Innovative calibration procedure of numerical models for FOWTs: an experimental validation

A. Bertozzi, F. Niosi, O. Dell'Edera, B. Paduano, G. Bracco
Dipartimento di Ingegneria Meccanica e Aerospaziale, Politecnico di Torino
andrea.bertozzi@polito.it
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1 Introduction

Numerical modeling of the floating offshore wind turbine (FOWT) dynamics plays a critical role at the design stage of a floating wind project. The relevance of these models depends on how they correspond to the **real-life situation**; specifically, prediction of the **platform motions** in the **wave** and **resonance** frequency bands is challenging.

2 Numerical modeling of the FOWT

Equation of motion: Cummins' equation

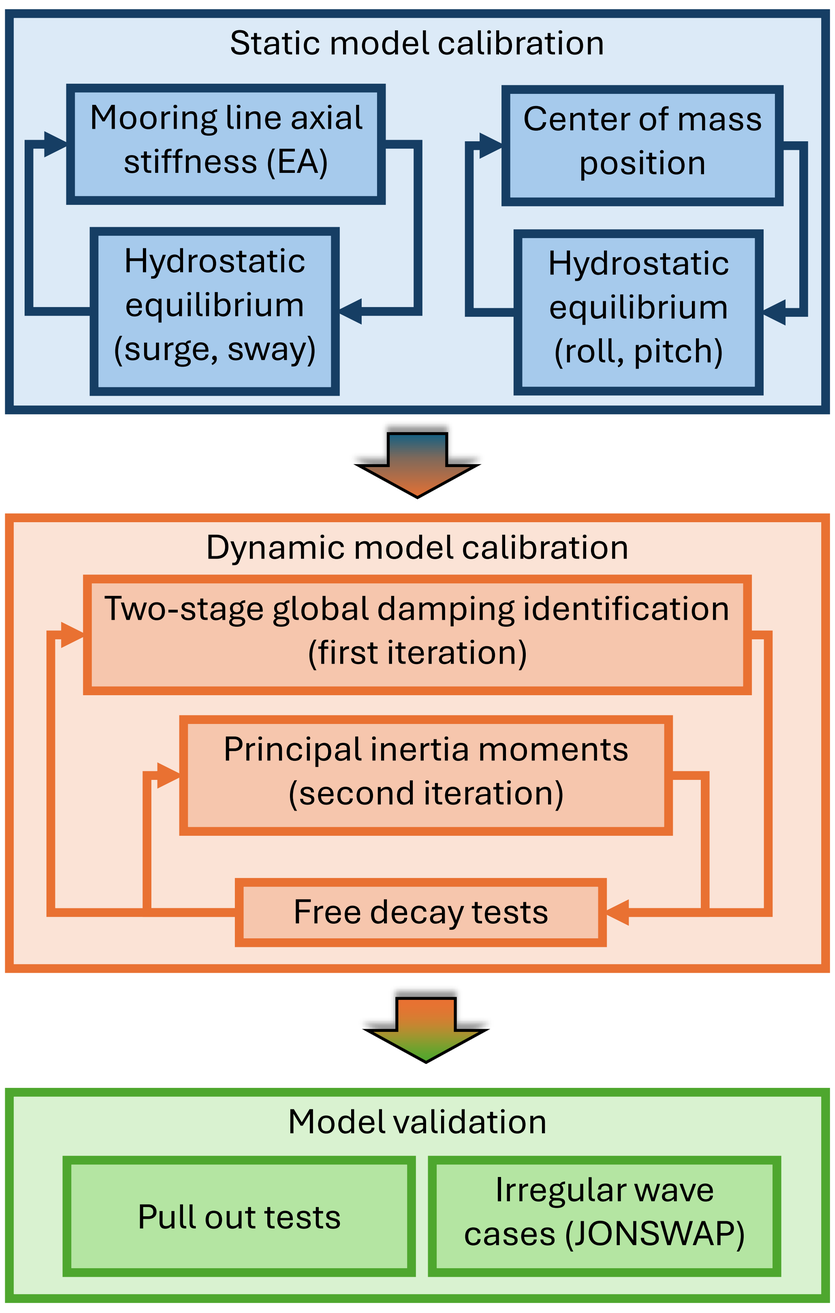
$$(\boldsymbol{M}+\boldsymbol{A}_\infty)\cdot\ddot{\boldsymbol{x}}(t)+\int_0^\infty \boldsymbol{B}_r(\tau)\cdot\dot{\boldsymbol{x}}(t-\tau)\cdot d\tau+\boldsymbol{C}\cdot\boldsymbol{x}(t)=\boldsymbol{F}_{ext} \quad (1)$$

- $\boldsymbol{M}$ Mass matrix
- $\boldsymbol{A}_\infty$ Added mass matrix at ∞ frequency
- $\boldsymbol{B}_r$ Retardation function
- $\boldsymbol{C}$ Restoring (hydrostatic) matrix
- $\boldsymbol{x}$ Platform motions vector
- $\boldsymbol{F}_{ext}$ External loads vector: wave excitation and mooring loads

Hydrodynamic and mooring loads

- Second order potential flow theory
- Full mean and low-frequency wave drift loads
- Global linear and quadratic viscous damping matrices
- Lumped mass model with linear stiffness

3 Model calibration

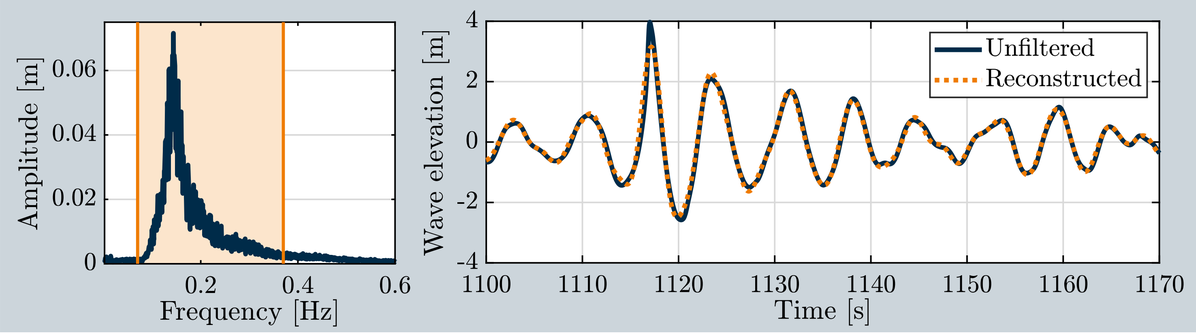


4 Model validation

Pre-processing of wave input

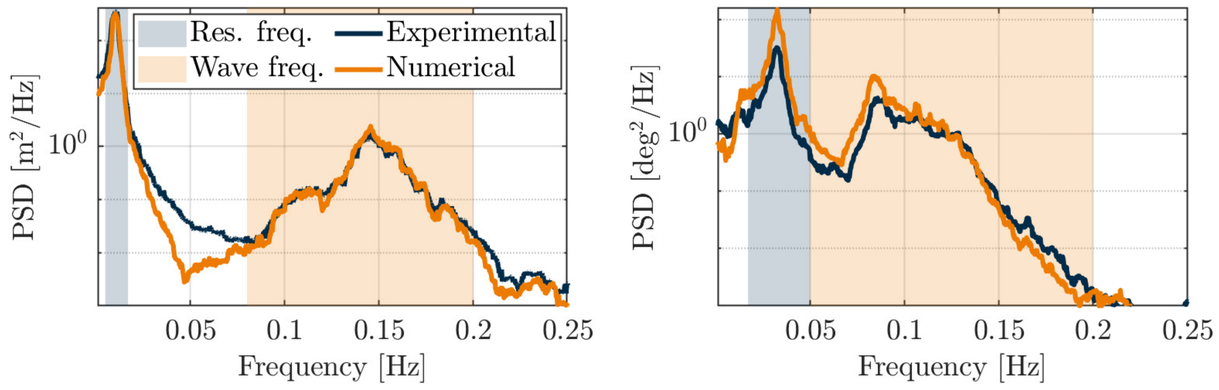
Pass-band filtering of the wave spectrum:

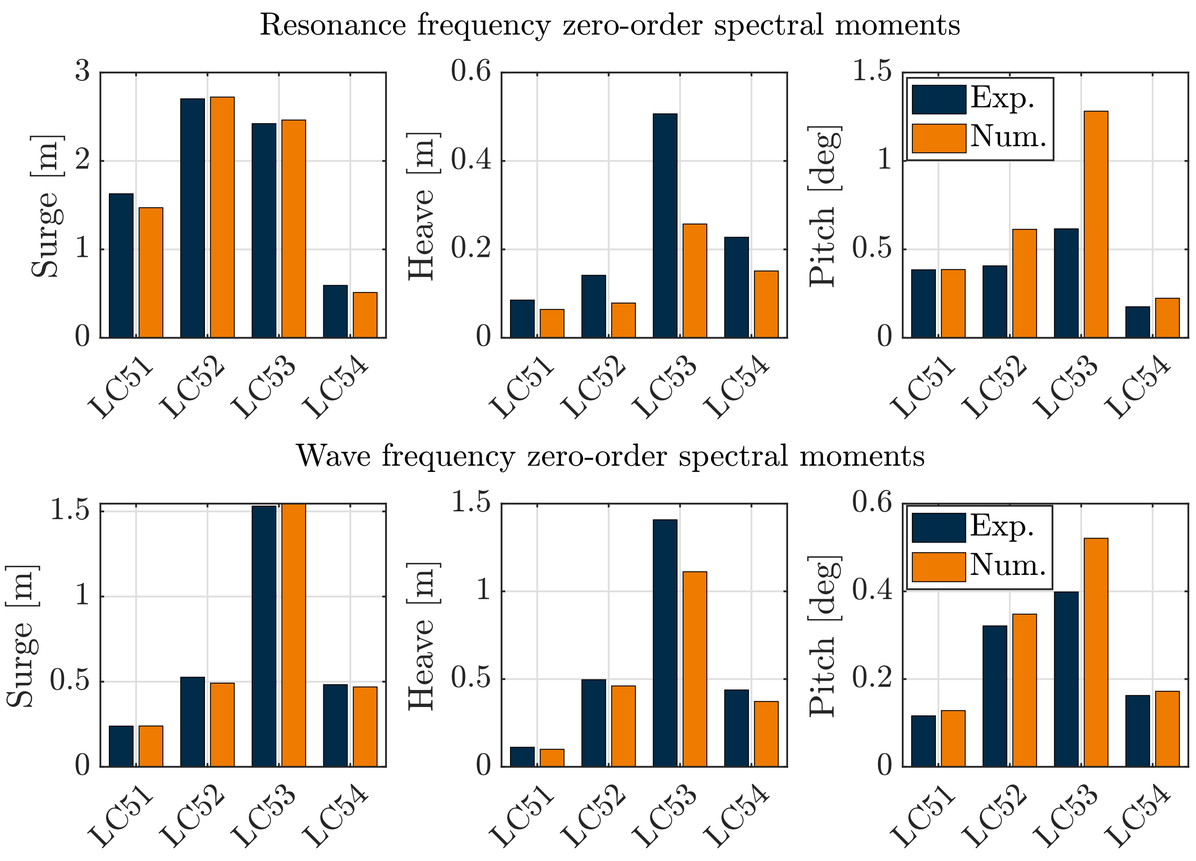
- Reduction of the **number of components**
- **Speeding-up** of the simulations



Model validation under four different irregular waves by comparing:

- Power spectral densities (PSDs)
- Zero-order spectral moments over **resonance** frequency band
- Zero-order spectral moments over **wave** frequency band





5 Conclusion

Systematic tuning of the numerical model of the semi-submersible yields **better prediction** of the platform's motions. The relatively computationally inexpensive proposed calibration procedure shows some limitations in the prediction of the **low-frequency motions**. Therefore, it is suggested to always include and calibrate **Morison drag coefficients** for the slender elements of semi-submersible structures for FOWTs.

Politecnico di Torino
Department of Mechanical and Aerospace Engineering
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