REMS
RENEWABLE ENERGY MARINE STRUCTURES

Cranfield

Mitigation of Loads on Floating Offshore Wind Turbines through Advanced Control Strategies

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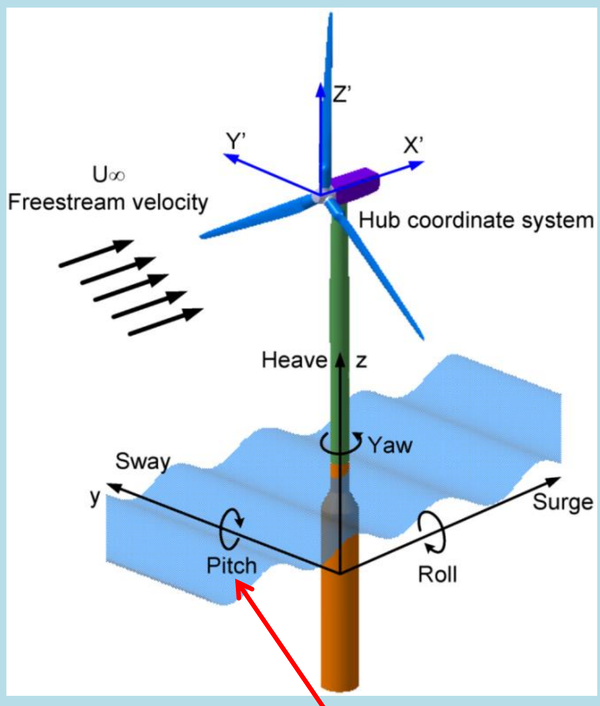
Main Issues for FOWTs

Motion: increased fatigue loads due to combined wave and wind loading.

Environment: complexity of installation, inspection and maintenance.

Cost: new technology with a requirement to be competitive long-term for both initial CAPEX and for LCOE



Aim

Investigate, design and test through simulation, novel control approaches to prevent undesirable loads that the turbine would experience when the floating structure is pitching.

Main Objectives

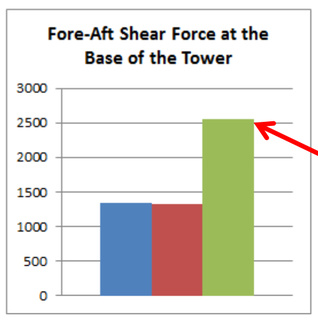
Identify and select a novel control strategy for chosen FOWT platform type.

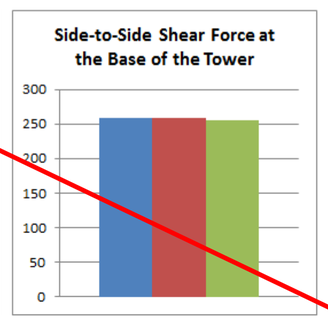
Validate ability to programme chosen simulation package for fatigue load analysis of the FOWT.

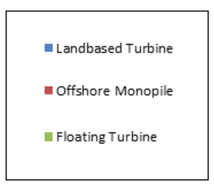
Define and build simulation and control models

Run simulations under different environmental conditions

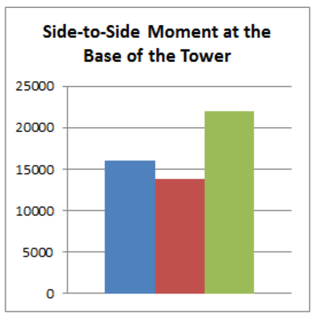
Identify benefits available from different control strategies.

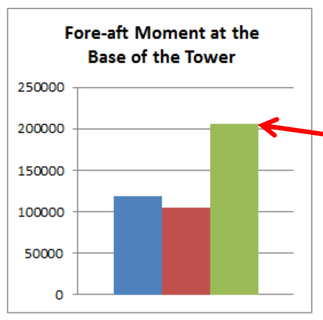


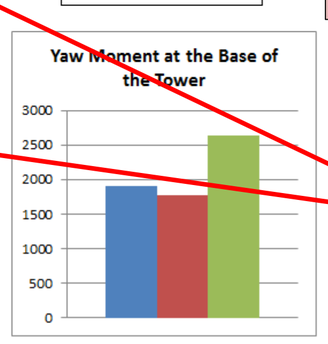




All senarios with an average wind of 12m/s
Offshore conditions with turbulent irregular waves







Reducing the platform pitch motion will reduce the tower fore-aft force and moments at the base of the tower

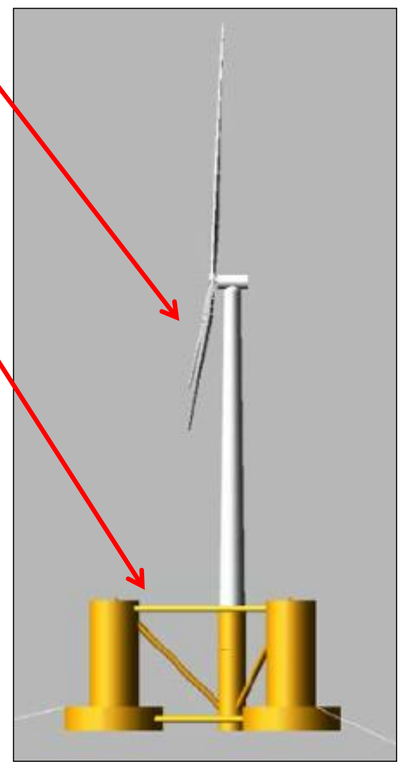
Increased tower fore-aft force and moment causes largest increase in fatigue loads on the tower of a FOWT

Reduce pitching motion of the FOWT through advanced control strategies

- Actively pitching blades to stall with variable speed control
- Tuned mass dampers
- Independent pitch control

Main Approach

- Analyse and verify a model of a floating Semisubmersible platform in FAST
- Validate against open source simulation results from Offshore Code Comparison (OC4) Phase II
- Turbine based on the NREL 5MW offshore baseline turbine
- Semisubmersible floating platform based on platform used for DeepCWind scaled experimental tests.
- Results from three organisations using FAST within OC4 chosen; National Renewable Energy Laboratory (NREL), Instituto Superior Tecnico (IST) and Goldwind.
- Build models for the turbine blade profiles for active stall
- Define and design control regimes and simulation systems.
- Run tests under different control and environmental conditions
- Compare and analysis changes in loads due to control strategies

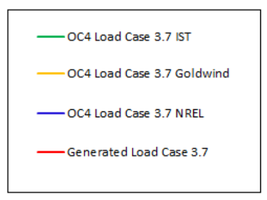


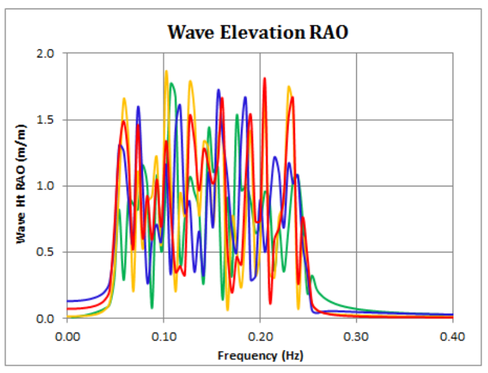
Validation Results

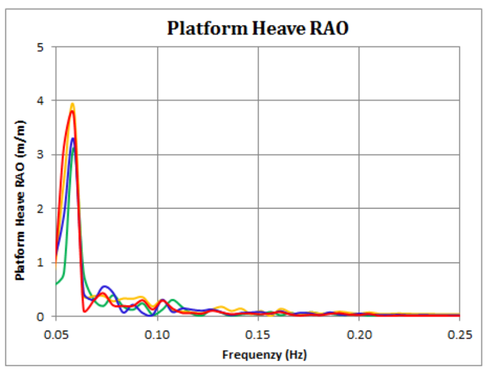
Response Amplitude Operator estimation

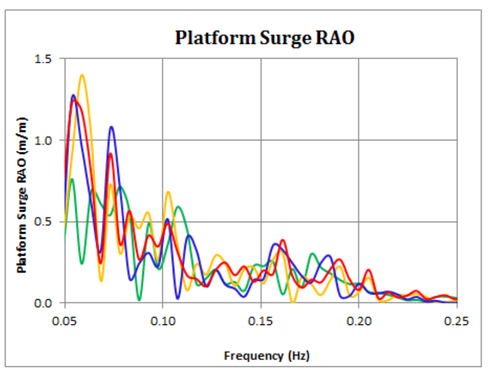
Wind condition: steady uniform with no shear and a wind speed of 8m/s at the hub

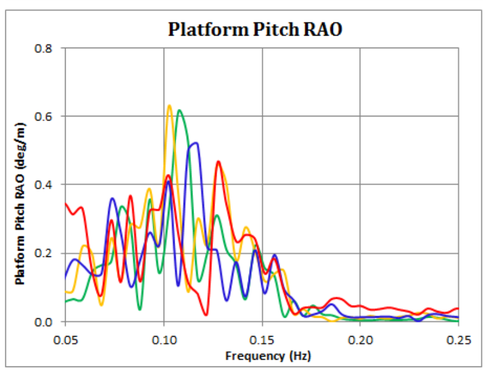
Wave condition: banded white noise with power-spectral density of $1m^2/Hz$ for 0.05 – 0.25 Hz

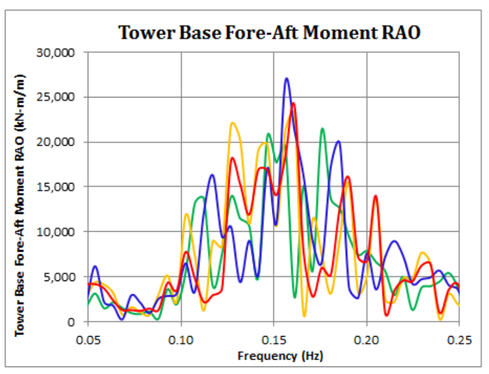












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