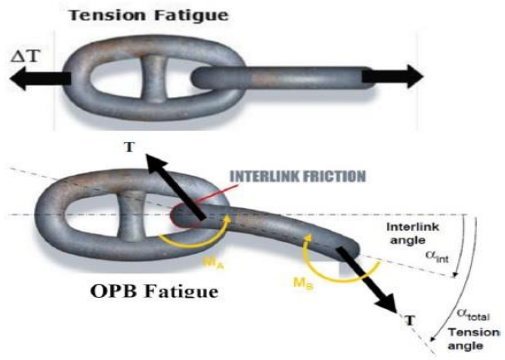
TU Delft

Offshore & Dredging Engineering

Technische Universiteit Delft

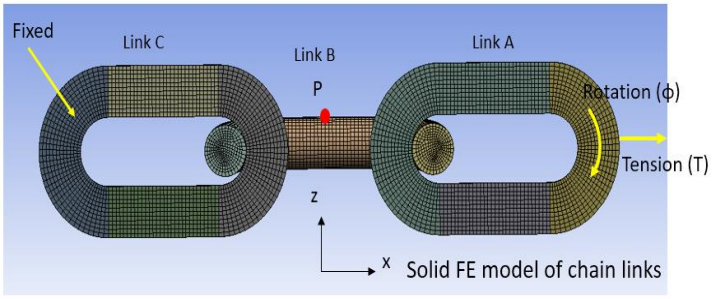
Models to explain out of plane bending mechanism in mooring chains



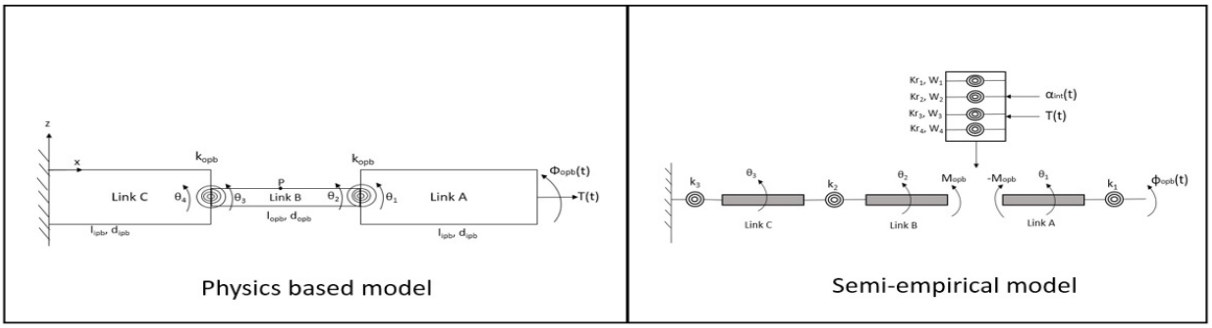
In 2002, several mooring chains of Girassol off-loading buoy which was installed offshore Angola, ruptured just after 8 months of service. After a series of investigations, a new failure mechanism called Out-Of Plane Bending(OPB) fatigue was identified. This failure mechanism is not considered in conventional assessment standards.

Generally, it has been assumed that chain links do not possess any rotational stiffness at their contact and they can rotate freely with respect to one another. However, due to proof testing of links, plastic strains at the link contacts are introduced, which results in moments resisting relative rotations. A phenomenon called “lock” happens, and the relative rotation between floater and mooring chain induces OPB stresses in the first couple of links, potentially causing them to fail earlier than expected.

Currently, there is no model or well defined methodology in literature which can comprehensively explain OPB mechanism in mooring chain links. Such a model or methodology is required to calculate OPB stresses in chain links for fatigue damage evaluation. These models need to be "simple" and "adequate" in the sense that it should idealize a complicated geometry of chain links while giving accurate predictions of OPB stresses when subjected to rotation and tension, at a fraction of time used by solid finite element (FE) models or full scale experiments. The research carried out in this master's project deals with development of such models to explain OPB mechanism in mooring chain links.



In this thesis, a new interlink stiffness model is proposed to describe the nonlinear hysteretic relationship between OPB moment/stress and interlink angle. The interlink stiffness model is then applied to a system of chain links using two different approaches: a physics based approach and a semi-empirical approach.



A main conclusion of this study is that when considering interlink stiffness, while floater rotations remain the same, tension in the mooring line changes. This raises concerns on the methodology that is currently followed.

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