Technische Universiteit Delft

Dynamic responses of a spar floating wind turbine in level ice with varying thickness

The wind energy industry in order to find stronger winds, has to go further offshore and move into deeper waters where bottom founded wind turbines cannot be deployed anymore. This is the main reason why floating wind turbines have been studied extensively in the past years. In the case of regions with cold climates, ice loads become significant and have to be taken into account when designing an offshore structures like an offshore wind turbine.

As soon as this strong background on ice is founded through extensive literature study, a set of existing measurements of level ice from the “ARISE” expedition that took place in Antarctica in East 2003 was used in order to formulate a random varying thickness ice field. This is achieved by constructing a tool which based on the spectrum from the existing measurements, a new random varying ice thickness floe is generated.

An existing model that considers constant ice thickness floes was updated in order to account for varying thickness fields. This was accomplished by modelling the ice floe as an Euler – Bernoulli beam of varying cross – section. It is noticeable to mention that ice fails in an arc shaped wedge. An FEM numerical model was implemented in FORTRAN that accounts for the variations in thickness. Moreover, beam elements of different widths were used in order to build up an approximation of the arc shaped wedge. By coupling the FORTRAN code with the aeroelastic code HAWC2, the effect of the varying thickness ice field is compared with the constant ice thickness floe.

The results obtained generally revealed a decrease in the ice loads when a varying ice field is considered. Moreover, it is observed that the varying ice thickness field introduces a more dynamic effect on the structure, especially for the low drifting speeds. As soon as aerodynamic loads are also included, then it is also noticed that the combined wind and ice loads, give rise to frequencies different from the ones only the ice loads excite.

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