Simulation of Marine Lifting Operations With Focus on Structural Response Control

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Introduction

Offshore oil and gas activities moves steadily into deeper waters and harsher environment .Subsea installations become more and more common for extraction of hydrocarbons. This development put heavy demands on contractors to be able to perform safe and efficient installations, inspections and interventions. At present many operations require benign environmental conditions and are thus limited to the summer period.

In this thesis work the focus have been on modelling lifting through the splash zone using USFOS. The structural response in this phase is to be considered.

Fig: Lowering of a suction anchor

Scope

1. Review of various subsea installations and equipment that will be installed by lift operations.
2. Familiarize with USFOS for modeling the lifting behavior by establishing a very simple, idealized model.
3. Establish the finite element model in USFOS for the cases sleeted for analysis. The vessel motions may be simulated on the basis of transfer functions for wave induced displacement or wave forces for various incoming wave angles.
4. Perform simulation of lifting operations for selected scenarios. The environmental conditions shall be varied
5. Evaluate the risk of yielding or buckling for the different cases.
6. Discuss the appropriateness of the tools for simulation of marine operations. Discuss the challenges that may need to be resolved.

Initial model

Initially a simple model of a pipe was studied. The model consist of a 45m long steel pipe, connected to two lifting wires. The top of the lifting wires are fixed.

This was done to get a better understanding of how USFOS could be used to simulate marine lifting operations. Further details about the results from this study will not be included in this poster

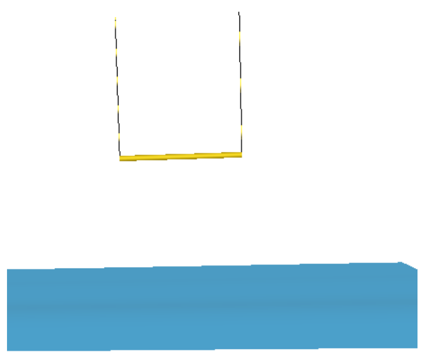


Fig: Initial model

Lowering of a subsea spool

The structure that is modeled is a subsea spool connected to a spreader bar and 4 slings. The slings are again connected to the lifting wire. The purpose of the spreader bar is to reduce stress in the spool due to the slings. This is to be removed from the spool after installation on the sea bottom.

The top of the wire is connected to a crane on a vessel. The vessel motions are determined by a RAO that is defined in USFOS.

Forces in the slings, wire, spreader bar and spool are considered in this study. The spool will be lowered into both flat sea and waves. Different cases of both regular and irregular waves have been considered.

The Jonswap spectrum have been used to model the irregular waves.

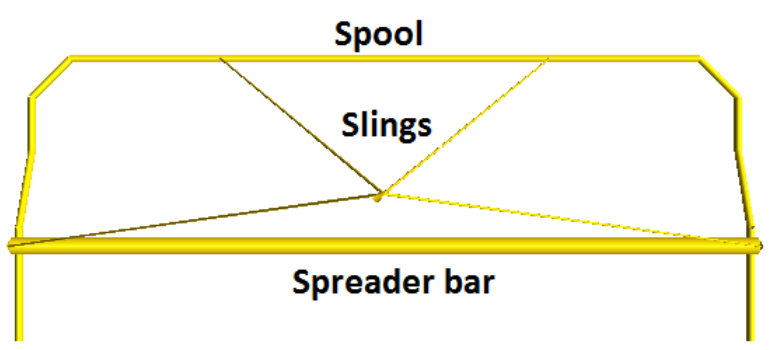
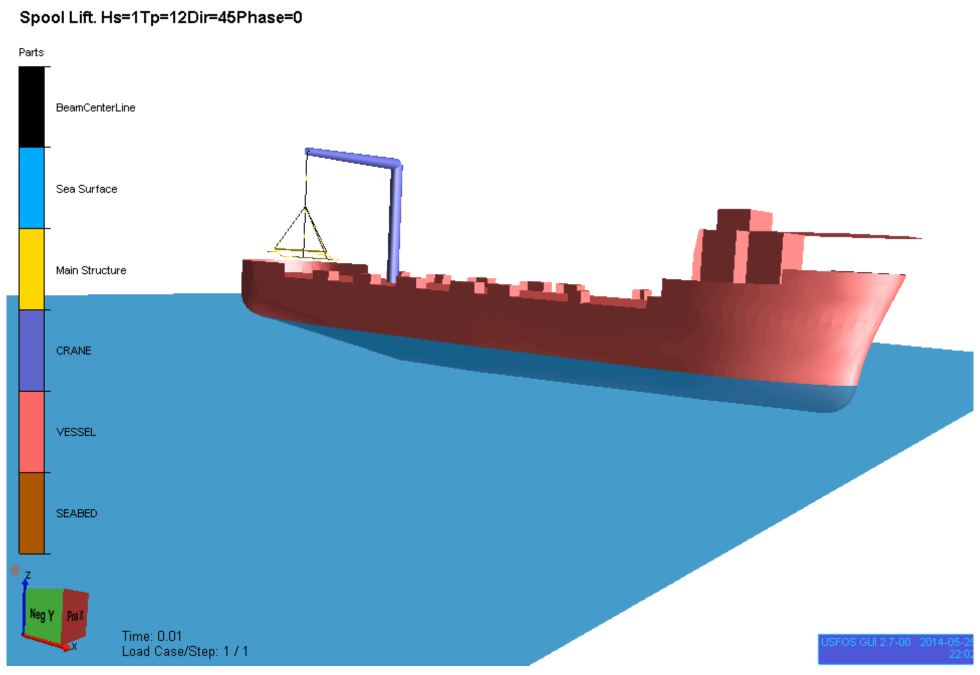
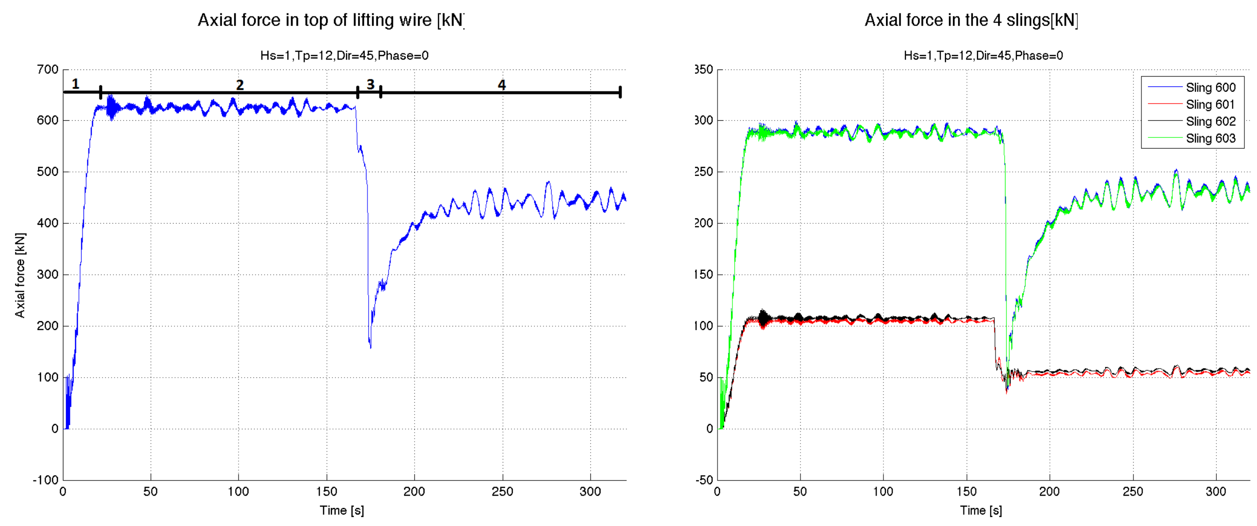


Fig: Subsea spool , spreader bar and slings seen from above

Spool and vessel model. Hs=1,Tp=12,Direction=45deg



Forces in the lifting wires and slings



Left: Axial force in top of the lifting wire. The 4 following phases are indicated:

1. Initial phase. Introduction of gravity and self-weight
2. Lowering of structure starts. Structure is in air.
3. Structure hitting the water. This result in a reduced force in the wire
4. Structure is submerged and the spreader bar is filled with sea water. This will increase the force in the wire

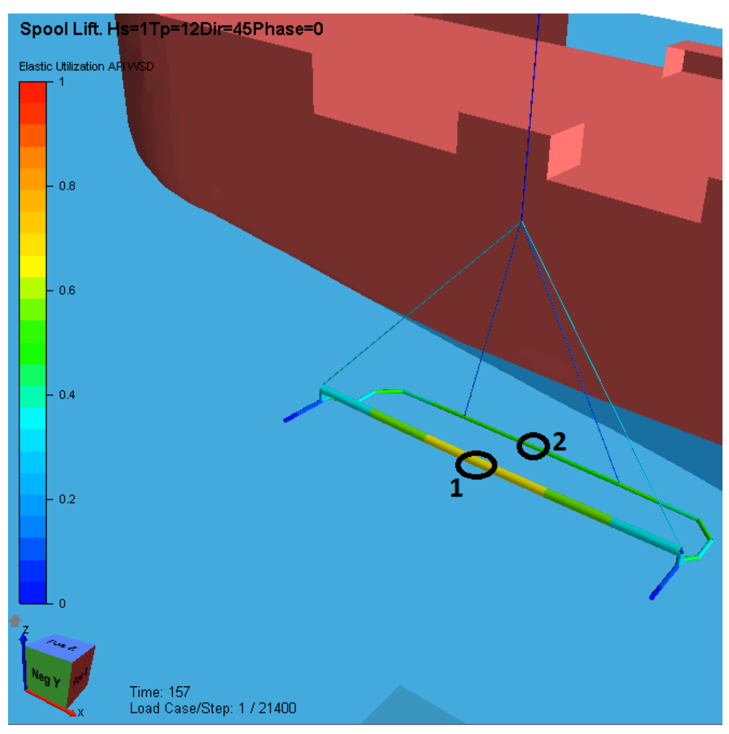
Right: Axial force in the four slings connected to the spool and spreader

It is critical that these forces in the wire and slings does not become zero during the lowering. This will correspond to slack wire/sling and can be followed up by high snap loads. These loads can be many times higher than the dynamic equilibrium load in air

Elastic utilization

The figure on the right shows the elastic utilization of the spool hanging in air. In USFOS the utilization Is calculated according to API-RP2A-WSD.

For this case, the most critical points are on the middle of the spreader (1) and the middle of the spool (2).



Summary

Several different cases of waves have been modeled in this thesis work. The structural response of the model have been considered in the different cases.

If more details about this study is of interest, it is recommended to read the final report.