Mesoscopic mechanical modelling and monitoring of a polyamide rope for mooring lines of floating offshore wind turbines

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Résumé

Floating wind turbines developed in shallow waters (depth less than 150 m) will be located in exposed areas where waves and wind are significant. A challenge for the floating systems is to find a robust mooring solution suited for long-term applications. Shallow water platforms can benefit from the Oil & Gas sector experience, but catenary mooring system is not optimized for floating offshore wind turbines (FOWT). A proposed solution is a semi-taut mooring system with synthetic ropes. Their high specific strength added to their flexibility will allow smaller line length, weight, and line tension. Synthetic mooring lines will ease the handling and improve safety during installation. Nylon 6 is of high interest thanks to its competitive price, high elongation to failure (up to 20%) and low stiffness. Its visco-elasto-plastic behavior is a source of damping, which is anticipated to allow floater structural optimisation. A new fiber coating has been developed for Nylon rope applications that require long duration (25 years) such as FOWT. Work performed during FEM's POLYAMOOR project proved that this new coating increases the durability and fatigue resistance of the nylon line up to the industry requirements. A key R&D challenge is to understand the contributions of their complex hierarchical multi-scale architecture, and their complex non-linear elasto-visco-plastic behaviour, to the dissipation and failure mechanisms of the rope. FEM's MONAMOOR project proposes the development of an anisotropic behavior law based on the rope meso-scale constituents (the rope-yarns which are the sub-scale of the strand) to answer these questions. The model, once implemented in a finite element analysis software, will allow the dissipation due to internal friction mechanisms, identified as the main source of damage of nylon fibres, to be separated from the dissipation linked to the fiber behavior. The MONAMOOR project also includes the development of new innovative sensors for the monitoring of these complex ropes. Development of sensors and meso-scale modelling are parallel and complementary topics. Both are being tested and verified during sea-trials on a prototype with a mooring system designed to be representative of FOWT dynamics. These sea-trials are also part of the MONAMOOR project.

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