FEM modelling of the mechanical phenomena at the mesoscopic scale within the cross section of a synthetic subrope for the mooring lines of floating offshore wind turbines.

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ABSTRACT

Synthetic ropes have been successfully used as mooring lines for O&G platforms at depths of several thousand meters since the 1990s. Today, floating wind turbines also need synthetic ropes for their mooring lines. The ropes used consist of a few strands twisted together. Mechanical phenomena at the mesoscopic scale of the cross-section are poorly understood, yet they are crucial to the fatigue life, creep elongation and cyclic visco-elasto-plastic behavior of these ropes (Civier et al., 2024). We adopted a modelling approach for understanding these phenomena.

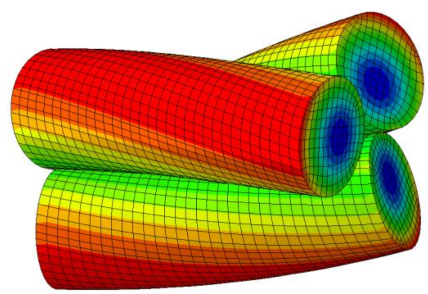

Figure 1: Example of a FE simulation of a traction on a 3-strand rope.

Using Criscione et al. (2001) strain invariants, we model the particular anisotropic behavior of fiber bundles, which is the material that constitutes the rope strands. In this way, mechanical phenomena such as fiber elongation, sliding against each other and compacting are distinguished. For each phenomenon, a relevant behavior law is implemented. The contact pressure between the strands is due to the helical shape of the path followed by the strands. Strands slide against each other at contact areas. This pressure and sliding between strands result in fiber compacting and shearing within the strands. This, combined with strand tension, produces a complex, heterogeneous field of stress and strain in the strands that has yet to be fully investigated.

References

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