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Are the installed offshore wind foundations sufficiently resilient against ship collisions?

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Nowadays, a large number of wind turbines are being installed offshore due to more stable and steady flow of wind at sea and also less noise and visual impact compared to onshore installations. In line with the growing number of offshore wind installations, a great deal of attention has to be paid to ensuring the safe operation of structures during service life. Offshore wind structures are subject to extreme environmental conditions and high dynamic stresses caused by wind, waves and operational loadings. More importantly, the offshore wind installations may be damaged by collision with commercial ships and/or service vessels traveling at high speeds. To date, the damage analysis of collisions between offshore ships and wind turbine foundations has received very limited attention. In this study, a nonlinear finite element analysis (NFEA) approach is applied to evaluate the damages to offshore wind turbines due to collision with service vessels. The model is applied to a case study where a 4000-tones class vessel collides with an offshore wind turbine with two types of foundation: monopile and jacket structure. Various collision scenarios are identified and their associated damages to wind turbine foundation are evaluated. The number of members damaged in each scenario is determined and several control measures are recommended for wind foundation protection in collision incidents. The results of this research provides a better understanding of the damages resulting from ship-turbine collision accidents and gives an insight on how the next generation of wind turbine foundations can be designed in a "collision-friendly" way.

Keywords: offshore wind turbine foundation; ship collision; damage analysis; risk assessment; finite element analysis (FEA).