

Impact of rotor solidity on wind turbine fatigue and extreme loads

For offshore wind turbines, as compared to onshore machines, acoustic emission regulations are usually less restrictive. Higher design tip speeds than would be acceptable on land are being employed. For a given rated power, this reduces rated torque and hence can save weight and cost in the drive train. In this context, within a generic study of load trends considering influences of turbine scale, wind conditions and key turbine design parameters, it is of particular interest to better understand the impact of changes of rotor speed and solidity on the fatigue and extreme loads of typical upwind, three bladed, horizontal axis wind turbines.

For this paper the focus is to investigate the dependence of fatigue and extreme loads on rotor speed taking account of necessary changes to blade design to preserve near optimum aerodynamic performance. This work helps to understand the impact of rotor solidity on design driving loads, which may be fatigue or extreme.

Simulations have been conducted according to IEC 61400-1 standard. The properties (chord, twist angle and etc.) of blades have to be modified to maintain similar aerodynamics for the different rotor speeds because tip speed ratio is a function of rotor angular velocity. This is done in a consistent way so that the results may be used to establish generic fatigue and extreme loads trends.

This reveals for example that the fatigue loads, edge-wise and flap-wise, of the blade root for operation in power production region (IEC DLC1.2) demonstrate an inverse behaviour between the rotor speed and loads with increasing speed reducing the fatigue loads increase and vice versa. The following figure shows the above mentioned behaviour of the fatigue loads of edge-wise blade root moment for Wohler coefficient 4 and 10, which stand for steel and composite material, respectively.

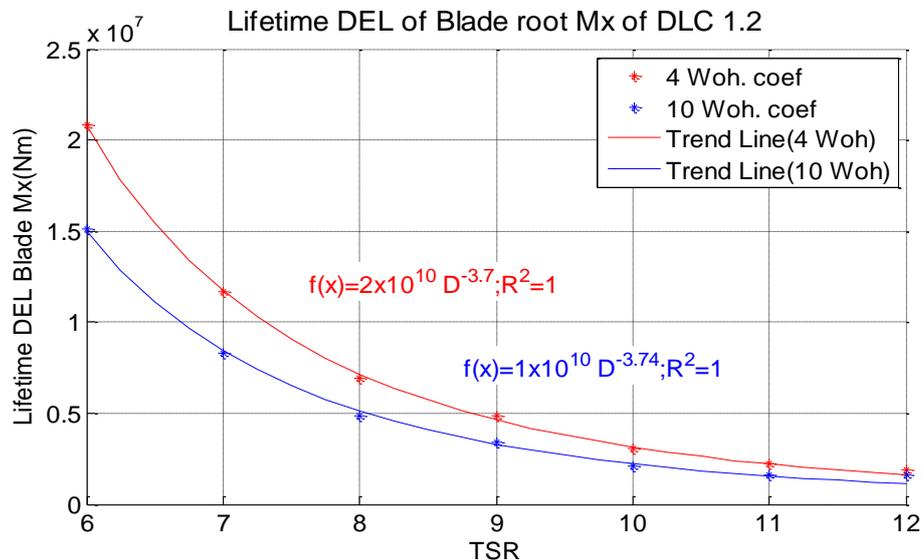


Figure 1: Lifetime DELs of blade root moment against tip speed ratio.