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5th EMship cycle: September 2014 – February 2016

Master Thesis

Fatigue Analysis of a Tension Leg Platform: Fatigue Life Improvement

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Reviewer: Prof. Patrick Kaeding, University of Rostock

Szczecin, February 2016

DNV GL Internship

- Office in Gdynia
- Advisory Maritime & Offshore Department
- Supervisor: Tomasz Msciwujewski, Principal Engineer

Thank you for supporting me in my time of need

Wave loads on offshore structures

Methodologies proposed

- Design details to reduce stress and strain concentrations.
- Avoid welding in areas where low ductility or fracture toughness steel is (e.g. K areas of wide flange members, corners of hollow steel sections).
- Provide adequate protection from the environment (e.g. provide measures to prevent galvanic action between dissimilar metals).
- Increase the thickness of the critical area.
- Improve surface conditions.
- Improvement of fatigue life by fabrication: Grinding, TIG dressing and Hammer peening.
- Use of high-performance alloys resistant to corrosion fatigue.
- Etc.

Objective

Quantify fatigue life improvement of certain structural modifications for TLP´s

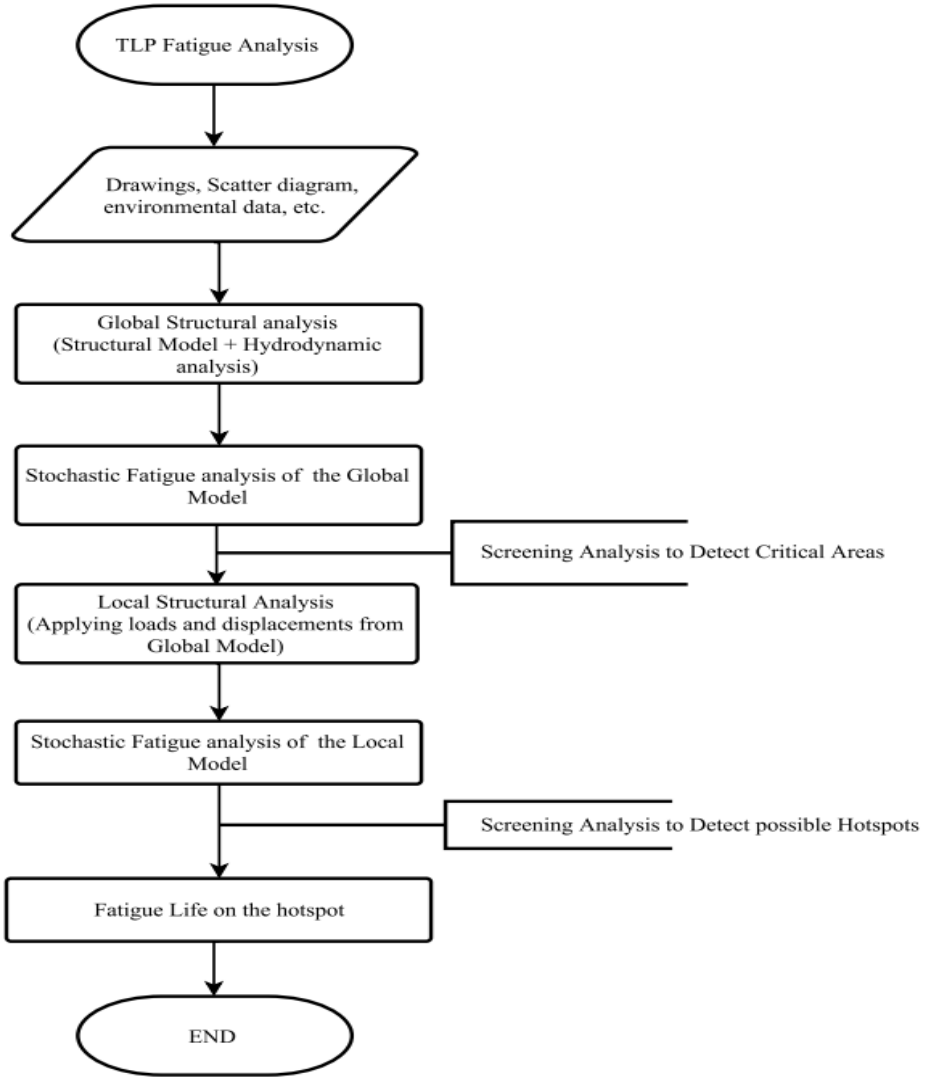
Motivation

Perform lower number of design iterations

Agenda

1. Methodology
2. Scope of work
3. Case of study
4. Analysis
5. Results
6. Conclusion
7. Future work

1. Methodology



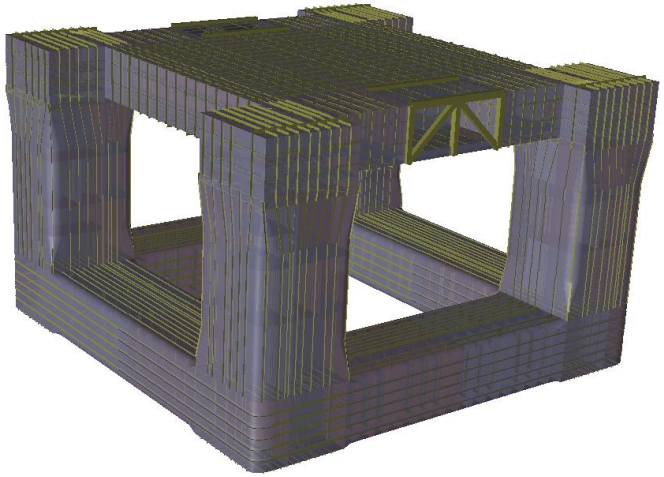
2. Scope of work

- Structural model developed by finite element method
  - Global model
  - Local model
- Hydrodynamic analysis performed in the frequency domain:
  - 3D panel method to evaluate velocity potentials and hydrodynamic coefficients
  - First order velocity potential -linear wave loads
  - Drag forces are determined using Morison formulation
- Quasi-static analysis of the structural response for the global and the local models
- Stochastic linear fatigue analysis based on S-N data
- Effects of thickness´s increments in critical areas
- Improvement of fatigue life by fabrication: Grinding, TIG dressing and Hammer peening.

3. Case of study

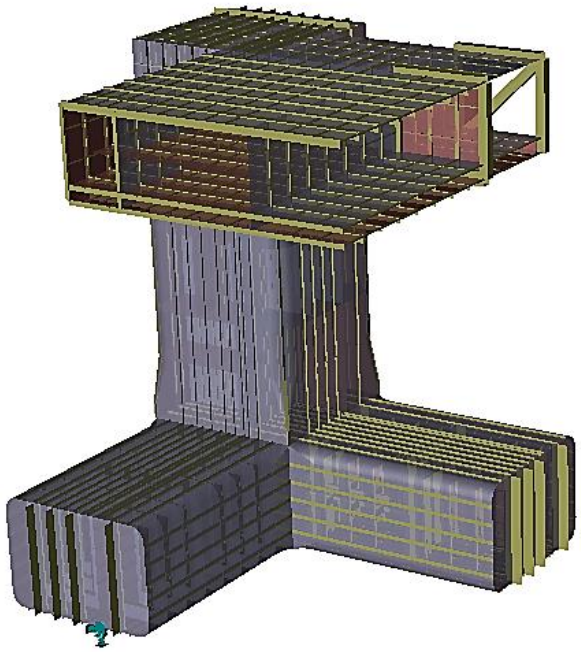
- Full-size TLP composed by four columns connecting pontoons
- Operational area: North Sea, 327.5 m of water depth
- Structure main particulars

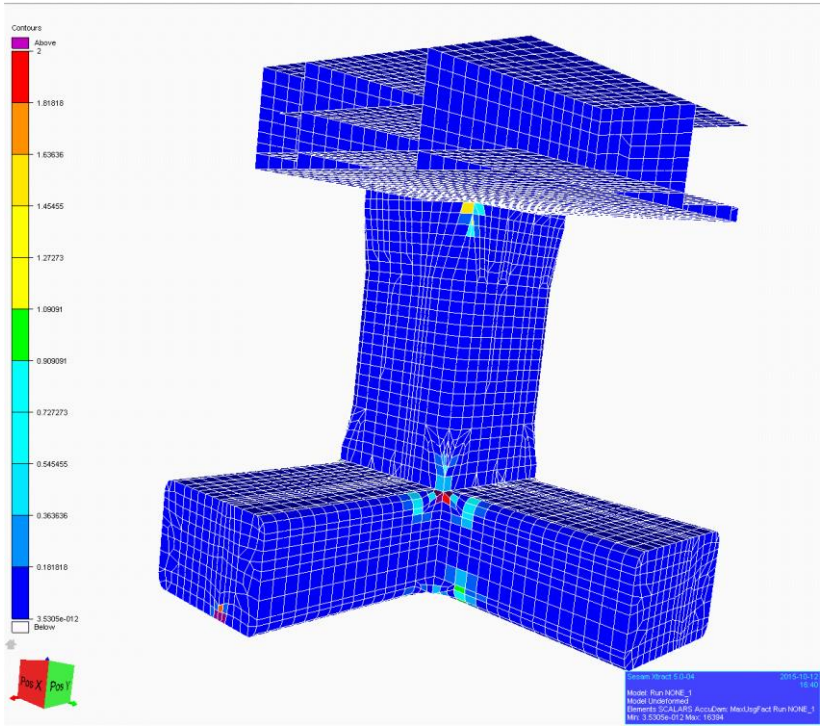
Length overall	85 m
Beam	85 m
Depth	54 m
Draught	27.5 m
Gross Tonnage	59517 t



4. Analysis

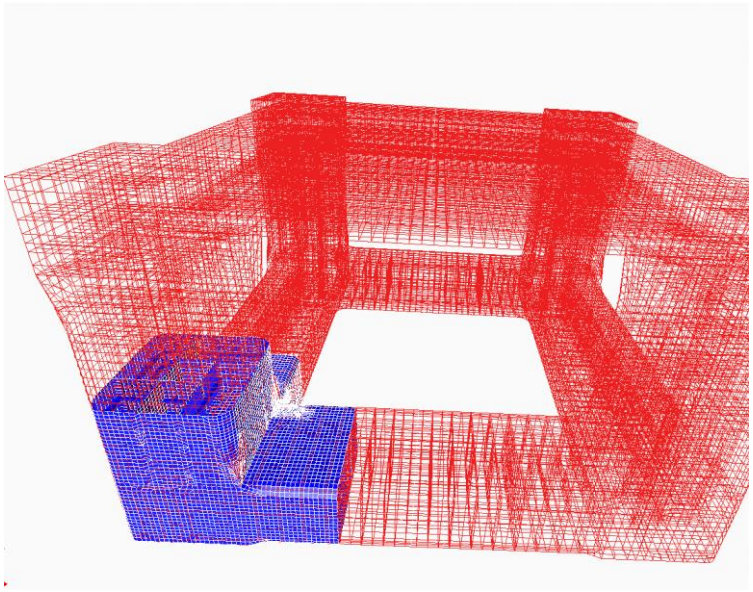
- The structure present a symmetry respect the axis X and Y
- Results are presented in form of usage factor

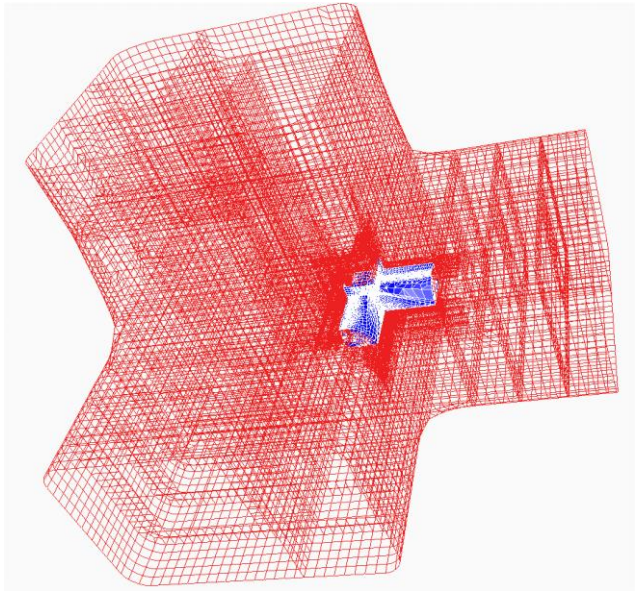




4. Analysis

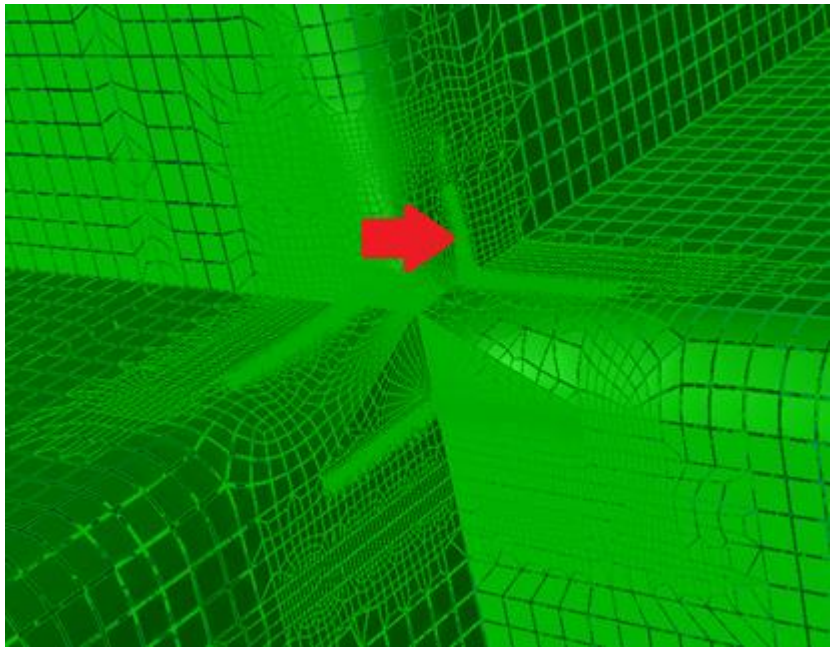
- Critical areas correspond to:
  - Hull and deck connections
  - Column to deck connections
  - Column to pontoon connections
- Considering the most critical area, local model was and developed

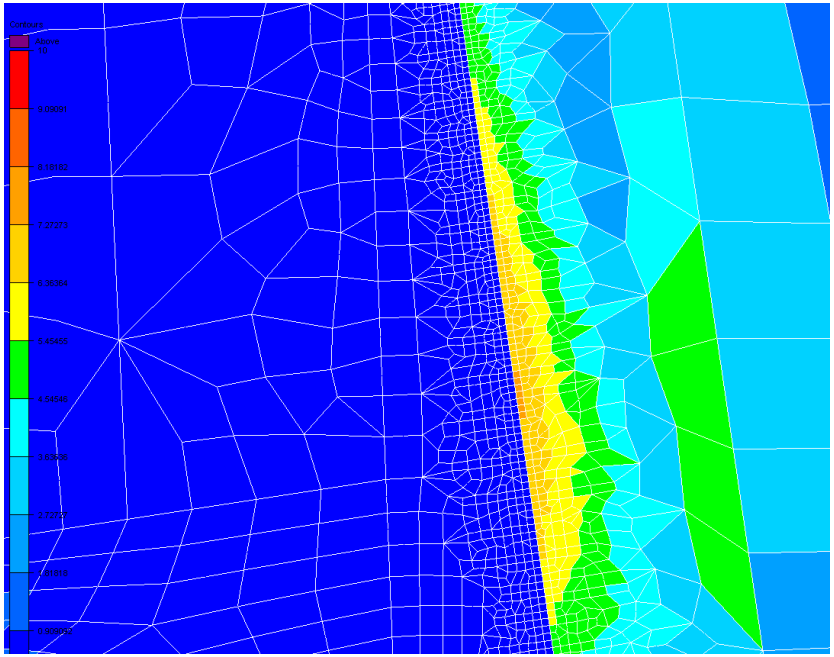




4. Analysis

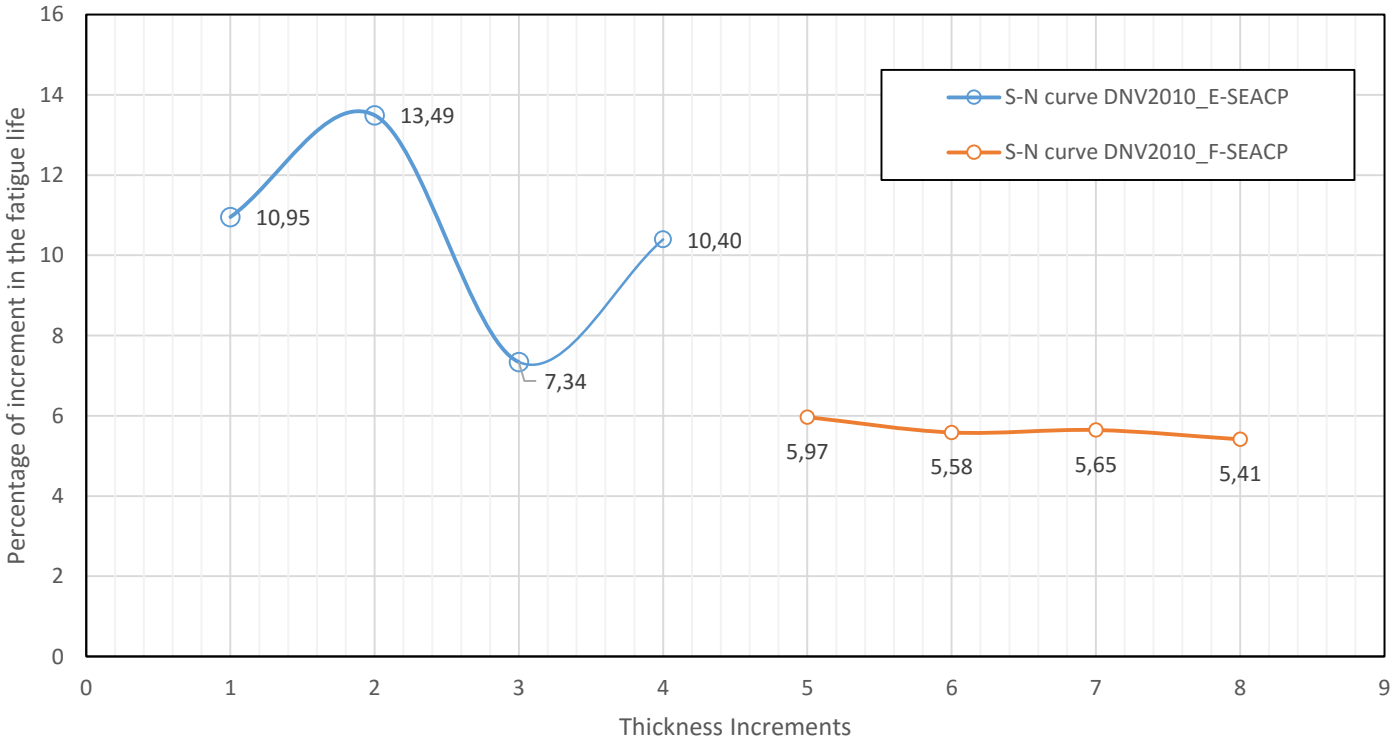
- Identification of possible hot spots in the critical area
- Mesh size t x t
- Effective Notch Stress





5. Results

Increment in the fatigue life for the different thickness of the critical area.



6. Conclusions Future work

Conclusions

- The increment of thickness could be contemplated as a solution in cases were the TLP design is close to reach the design fatigue life, expecting increments of the 5 % range.
- Improvement of F.L by fabrication. Use of these treatment could look like a fast solution to the design problems, but should be avoided except for punctual cases where the area of the hotspot could be easily submitted to grinding treatment.

7. Future work

- Validation of results
- Analysis of more TLP structures
- Use of Non-linear models to represent the wave forces
- Performance of High and Low frequency analysis
  - Springing and Ringing
- Consideration of further methodologies

Thank for your attention

Adrian Hita