As offshore wind farms are being installed farther and in deeper waters offshore, new, and more sophisticated marine substructures such as jackets need to be used. Herein, a 10MW wind turbine mounted on a jacket substructure at a mean water depth of 50 meters is investigated with regards to the fatigue design loads on the braces of the jacket. Since large wind turbines of 10MW rating have low rotor speeds (p), the modal frequencies of the substructures approach 3p at low wind speeds, which leads to a modal coupling and resonance. Therefore an active control system is developed which provides sufficient structural damping and consequently a fatigue reduction at the substructure. The resulting reduction in fatigue design loads on the jacket structure based on the active control system is presented.