Seismic protection of wind turbines using tuned mass dampers

Abstract: The seismic efficiency of tuned mass dampers is numerically analyzed by means of a three-bladed 5 MW onshore reference wind turbine. The calculations are carried out by the aeroelastic dynamic horizontal axis wind turbine simulator FAST with its seismic and structural control codes. Time-histories of five historic earthquakes are used. These are Tokachi-Oki (1968), El Centro (1979), Northridge (1994), Kobe (1995) and Kocaeli (1999). The simulations are performed simultaneously with turbulent wind at 1-25m/s mean speeds. The optimum TMD parameters are calculated using Den Hartog’s criteria for natural damper frequency and damping ratio. A mass ratio of 5% is chosen for the analyzed TMD. The acquired results show that TMD can mitigate especially the periodic structural vibrations effectively. This effect is observed both for the wind and for the seismic loading, which shows that the seismic vibration mitigation effort of a TMD mainly depends on the frequency content of the earthquake. During El Centro earthquake, which causes mainly transient vibrations, the efficiency of TMD is not significant. From the analyzed other four earthquakes, particularly the seismic vibrations caused by the Tokachi-Oki earthquake are reduced.
remarkably, by which the turbine tower without TMD reaches its highest RMS and peak deflection.