

Vibration Reduction Of Wind Turbine Blade Using A Multi-Directional Tuned Mass Damper Inerter

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This research develops a novel two-dimensional non-linear tuned mass damper inerter (2d-NTMDI) to effectively reduce bi-directional structural responses. The 2d-NTMDI consists of a mass and two sets of springs, dashpots and inerters configured in two axes. The resultant restoring forces are nonlinear with respect to the displacements in two axes. While the proposed novel 2d-NTMDI has the capability of suppressing bi-directional vibrations simultaneously, the system nonlinearity complicates the optimization. A numerical search approach is adopted to determine the optimum design parameters of the 2d-NTMDI. To evaluate the effectiveness, the proposed 2d-NTMDI is deployed in a 5MW-wind turbine blade suffering from bi-directional vibrations in the edgewise and flapwise directions. To this end, an analytical model of a wind turbine blade with a 2d-NTMDI is established. The wind loading is computed using blade element momentum theory. The effectiveness of the 2d-NTMDI is examined under different loading conditions. Also, the fatigue damage of the wind turbine blades is calculated according to the rain-flow cycle counting approach and Miner's law. It is concluded that the optimized design 2d-NTMDI can prolong the blade fatigue life by 35%.