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Evaluation of a low-fidelity hydrodynamic modelling approach for a floating wind turbine mounted on an enhanced spar

Applying a low-fidelity hydrodynamic approach to a structure with large and slender members

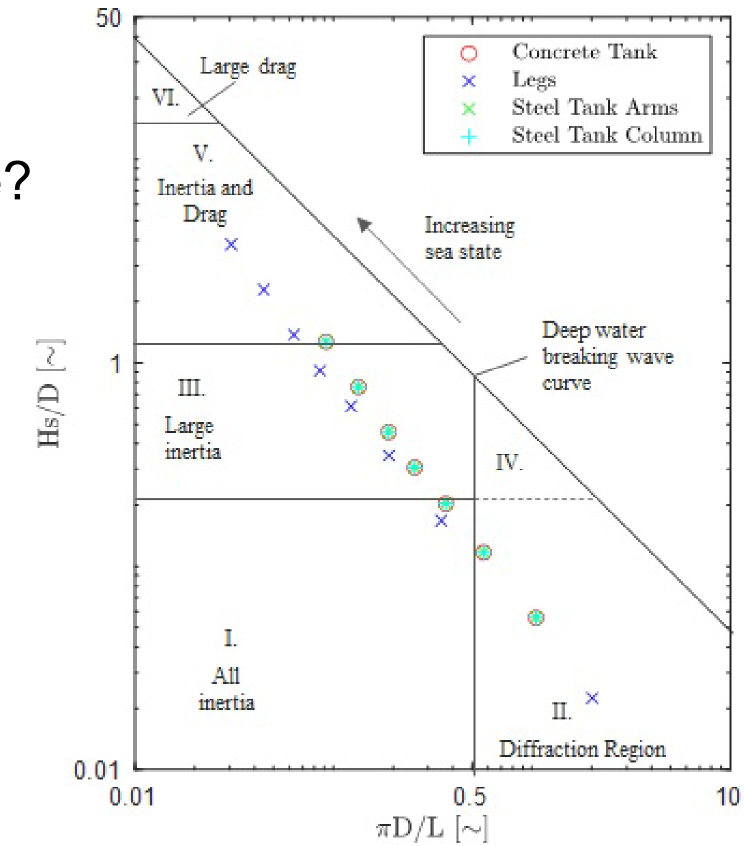
The **WIND-bos** platform is a type of **enhanced spar** combining both large and slender members

How can we characterize the flow for this structure?

- **Mild sea states** → Diffraction dominated
- **Moderate sea states** → Inertia dominated
- **Severe Sea states** → Large Inertia, moderate drag

Most engineering tools (HAWC2, FAST, etc) use a Morison-based approach

Is this approach suitable for platforms containing slender and large members?



Source: Chakrabarti S. (1987), *Hydrodynamics of Offshore Structures*

Applying a low-fidelity hydrodynamic approach to a structure with large and slender members

An extensive series of tests were performed at BGO First's test facility with a **1/40th Froude-scaled model** of DTU 10MW RWT and the WIND-bos platform.

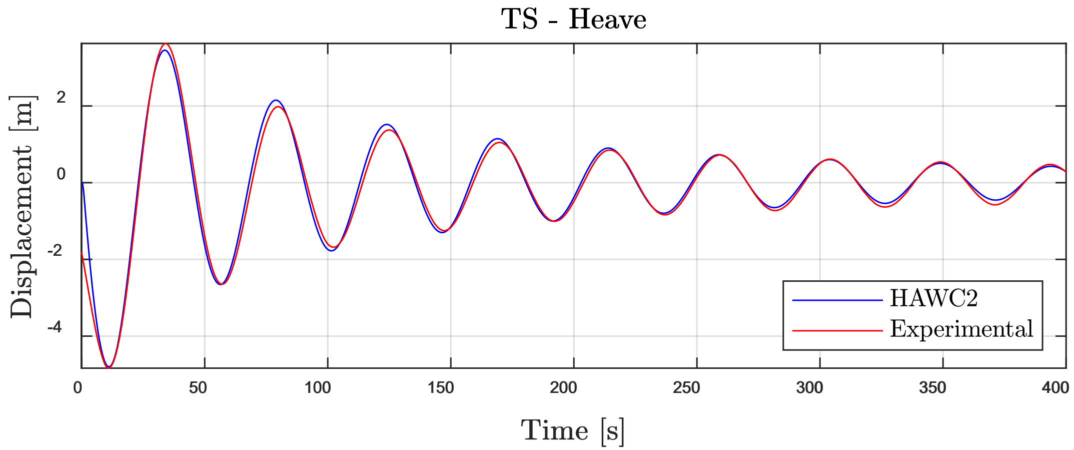
The basis for the validation process were:

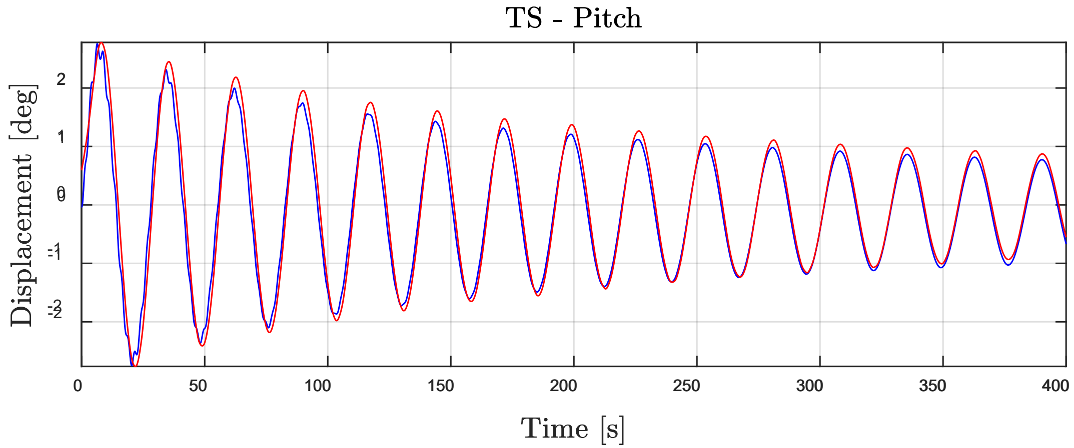
- Decay tests in all DOFs (free-floating and moored settings)
- Motion RAOs under Airy waves

A Morison's Eq. approach is used in **HAWC2** to model the hydrodynamics by selecting and calibrating a set of **fixed** C_A and C_D

BGO First facility, operated by Oceanide. La Seyne-sur-mer, France

Validation of structural and hydrodynamic properties





Calibration based on comparison with decay tests

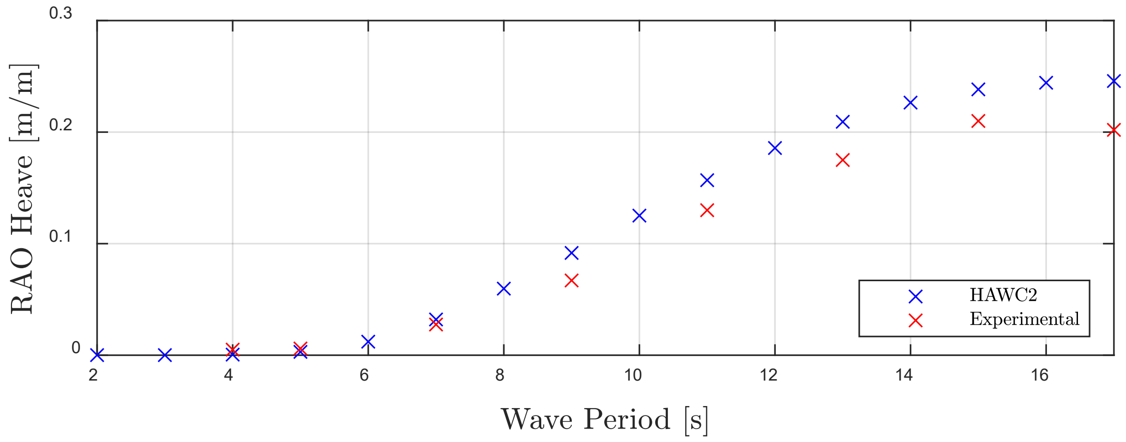
C_A → Nat. frequency adjustment

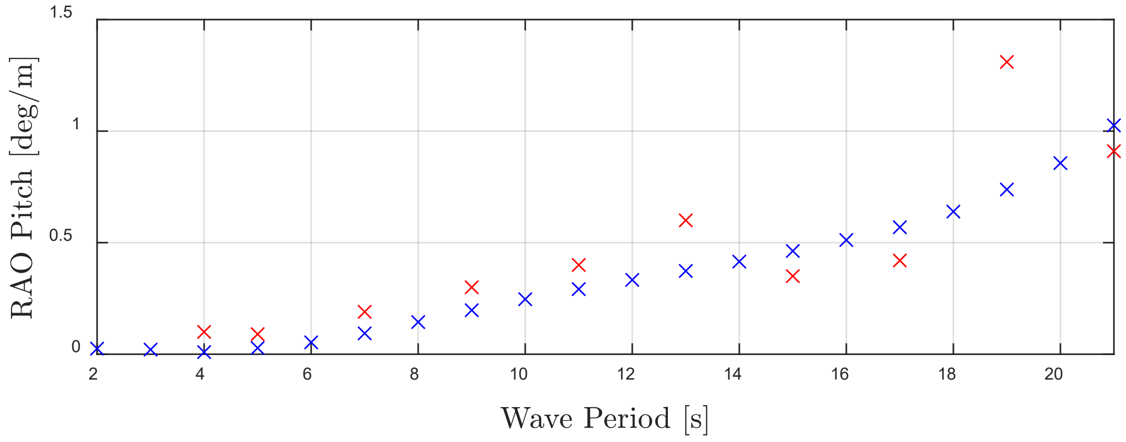
C_D → Damping level adjustment

Remarks:

- Independent force coefficients for each member
- Coeff. selection based on literature
- High level of agreement achieved prior to any adjustment
- C_A in Hull increased 20%
- C_D in Hull and Counterweight increased 10%
- Heave, pitch, and roll DoFs affected due to members orientation
- Extra linear $C_{D,axial}$ coeff. in heave added based on comparison with exp. data

Validation of dynamic response with wave loading





Motion RAOs allow the evaluation of the dynamic response under different wave regimes

Remarks:

- Overall fine agreement among all sea states
- Small deviation assumed to be caused by frequency-variation of added mass, radiation damping, and viscous damping.
- Calibration can be performed for more than one sea state

Conclusions

- An **excellent agreement** is expected in terms of **damping level** and **natural frequencies** when comparing with exp. decay tests.
- The **dynamic response** under wave loading was found to be in **fine agreement** among a broad range of sea states.
- A **Morison's Eq.** approach is **sufficient** for this platform, reducing the computational burden while providing reliable results.
- The agreement can be improved by adjusting the coefficients for more than one sea state. If exp. results are not available, look-up tables based on KC no., Re no., etc; can be found in the literature.

Thank you

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