

Evaluating Passive Structural Control of Fixed Tidal Turbines

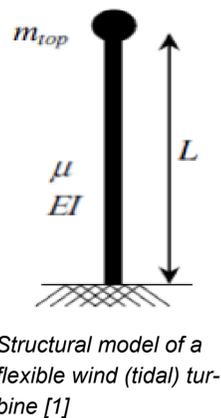
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Introduction

Considering waves and tidal currents as random excitations, the dynamic loads on tidal turbines is a complicated physical problem.

The aim of this project is to design a tidal turbine station keeping system with a tuned mass damper in order to reduce fatigue and peak structural loading experienced by the turbine. This may result in a reduction of mass and costs associated with the structural support and station keeping system.

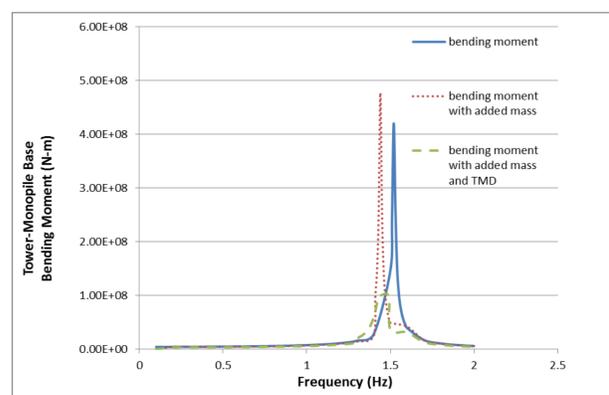
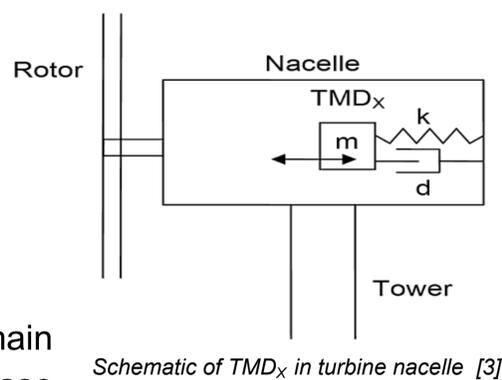


Response Calculation

The algorithm used is based on dynamic analysis, and the tower-monopile dynamics can be modelled as forced response of a non-gyroscopic damped linear system, given by:

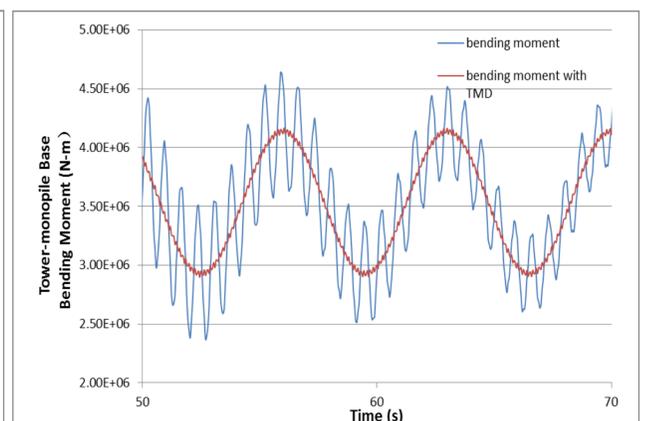
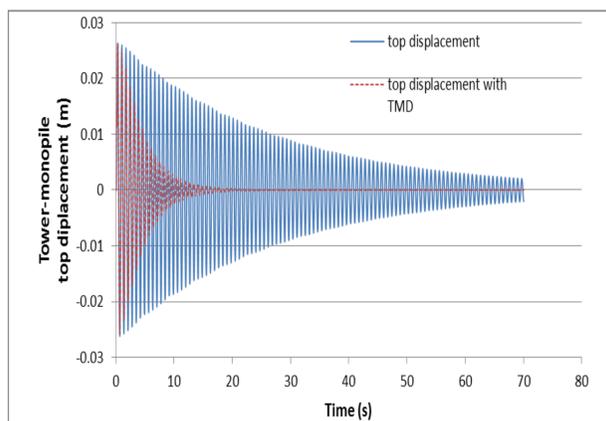
$$M\ddot{x} + D\dot{x} + Kx = F(t)$$

Unlike onshore and offshore wind turbines, tidal turbines are fully submersed in water, so the effect of added mass cannot be ignored. The evaluation undertaken and results presented are for the system calculated with optimum TMD of the tower-monopile structure.



Results

Figures show the frequency domain analysis for the tower-monopile base bending moment in three different conditions, the time series result of a dramatic impact on tower-monopile system and the time series result of tower-monopile system under periodic wave-current coupled forces.



Conclusions

This work has demonstrated, unlike offshore wind turbines, tidal turbine tower-monopile systems always show higher first natural frequencies. Furthermore the added mass correction will make natural frequencies of the structure slightly reduced. TMD_x has significant effects in resonance reduction and for-aft fatigue load-reduction under instant fluctuating impacts. However TMD has an insignificant effect when modest periodic loads are applied on the structure.

References

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