The Effects of Foundation Damping on Offshore Wind Turbines with Yaw Misalignment

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Large offshore wind turbines offer an attractive renewable energy option for the northeastern U.S., due to the relative proximity of an abundant wind resource to large population centers. However, the high cost of their support structures remains a concern. Current offshore wind turbine designs largely ignore damping from the foundation, although small increases in damping can significantly decrease the fatigue and damage accumulation over the turbine’s lifetime. Understanding and incorporating foundation damping into offshore wind turbine design guidelines can therefore reduce the materials and cost associated with offshore wind turbine support structures. Previous research from this team developed a method to design reliable turbine foundations, concluding that reliability plateaus at 37m pile depth, that bending capacity influences reliability more than pile diameter, and that reliability is equally sensitive to soil and load variations. Other research from this team concludes that slight increases in overall damping have little effect on operating turbines, but can reduce loading and fatigue damage significantly in parked-and-feathered turbines. This new research aims to understand how increasing damping (by including foundation damping) affects the loading on a monopile support structure under yaw misalignment. Using the aeroelastic code FAST to model the monopile-supported National Renewable Energy Laboratory 5MW reference turbine under IEC-6-based yaw errors, this study will determine the effects of foundation damping relative to the effects of yaw misalignment on load dynamics. Understanding load dynamics under increased damping and yaw misalignment is key to future studies on fatigue damage accumulation under these conditions, which in turn will develop into better design guidelines for offshore wind turbine support structures.