Assessment of marine riser joints during offshore drilling operation

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Introduction

Drilling risers provide a link between the well and the rig, and it is therefore one of the most safety critical systems during offshore operations.

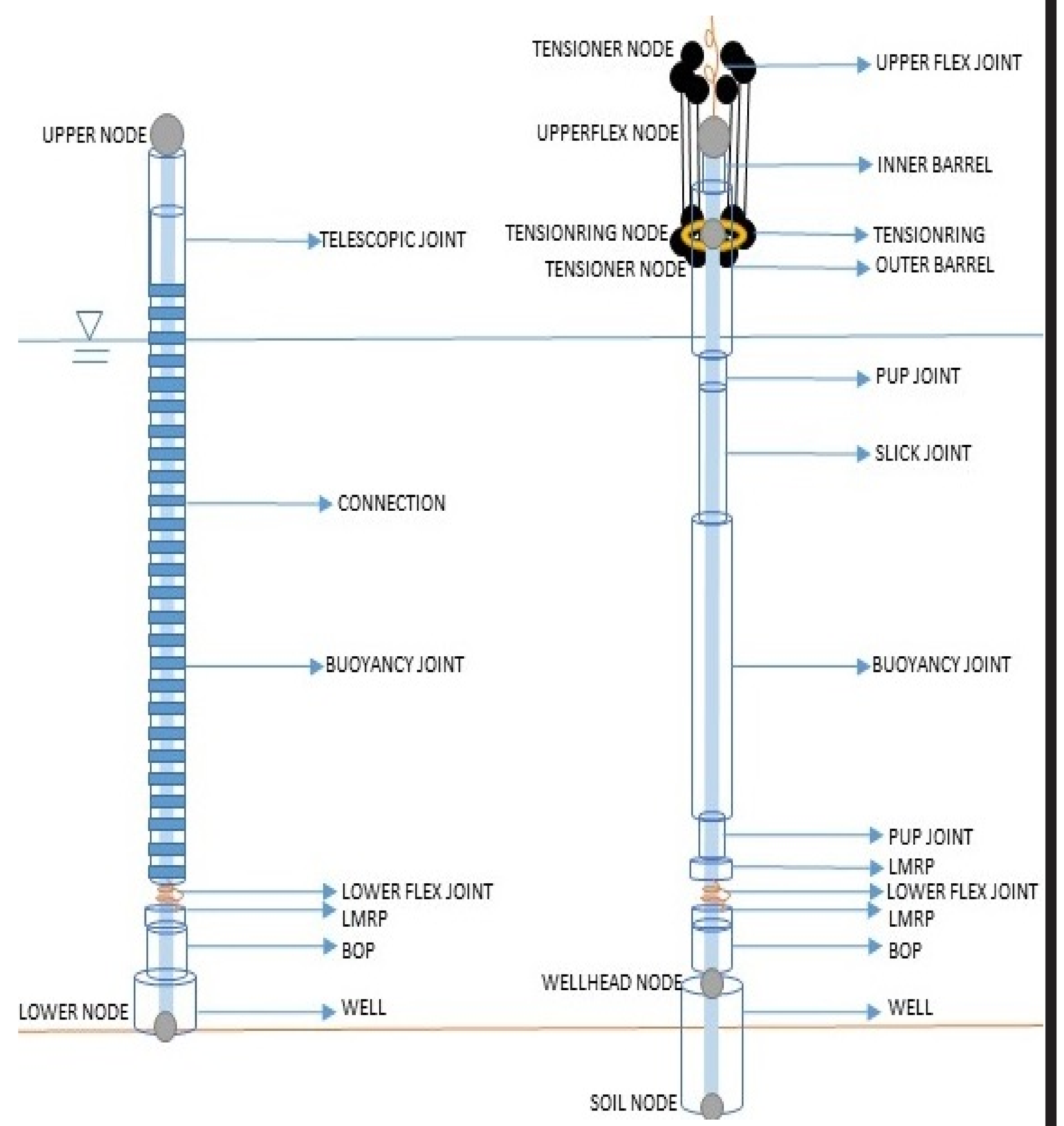
Drilling operations are often performed at 2000m water depth, but the demand for deeper operations are increasing which means the risers must withstand higher pressures and loads. In order to ensure that the system and operation are safe, rules & standards provide recommended methodologies for how to design the systems. There are however, no methodology for the mechanical assessment of marine riser joints.

Objective & Scope

TH HILL, a Bureau Veritas Group's enterprise in Texas are developing a new standard for how to assess riser joints during offshore drilling operations. The scope of this thesis will address part of the development work and focuses on creating a methodology for the mechanical modeling of riser and riser joints with respect to yield and fatigue.

The methodology consist of:

- Simplified model in Flexcom
- Simplified drift loads
- Drift loads from Ariane
- Investigation of current direction
- Investigation of boundary conditions
- Investigation of wave kinematics
- Global load analysis wrt. yield
- Fatigue analysis
- Sensitivity study of SCF for fatigue analysis
- VIV analysis with SHEAR7
- Sensitivity study of SCF for VIV analysis



Methodology

- The model is shown in the picture to the left in the objective & scope section.
- The riser is 2000m and includes a well, BOP, LMRP, LFJ, buoyancy joint and a telescopic joint.

- The buoyancy joint is the longest joint, and is the main focus in this thesis.
- The other components have infinite stiffness.
- The section has 4 lines, and the connections are designed as point masses along the riser.
- The bc. are fixed at the sea bed.
- The bc. at surface are investigated wrt. to the true behaviour of the tensioner system.
- The top tension is found by iteration.

- The location of the riser is the Gulf of Mexico, with limiting conditions of Hs=6m.
- Drift loads form a semi-submersible with DP are included with time histories.
- The limiting condition for the DP system is 20m.
- Current direction, simplified drift loads and wave kinematics are studied.

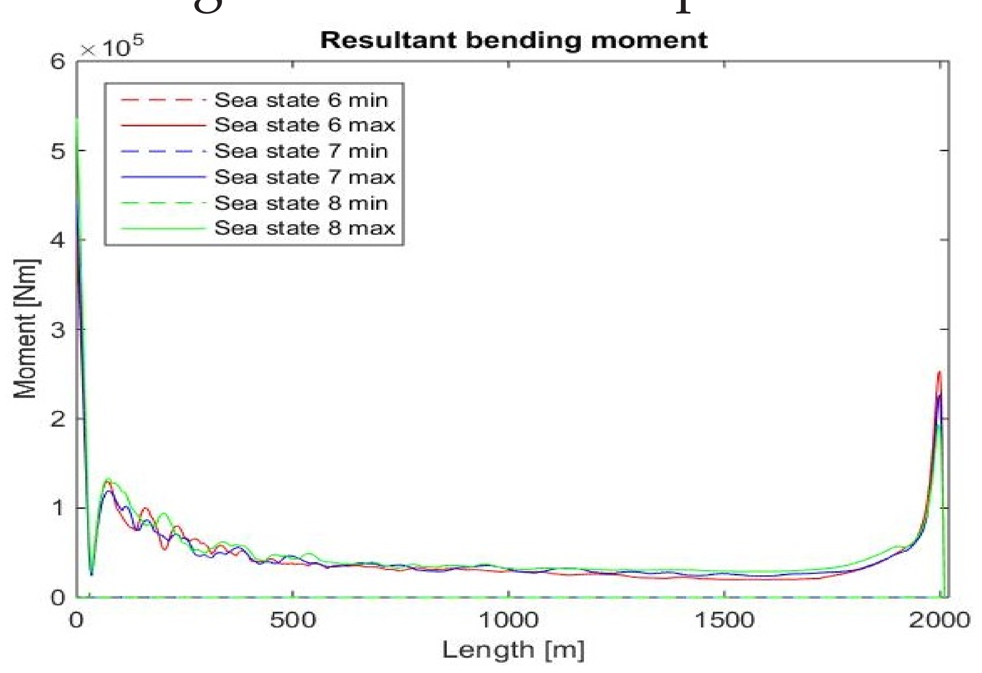
- 1 heading of current, wind and wave is selected in the final global load- and fatigue analysis.
- 1 heading includes 31 sea states, but only 27 have displacement below 20m from the DP.
- The worst sea states from the global load analysis are investigated wrt. yield.
- bending moment, effective tension and shear force are studied for a 3-hour sea state.

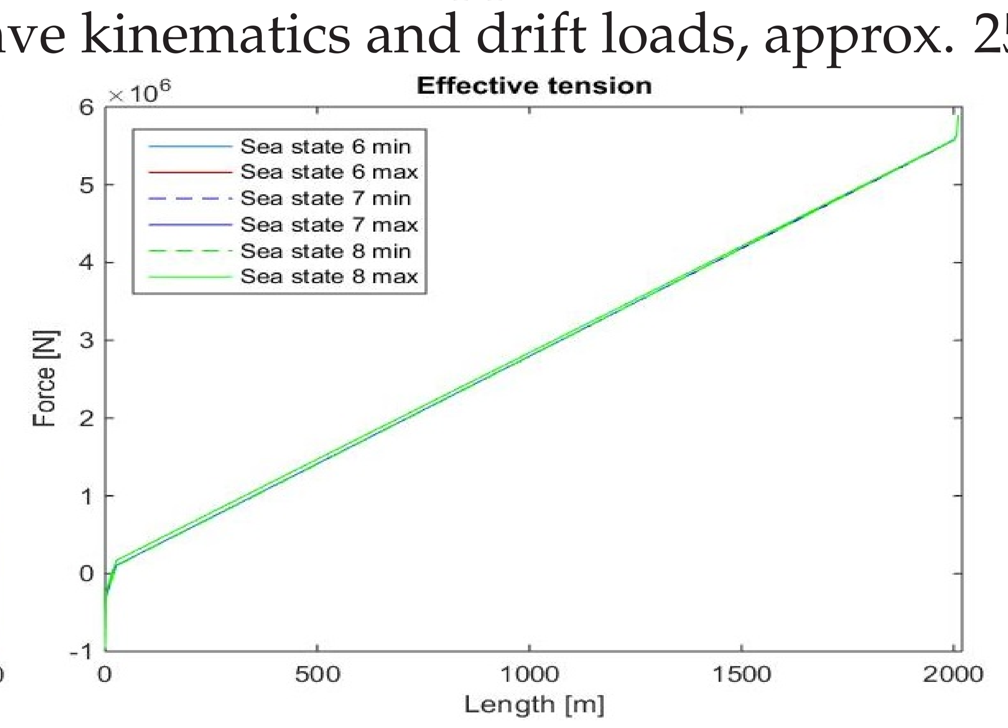
- Fatigue is investigated with 3 cycle counting methods, i.e. rainflow, statistics and spectrum.
- A sensitivity study of the fatigue analysis with SCF 1, 10 and 20 is performed.
- A fatigue analysis with no drift loads is performed.
- A VIV analysis with different SCF is carried out.
- The total damage is calculated from contributions of waves and current.

Results & Conclusion

Results wrt. yield

Sea state 6, 7 and 8 gave the highest moments over the riser.
Highest moment at bottom due to the bc at the seabed, approx. 475kNm
Next highest moment at top due to wave kinematics and drift loads, approx. 250kNm.





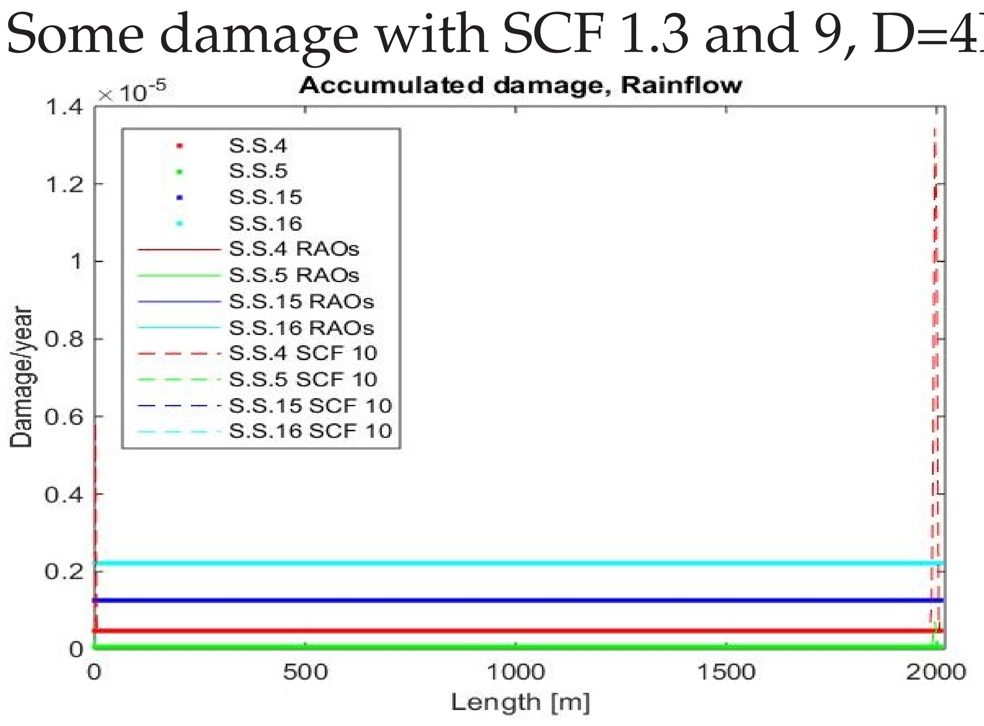
From the left: Resultant moment, 3-hour sea state, effective tension.

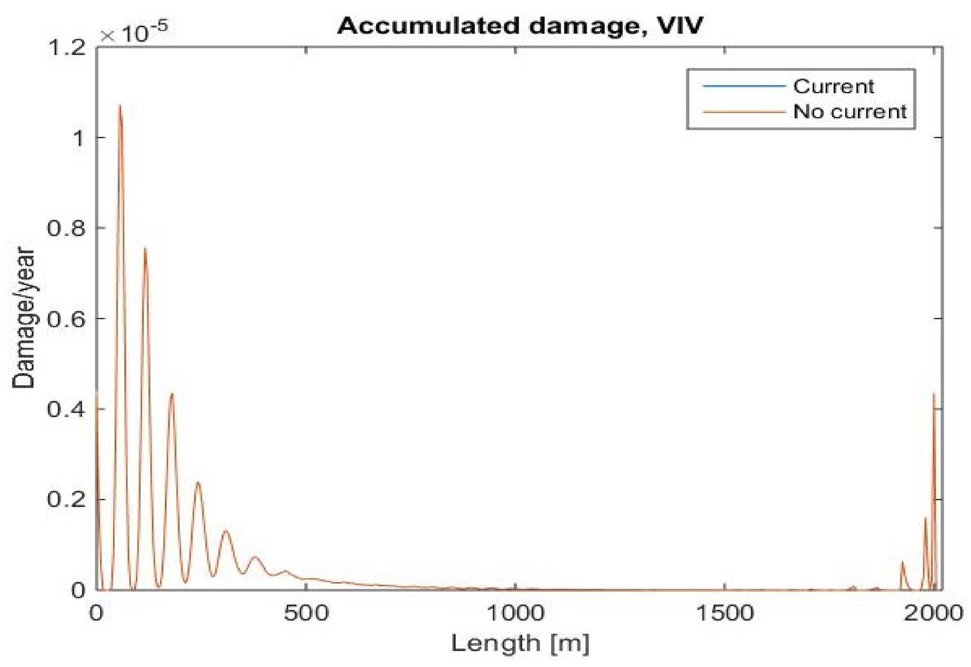
Results wrt. fatigue

Low damage with SCF 1 with rainflow, spectrum and statistics.
Some damage with SCF 10 and 20.
Sea state 4, 5, 15 and 16 gave the highest damage.

- Sea state 4: D=5.4E-9
- Sea state 5: D=3.0E-10
- Sea state 15: D=1.1E-9
- Sea state 16: D=1.1E-9

Low damage from VIV analysis, approx.D=1.1E-5
Some damage with SCF 1.3 and 9, D=4E-5 & D=0.47





From the left: Damage from analysis w/SCF 1 & 10 & no drift forces, VIV analysis with SCF 1