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Numerical Investigation of the Response of Floating Offshore Wind Turbines During Extreme Typhoon Conditions

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1 Introduction and Background

Wind turbines subjected to extreme events, including typhoons, will experience structural responses that can lead to components failure, due in part to the high wind speeds, high turbulence and rapid changes in wind direction induced by the extreme event. As floating offshore wind turbines experience larger motions and more unsteady flow conditions than their bottom-fixed counterparts, it is essential to understand the possible impact that such extreme events may have on the turbine loads and response.

In this ongoing work, the response of a spar type floating wind turbine in typhoon conditions is studied using numerical modelling techniques and measured typhoon environmental conditions. The aeroelastic code FAST [1] is used to model the turbine. The results of the simulations are compared with field data from the Goto Islands' floating offshore wind turbine demonstration project, where a 100kW spar type floating test turbine was exposed to a real typhoon and survived with no damage, and the response of the turbine in the typhoon was measured and published [2]. The aim of this work is to assess the suitability of FAST for simulating floating offshore wind turbines in extreme environments.

2 Results

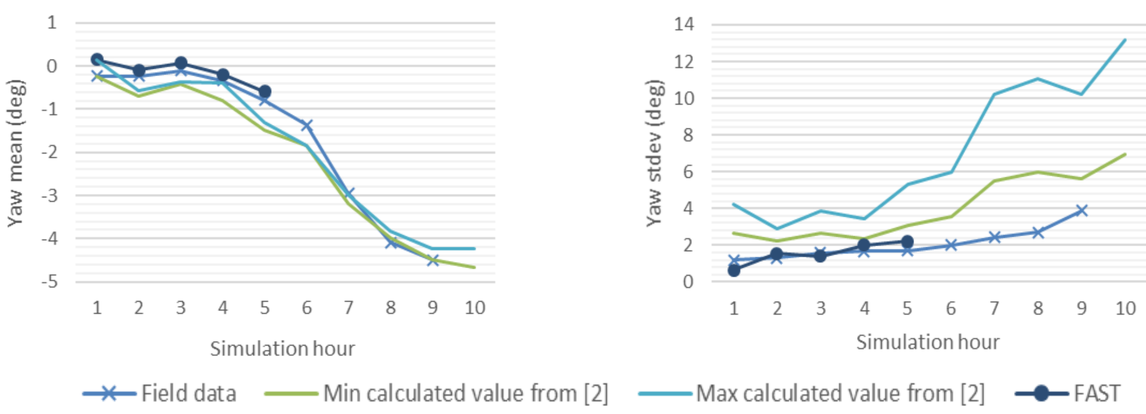

Figure 1 (a) Mean values of yaw motion. (b) Standard deviations of yaw motion

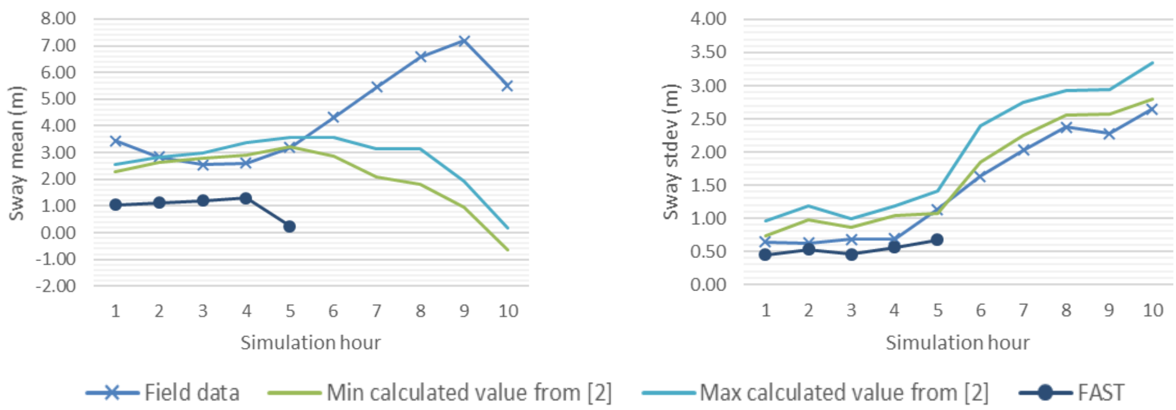

Figure 2 (a) Mean values of sway motion. (b) Standard deviations of sway motion

The FAST simulations are each carried out for one hour using the average environmental conditions over each hour of the typhoon for which field data on the turbine response is available. The simulated platform motions, tower bending moments and mooring tensions are compared with those from the field data and from previous numerical simulations published in [2]. The results obtained thus far show that the agreement between FAST and the field data is good for some measurements, particularly yaw motion as shown in Figure 1, however further investigation is being carried out to understand why there is a larger error in the predictions for other measurements such as sway motion, shown in Figure 2.

3 Future work

In future work, the turbine response to the typhoon will be modelled using a CFD approach in OpenFOAM through the use of the Simulator fOr Wind Farm Applications (SOWFA) [3], and the results will be compared against those from the FAST simulations and the experimental data. The purpose of this study will be to compare CFD with FAST for simulating floating offshore wind turbines in extreme environments, and to help determine where each modelling approach is best suited in the design process for floating offshore wind turbines. Additional future work will involve the simulation of a full scale wind turbine in typhoon conditions using FAST and CFD modelling, and investigating the impact that blade geometry design has on the performance of floating wind turbines in operational and extreme typhoon conditions.

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Bibliography

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