Analysis Methods for Mooring Systems with focus on Accidental Limit State

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Scope of Work

The scope of this work is to compare the time domain (TD) and frequency domain (FD) methods for mooring analysis, and to explore the possibility for a progressive collapse for an already damaged mooring system (Accidental Limit State). The following scheme is proposed for the work:

1. Review relevant literature and describe the different aspects of FD and TD analysis methods for extreme vessel offset and extreme mooring line tension. The software tools MIMOSA (FD) and SIMO/RIFLEX (TD) shall be used.
2. Establish numerical simulation models for TD and FD analysis. Make a thorough comparison of the FD and TD results. The comparison shall cover both mean, LF and WF responses as well as the total response.
3. Particular analysis of a line failure in a selected storm. It is of interest to assess if a line failure in a particular storm will lead to a progressive collapse of the complete mooring system. The probability distribution of the most loaded remaining line will be established given a failure of the neighbouring line.

Summary

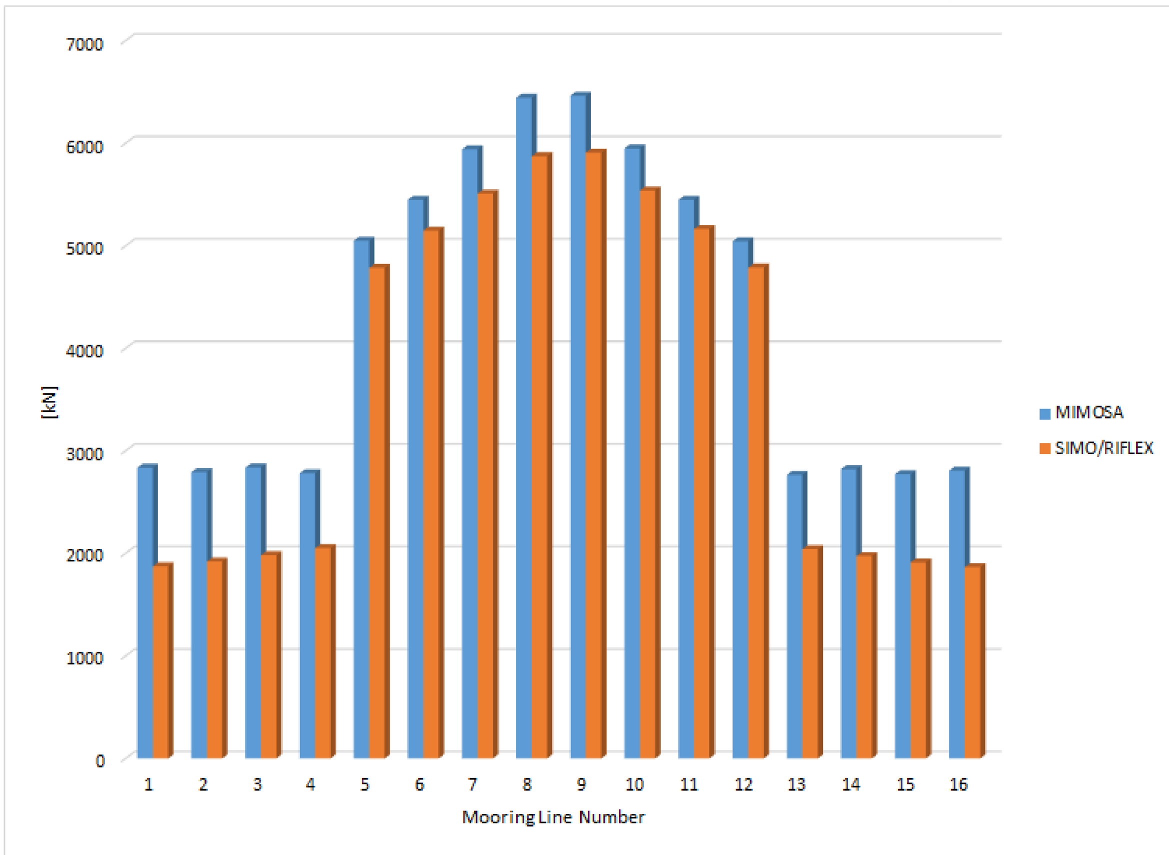
A semi submersible platform with mooring system has been analysed in FD with the MIMOSA software, and in TD with the SIMO/RIFLEX software package. The environment tested for was a typical 100-year condition. To ensure compatibility between the two different models, all the input has been compared and approved. After the analyses, relevant output parameters have been compared, including the most probable maximum tensions and offsets, the restoring curves and the tension standard deviation.

The semi submersible has also been analysed for an accidental limit state, for the same environmental condition, but with 20 different seed numbers. The most loaded line has been cut at the beginning of each time series, and the motions and tensions for the damaged system have then been compared to the same seed numbers with an intact system.

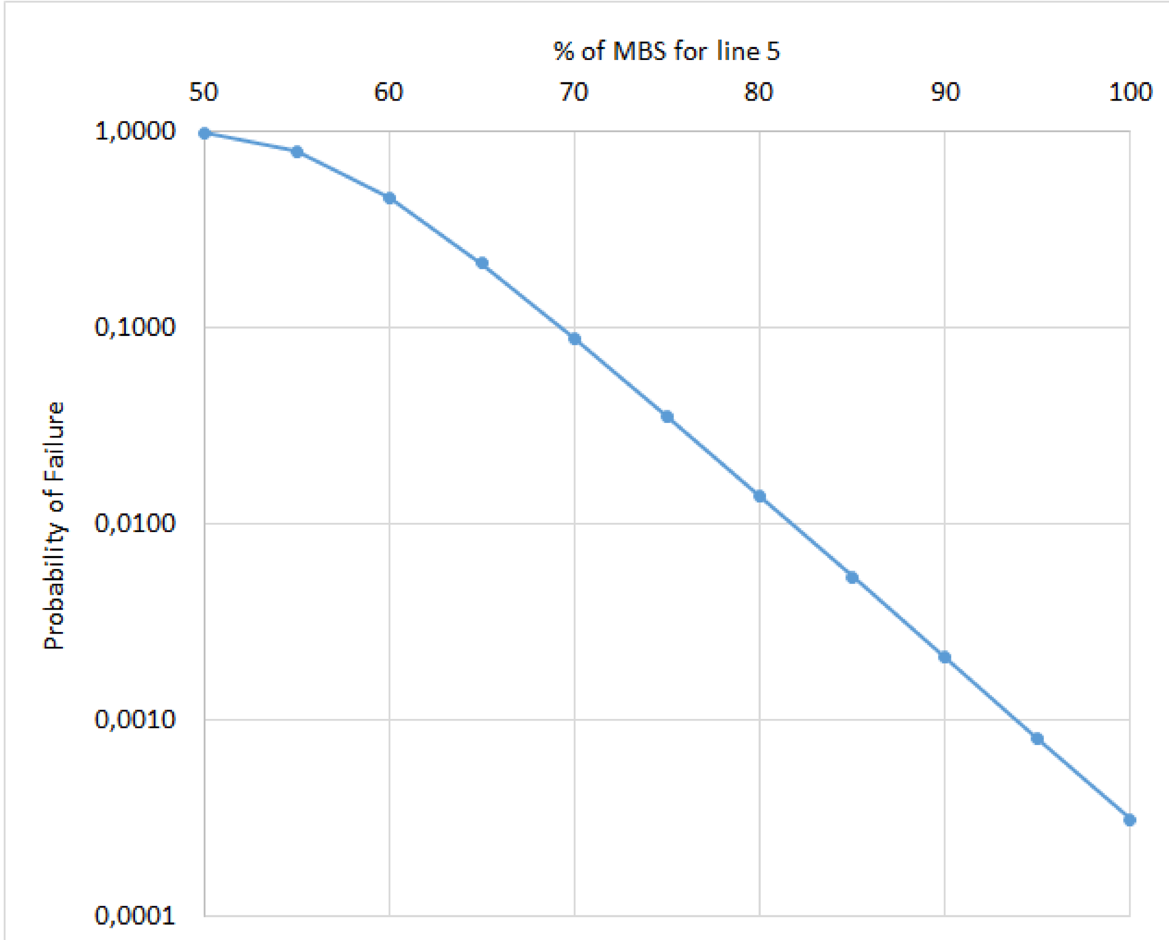
The moment of failure has also been investigated, to see if the maximum tension will occur at the transient phase, when the platform settles at a new equilibrium position. To do this, an analysis was performed where the most loaded line was cut at different time steps in vicinity to the time step where the maximum tension was recorded.

Results

There isn't room for all the results, so only the most relevant/interesting are posted here.

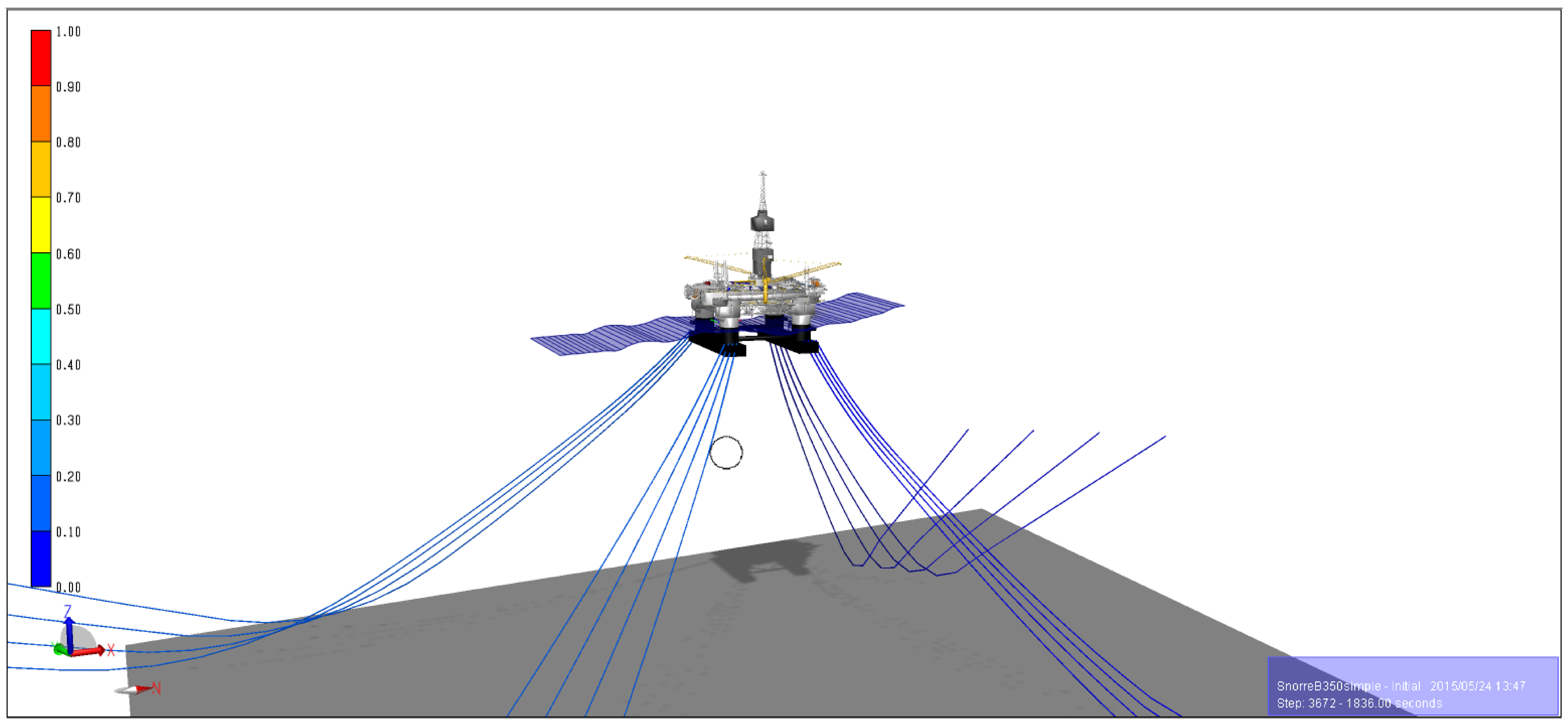


The figure to the left shows the maximum tension in all sixteen mooring lines, with contributions from SIMO/RIFLEX and MIMOSA. As the figure depicts, the maximum tension comparison is acceptable, with 9.4% deviation in the most loaded line. The results from MIMOSA are conservative, which is expected due to the linearisation and excluding of damping contribution.



The graph shows the probability of failure as a function of MBS, when one line is already broken. When the MBS is 100%, which is reasonable, there is only a 0.03% chance of failure. With a degradation of MBS to 80%, there is still just 1.38% chance of progressive collapse. This shows that the mooring system has a high redundancy, and is robust even with one line broken.

Snorre B Semi Submersible Model



The model analysed was the Snorre B semi submersible platform, with 16 mooring lines grouped in four clusters. A picture of the SIMO/RIFLEX model, displayed in the SIMA GUI, is shown above.

Information

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References

Some important references used in this thesis are:

- SIMO - Theory Manual, 2009
- MIMOSA - User/Theory Manual, 2012
- Sealoads on Ships and Offshore Structures, O. Faltinsen, 1990