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D4.6 Model validation against experiments and map of model accuracy across load cases

Different numerical tools are required for different stages in the design of a floating offshore wind substructure. Simplified, low-order tools are useful to explore various design variations in the early stages, while state-of-the-art (SoA) models are employed to assess the final design under several environmental conditions. The numerical tools can be benchmarked against physical tests and compared to each other. This is the aim of the present deliverable which provides an assessment of the state-of-the-art and simplified numerical models for the two public floaters of the LIFES50+ project.

For the OO-Star Wind Floater Semi 10MW, the design-driving load cases are identified as DLC 1.2 (normal environment), 1.6 (severe sea state) and 6.1 (extreme environment), referencing work of WP7. The OO-Star FAST model presented in D4.5 is adapted and compared to test results of DLC 1.6 and 6.1. A global linear damping matrix is calibrated for each sea state such that the standard deviation in each degree of freedom is matched for a subset of the full time series. The results show that this approach is viable and generally yields predictions within 10% error at the 95% percentile of the response's exceedance probability for the full test duration. We find that a better match may be possible if the damping calibration is carried out for simulations with the same duration as the tests, or if the full second-order solution is used instead of the Newman's approximation.

The OO-Star SoA model of D4.5 with linear radiation-diffraction forcing is further used to benchmark a simplified frequency-domain model, QULAF. The two models are compared for ten environmental conditions within DLC 1.2. The tower-base moment is estimated by the frequency-domain model with errors up to 12% for wave-only cases and 7% for wind and wave cases, and CPU speeds around 1300 and 2700 times faster than real time, respectively.

For the NAUTILUS-DTU10, the design-driving load cases identified in D7.7 are also DLC 1.2, 1.6 and 6.1. The NAUTILUS FAST model of D4.5 is adapted and compared to model basin test results of DLC 1.6 and 6.1. The damping is calibrated through adjustment of the drag coefficients of the different Morison elements. While the calibration of the drag coefficients yields a good match in the slow-drift response for surge and sway in the pink noise test, and provides good results in the wave-frequency range, the low-frequency response for the irregular wave cases is generally under-predicted. This is linked to a simplified and quasi-static representation of the mooring system; difficulties in achieving a calibrated damping that can reproduce all DOFs accurately at the same time; and possible in-accuracies in the applied Newman approximation for the second-order forcing.

The NAUTILUS FAST model is further compared to a frequency-domain simplified model, which includes constant added mass and parameterized actuator-disc aerodynamics. Results for two irregular sea states in terms of time series and power spectral density show very good agreement with the FAST model in surge, heave and pitch.

The report finalizes with a global summary.