ECN Wind Energy Industrial Support

EWIS

Being one of the leading institutes on wind energy research, ECN has established the new EWIS (ECN Wind Industrial Support) group in 2009 to better bring the R&D results to the market. During the last three decades, ECN has developed expertise on aerodynamics, structural analyses, turbine control, offshore operation and maintenance, and grid connection. With the growing wind industry, ECN received more requests for assistance and EWIS has become the vehicle to support the wind energy industry in their product developments.

EWIS's focus is on the high end of the market which means that we will make use of tools and knowledge that have been developed in-house and include the latest R&D results!

The EWIS team is a mixture of young professionals and experienced researchers which ensures a fast response and high quality.

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Aeroelastic rotor blade stability analysis

The Service

The service comprises the aeroelastic stability analysis of rotor blades for the specific operational conditions of each type of wind turbine. Aeroelastic stability concerns the interaction between the dynamic deformations of the structure and the aerodynamic forces acting on the blades. Unwanted vibrations and structural failures could arise if there are aeroelastic instabilities. Static divergence and flutter are well known phenomena in this respect. The analysis takes into account that wind turbine rotor blades are designed for use on different wind turbines. The design of large size rotor blades does not only deal with aerodynamic performance but also with a weight-efficient structure and smooth aeroelastic behaviour in order to keep the design loads low. Basis of the aeroelastic response of a wind turbine rotor starts in the blade design by avoiding resonant frequencies and providing aeroelastic stability of rotor vibrations.

The Approach

The wind turbine rotor blade aeroelastic stability analysis at ECN will be done with the in-house developed code Bladmode on the basis of its detailed aerodynamic and structural properties. The Bladmode code gives the eigenmodes and eigenfrequencies of the blade with which the behaviour can be analysed for a series of operational wind velocities. The interaction with the turbine is only included by the tower fore-aft dynamics and the drive train interaction while the controller is represented by the quasi-steady blade pitch-angle as function of generator speed, which implies that the aeroelastic stability analysis of the rotor blades can be performed early in the design of a wind turbine.
Analyses with Bladmode may focus on the detailed aerodynamic flow over the rotor blade for which one may switch between a BEM-based model and a Vortex-Wake model. This allows evaluation of e.g. the vorticity near the blade tip. The stability analyses with Bladmode are performed for all operational wind velocities. The basic approach investigates possible resonant frequencies, the quasi-steady blade torsion and the 1P variation in blade torsion. The basic analyses also include the aerodynamic damping of the eigenmodes for all operational wind velocities.

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Based on the initial results of the analyses with Bladmode or based on specific questions, several studies may be investigated, most of which are in terms of parameter variations, or switching some aspects 'OFF'. The Bladmode analyses can also be used to design the 'peak-shaving' pitch strategy on basis of the combination of annual yield and maximum axial loads and tip deformations.

The Results

A report will be drafted addressed to the customer that provides insight into the results of the different aeroelastic analyses that have been performed. From these analyses the conclusions about the stability of the blade design will be drawn up and possible recommendations to further improve the stability or the design of the blade from an aeroelastic point of view will be given. The effect of changing some of the variables can be included in this report, for example the inclusion of the torsional stiffness of the blade, both on the aeroelastic properties and on the power performance. It is also possible to give some insight into the effect of different pitch strategies, etc.

The Experience

For several decades ECN Wind Energy is recognised as one of the leading R&D institutes on wind turbine structural behaviour and aeroelasticity. Several design tools have been developed and are being improved continuously. The experience in rotor blade design is extensive; many designs have been made for a great number of clients. Creating these designs also includes aeroelastic stability analysis.
In particular for the large light-weight rotor blades aeroelastic analyses have been performed with Bladmode. These analyses resulted in recommendations to, for example, adjust blade stiffnesses or apply some 'structural pitch'.

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