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A Blind Comparative Study of Focused Wave Interactions with Floating Structures (CCP-WSI Blind Test Series 3)

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Results from the CCP-WSI Blind Test Series 3 are presented. Participants, with numerical methods, ranging from low-fidelity linear models to high-fidelity Navier–Stokes (NS) solvers, simulate the interaction between focused waves and floating structures without prior access to the physical data. The waves are crest-focused NewWaves with various crest heights. Two structures are considered: a hemispherical-bottomed buoy and a truncated cylinder with a moon-pool; both are taut-moored with one linear spring mooring. To assess the predictive capability of each method, numerical results for heave, surge, pitch, and mooring load are compared against corresponding physical data. In general, the NS solvers appear to predict the behaviour of the structures better than the linearised methods, but there is considerable variation in the results (even between similar methods). Recommendations are made for future comparative studies and development of numerical modelling standards.

INTRODUCTION

Numerical predictions are being used more and more frequently in the design and development of offshore installations. Consequently, there exists an exhaustive range of numerical models, covering the entire spectrum of fluid phenomena (typically with considerable overlap in capability across large groups of existing codes). The usual compromise between computational efficiency and level of the physics being solved, i.e., model "fidelity," still strongly dictates the model used by end users. Despite this, there is no consensus on the required numerical model fidelity for any particular wave–structure interaction (WSI) application, and it is likely that in most cases either important physical phenomena are neglected or excessive computational resources are used. Consequently, if numerical models (particularly high-fidelity ones) are to be used effectively by the industry, a greater understanding of the boundaries of each model's predictive capability is required (Ransley et al., 2016). Furthermore, as demonstrated in the CCP-WSI Blind Test Series 1 (which considered a fixed structure) (Ransley et al., 2019), judging the predictive capability of a model quantitatively is far from trivial; the "quality" of the numerical result tends to be strongly affected by the implementation strategy and experience of the operator, and what constitutes a "good" result depends heavily on the application and the requirements of the end user.

The CCP-WSI Blind Test Workshops have been designed to tackle these issues and raise the necessary questions to maximise the value of future comparative studies. It is hoped this will accelerate the development of numerical modelling standards in WSI applications and increase the uptake of state-of-the-art numerical techniques by industry. These workshops bring together numerical modellers from the WSI community and assess the numerical codes currently in use by inviting participants to simulate a set of bespoke physical validation experiments, covering a range of relevant complexities, without prior access to the physical measurements. The "blind" nature of the CCP-WSI Blind Test Workshops allows for assessment of numerical methods, without artificial manipulation of the results to match the physical measurements (which clearly represents a potential source of bias in traditional comparative studies). Furthermore, to enable contributions using all WSI modelling strategies, no constraints are applied to the computational implementation, and participants are encouraged to use "best practice" to generate their solutions. However, as was made clear in the CCP-WSI Blind Test Series 1 (Ransley et al., 2019), participants can have a very different idea of what "best" practice is, and this can result in distinct differences in the quality of the solution, even when comparing similar models. This does complicate the assessment, but it is important in demonstrating to industry end users the risk posed by a lack of best practice guidelines (without which the appropriate constraints are unknown anyway). It is, therefore, critical that this effort continues and complements other efforts (Wendt et al., 2019) to help standardise numerical modelling practices. Only then will we make progress

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KEY WORDS: Code comparison, numerical validation, CFD, PIC, linear potential theory, nonlinear Froude-Krylov, hybrid codes, cylinder, moonpool, wave energy converter, heave, surge, pitch, mooring load.