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Modeling of the mechanical response of polymer mooring ropes to study the construction effects

Tom Armand[1], Guilhem Blès[2], Matthieu Le Saux[3], Yann Marco[4]

[1] ENSTA, Institut Polytechnique de Paris, UMR CNRS 6027, IRDL, F-29200 Brest, France, France.
tomarmand@live.fr
[2] ENSTA, Institut Polytechnique de Paris, UMR CNRS 6027, IRDL, F-29200 Brest, France, France.
guilhem.bles@ensta.fr
[3] ENSTA, Institut Polytechnique de Paris, UMR CNRS 6027, IRDL, F-29200 Brest, France, France.
matthieu.le_saux@ensta.fr
[4] ENSTA, Institut Polytechnique de Paris, UMR CNRS 6027, IRDL, F-29200 Brest, France, France.
yann.marco@ensta.fr

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Abstract

Shared mooring systems and polymer-based mooring lines have the potential to increase mooring line reliability and robustness in increasing components lifetime and reducing maximum loads, so open the door to rope sizing and cost reduction. The Enhancing Shared mOoring system design for floating Offshore wind faRms (ESOMOOR) CETPartnership project addresses this issue. Polymer ropes, such as those made from PA or PET, are promising candidates due to their compliance and durability. However, their mechanical response is complex: it depends not only on the properties of the filament material but also on the hierarchical rope structure (construction), such as the number of sub-elements, twist angles, and lay length [1]. This study focuses on the effect of these construction parameters on the mechanical behavior of polymer ropes. To analyze these effects, a finite element model at the mesoscopic scale is proposed. This model represents the sub-rope as an the arrangement of strands in contact. The strands are represented as continuum media. Non linear material contribution is account for via an equivalent homogeneous hyperelastic constitutive model is used to capture the anisotropic behavior of the rope-yarn bundles that make up the strands [2]. This constitutive model accounts for key phenomena such as fiber elongation, sliding,

and compaction. With a model explicitly representing several lay lengths, simulations can be very time-consuming [3], making parametric studies difficult to perform. Therefore, based on geometric and kinematic considerations, a reduced model representing only a portion of a lay length is proposed, preserving the degrees of freedom coupling of a full rope.

Keywords:

Polymer mooring ropes Construction effects Mechanical response Mesoscale finite element modeling Anisotropic hyperelastic constitutive behavior Large strains

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