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On the use of tuned mass dampers for vibration mitigation in offshore wind turbines

Mina Ghassempour, Giuseppe Failla, Felice Arena, Giovanni Malara

Abstract: Vibration mitigation in horizontal-axis offshore wind turbines is of crucial importance to prevent fatigue damage of the structural components. Among others, many studies have examined tuned mass dampers (TMDs) in order to reduce tower-top oscillations under combined wind-wave loadings. In this context, the paper investigates the dynamic response of a 5MW offshore wind turbine resting on a tripod in intermediate water depth (50 m), when an omnidirectional TMD is installed inside the nacelle. Fully-coupled, non-linear aero-hydro-servo-elastic dynamic analyses are implemented in GH-BLADED, a software package certified by Germanischer-Llyod for analysis and certification of offshore wind turbines. A wide range of potential tuning frequencies, mass and damping ratios are explored, in both operational and parked rotor conditions at a typical offshore site. The main conclusion of the study is that the tuning frequency to attain optimal reduction of structural vibrations shall be changed depending on the wind velocity in operational conditions, while is equal to the natural frequency of the first support-structure modes when the rotor is parked. This result is attributable to inherent non-linearity of rotor dynamics and demonstrates that a conventional design of the TMD based on the natural frequencies of the support-structure modes may not be suitable for offshore wind turbines.

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[1] Mina Ghassempour, M.Sc. (Ph.D. student): University of Reggio Calabria, Via Graziella, 89124 Reggio Calabria, Italy (IT), mina.ghassempour@unirc.it , the author presented this contribution at the conference in the special session: "Innovative strategies for vibration control and mitigation" organized by G. Failla and R. Santoro.

[2] Giuseppe Failla, Associate Professor: University of Reggio Calabria, Via Graziella, 89124 Reggio Calabria, Italy (IT), giuseppe.failla@unirc.it .

[3] Felice Arena, Professor: University of Reggio Calabria, Via Graziella, 89124 Reggio Calabria, Italy (IT), arena@unirc.it .

[4] Giovanni Malara, Ph.D.: University of Reggio Calabria, Via Graziella, 89124 Reggio Calabria, Italy (IT), giovanni.malara@unirc.it .