Offshore wind turbines with jacket foundations, structural dynamic analysis and sensitivity analysis: Towards optimization.

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ABSTRACT

Nowadays, there is an increasing interest in the design of offshore structures as the wind energy field is currently changing its usual onshore location to offshore spots. The analysis of offshore structures is subject to many uncertainties regarding the applied loads and the computational models. The uncertainty in the loads arises from the determination of the loads themselves and the impact they have in the structure complicating the analysis and the possibilities of structural optimization.

This work presents a computational model of the whole offshore structure including the rotating blades and its dynamic analysis subject to in-place loads as wind, waves, current, and buoyancy. The foundation modeled for the offshore wind turbine in this case is a jacket type steel structure. The aerodynamic loads are computed through the Blade Element Momentum Theory with the aerodynamic properties of the blades and considering wind shear and the tower blockage. The wave loads are computed in the submerged elements of the foundation using common wave theories along with the Morison's equation for the calculation of the exerted pressure.

The integration of the dynamic equations of motion is carried out by means of the Newmark Integration Method. The time history analysis for this type of structures is specially demanding in terms of computing time. Thus, the best way to approach the structural optimization is by means of gradient based optimization algorithms. Different techniques such as finite difference and analytic differentiation are compared in terms of accuracy and efficiency to compute the sensitivity analysis.