Drive Train Fatigue Reliability Analysis: Fixed vs. Floating Offshore Wind Turbines

Supervisor: Dr. Donatella Zappalá
Daily co-supervisor: Dr. Sumit K Pal
Student: Georgios Verykokkos
MSc Program : Sustainable Energy Technology

TU Delft
Delft University of Technology

Background

Wind turbine drivetrains suffer significant impact loads that severely affect the reliability and safety of wind turbines. Bearings and gears within the drivetrain are critical components with high repair costs and lengthy downtime [1]. It is therefore crucial to assess their dynamic fatigue reliability to mitigate operational and maintenance costs, reduce downtime, and enhance their availability and safe service [2].

Compared to bottom-fixed monopile wind turbines, floating turbines must withstand a unique and challenging set of loads caused by both wind and wave conditions [3] which poses several additional challenges to the reliability of their drive train. Due to accumulated fatigue, offshore wind floating turbines may develop damage in their critical locations sooner than expected [4]. To de-risk floating wind development, accurate predictions of these loads and their impact on the reliability of the key drive train components are necessary [5].

Importance

Addressing the reliability of the drivetrain components is vital for harnessing offshore wind energy, which is a key element of sustainable energy technologies with huge potential. By enhancing the reliability and predicting the drivetrain loads of both bottom-fixed and floating offshore wind turbines, the project contributes to the reduction of the operation and maintenance costs, the minimization of downtime, and the increase of the energy generation. In this way, it renders the offshore wind energy more cost effective and maximizes the energy generation by this renewable energy source.

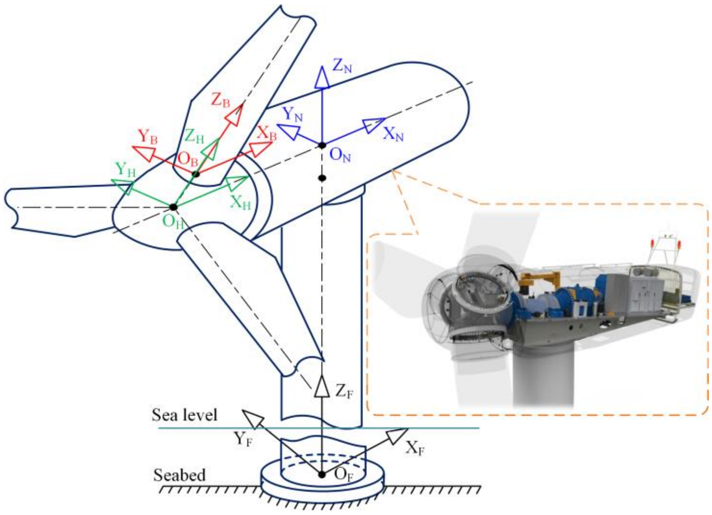

Figure 1: Structure and coordinate system of wind turbine drivetrain [2]

Objective

The main objective of this master project is building a framework for performing a systematic assessment and comparison of the reliability of the main drive train components of bottom-fixed and floating turbines. Furthermore, a detailed fatigue reliability analysis is going to be conducted for both wind turbine configurations and the impact of the motion of the floating offshore wind turbines will be identified.

An established aero-hydro-servo-elastic coupling dynamic model of a DTU 10 MW reference wind turbine with the full drivetrain built in SIMPACK will be used to simulate a variety of control strategies and environmental operating conditions. The model considers the flexibility of the tower and blades, the stochastic loads of wind and waves and gear meshing features. The drive train reliability will be assessed considering loads on gears and bearings.

References

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