NTNU – Trondheim
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Effect of corrosion pits on fatigue life of mooring lines

Context and motivation of the research

Offshore mooring lines are structural systems used to secure the positioning of floating offshore platforms by means of connecting the floating structure to an anchor on the seabed. They usually consist of steel chains, although alternative configurations exist such as synthetic fiber ropes and a combination of chain and rope segments. A steel chain mooring line is a serial system, which means that the failure of a single link yields structural failure of the complete mooring line. A mooring line failure increases the load level on the adjacent lines and is therefore increasing the risk of collapse of the complete system. Structural collapse is associated with large environmental and economic consequences. Consequently, the detection of failure of a mooring line is usually followed by operation shutdown, which is associated with large economical losses.

In practice, the failure rate of offshore mooring lines is larger than it is projected and admissible. Mooring systems are prone to fail due to a combination of deterioration mechanisms. They are subject to large environmental cyclic loading while exposed to a highly corrosive environment. A better understanding of the deterioration phenomena is required in order to improve the design of mooring lines and to enhance their structural reliability. Several investigations have emphasized the significant effect of corrosion on the fatigue life of mooring chains. To account for this phenomenon, industry guidelines provide a basic approach to estimate the material loss and the chain bar diameter reduction by assuming a uniform corrosion and wear per year. However, mooring chain inspection data has revealed that these chains occasionally experience severe local corrosion (called pitting corrosion). Corrosion pits act as stress raisers on the chain link surface, fostering crack initiation. Therefore, structural failure is in general not a linear superposition of the effects of corrosion and fatigue, but a complex combination of both phenomena.

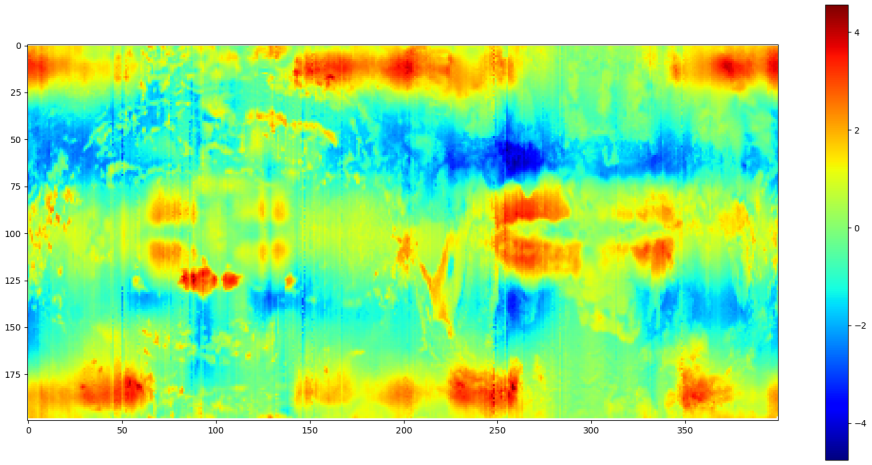

Figure 1. Example of a surface scan of a mooring line link.

Objectives

The results of this MSc Thesis aim at (i) gaining insight into the deterioration phenomena and their effect on the structural integrity of offshore mooring lines; (ii) contributing to the improvement of the current design basis and decision support of offshore mooring lines; and (iii) enhancing the basis for the reassessment of the fatigue failure risk of mooring lines based on data obtained from surface testing identification of corrosion.

A stochastic model that captures the main geometrical features and spatial variability of corrosion pits in mooring lines subject to marine exposure is to be developed. Surface scanning data of retrieved chains is available, as well as fatigue test data. Supervised machine learning can be applied to adapt empirical data to geometries that can be used to represent the expected corrosion pits. Furthermore, a causal Bayesian Network structure representing the relation of influencing parameters to pitting corrosion and its spatial distribution can be learned. The study may focus on answering the following questions:

1. How can pitting corrosion be represented in time and space?
    - What do the pits generally look like?
    - Where are they likely to be found?
    - What is the probability of finding a certain pit geometry at a certain location?
2. What is the phenomenon leading to pitting corrosion and its development and distribution on the chain link surface?
3. How does spatially distributed pits affect fatigue life of the offshore mooring lines?
4. Develop a prior generic probabilistic model for the assessment of the fatigue life of mooring lines.
5. Enhancement of the prior model with processed data gathered from retrieved links. The parameters of the model developed in the previous point can be updated by applying Bayesian methods.
6. Develop a probabilistic model for the reassessment of mooring lines given *in situ* surface scanning.

Organizational aspects

The supervision will be co-supervised by the following team:

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Suggested reference literature

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