-linear Froude–Krylov forces (Babarit et al., 2010).

Higher-fidelity NWTs, such as CFD-based numerical wave tanks (CNWTs), are inherently able to capture all relevant hydrodynamic non-linearities (viscous and rotational fluids, turbulent effects, non-linear free-surface deformation, etc.), by numerically solving the Reynolds-averaged Navier–Stokes (RANS) equations. Thus, CNWTs are valid over a wide range of test conditions and, thus, assuming inviscid and irrotational fluids, are associated with minimal computational cost and are valuable tools for parametric studies or optimisation algorithms. However, due to the required linearisation of the hydrodynamic equations, lower-fidelity models are only valid when considering linear conditions, i.e., small amplitude waves and device motions. Still assuming irrotational and inviscid fluid, non-linear free-surface deformations can be captured in fully non-linear potential flow solvers, such as OceanWave3D (Engsig-Karup et al., 2009). Furthermore, linear models can be extended to capture non-linear effects, such as viscous drag (Morison et al., 1950) or non-linear Froude–Krylov forces (Babarit et al., 2010).

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