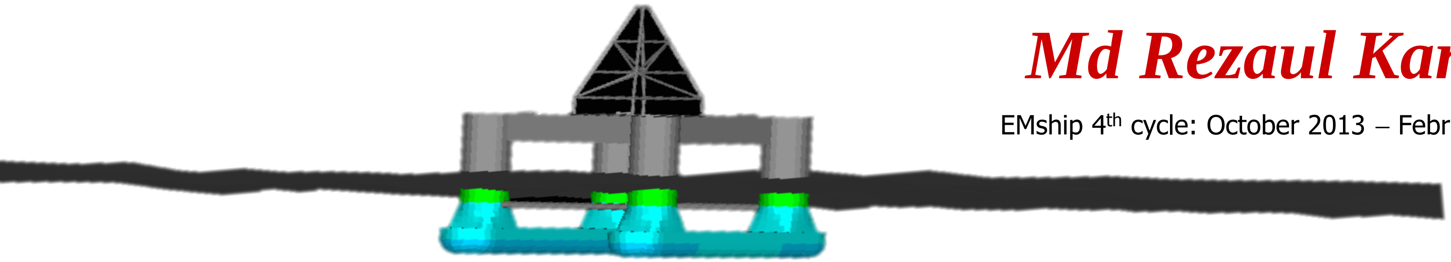


Md Rezaul Karim

EMship 4th cycle: October 2013 – February 2015

Master Thesis

Fatigue Analysis of Offshore Drilling Unit

Supervisor: Professor Maciej Taczala, West Pomeranian University of Technology, Szczecin, Poland
Internship Supervisor: Mr. Tomasz Msciwujewski, DNV-GL, Gdynia**,** Poland
Reviewer: Prof. Hervé Le Sourne, ICAM, France

Szczecin, February 2015

AGENDA

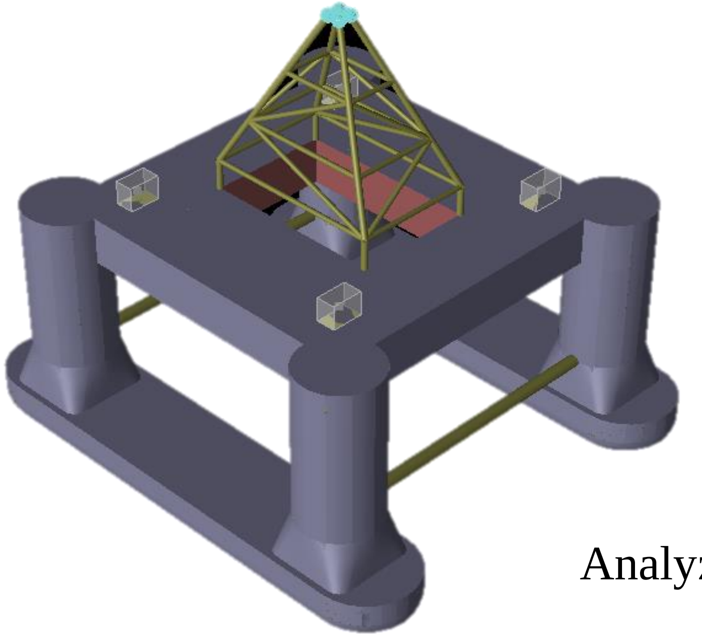
- Introduction
- Objective
- Methodology
- Analysis
- Conclusions
- Future Development

- Drilling extended further offshore into deeper water to access additional energy resources
- structures are largely exposed to stresses- induced by time variation- generated principally by sea waves
- Challenge to ensure integrity and structural safety of the offshore platform in extreme environment

Drilling in Deep-Water

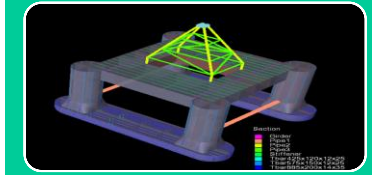
Wave induced Loads

- **Global Fatigue Analysis**
  - 3D FE- Modelling
  - Hydrodynamic Analysis
  - Structural Analysis
  - Identify Fatigue Critical Locations



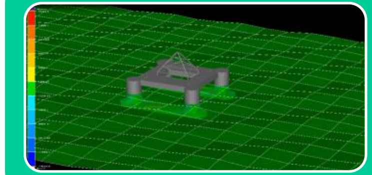
Analyzed Drilling Unit

Parameter	Technical Data
Characteristic Length	80.6 m
Height of Pontoon	7.5 m
Width of Pontoon	16 m
Height of Column	33.5 m
Diameter of Column	12.9 m
Height of Deck	8 m
Spacing of Columns	54.72 m



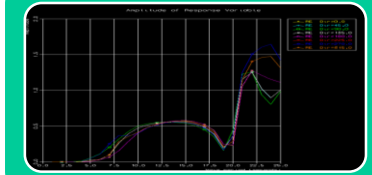
3D-Modelling

- Sesam-GeniE



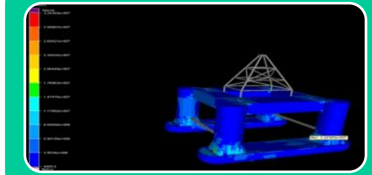
Hydro-dynamic Analysis

- HydroD-Wadam



Global Motion Response

- Postresp



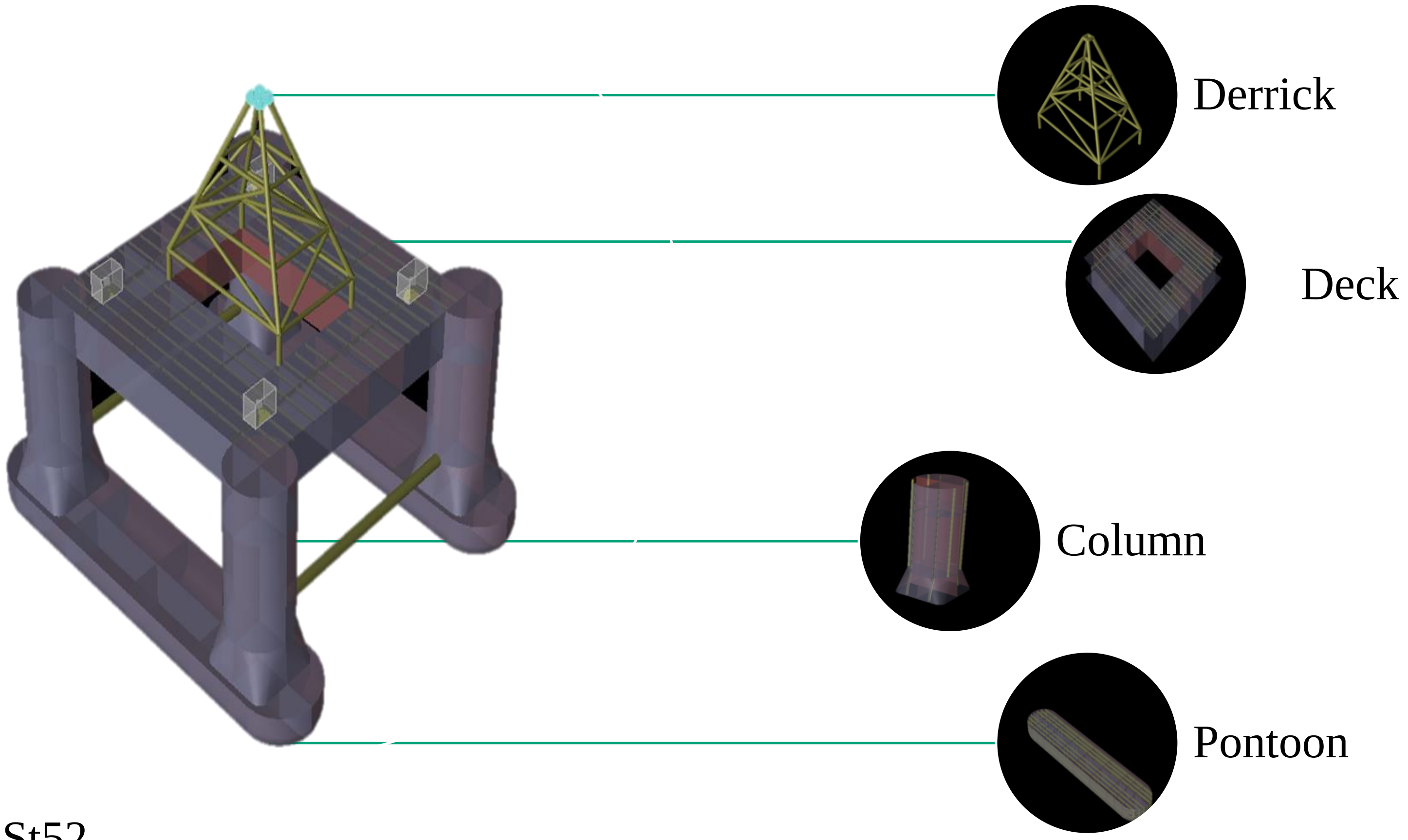
Structural Analysis

- Sestra

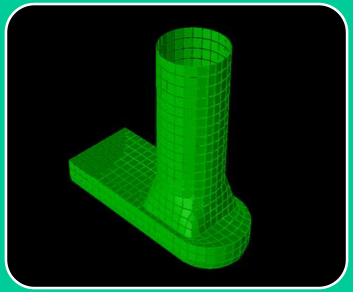
Global Fatigue Analysis

- Stofat

Key Sub-Assemblies: Pontoons, Columns, Deck and Bracing

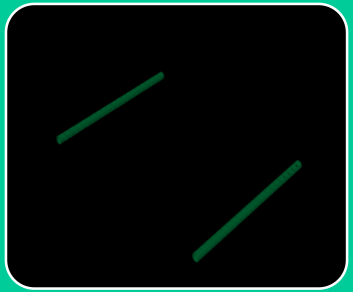


Material: St52



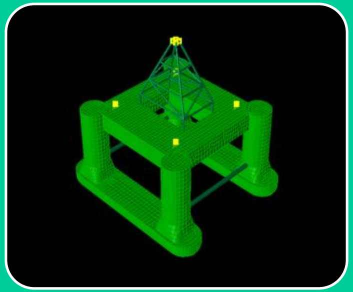
Panel Meshed Model

- Wet Surface
- Potential Theory



Morison Meshed Model

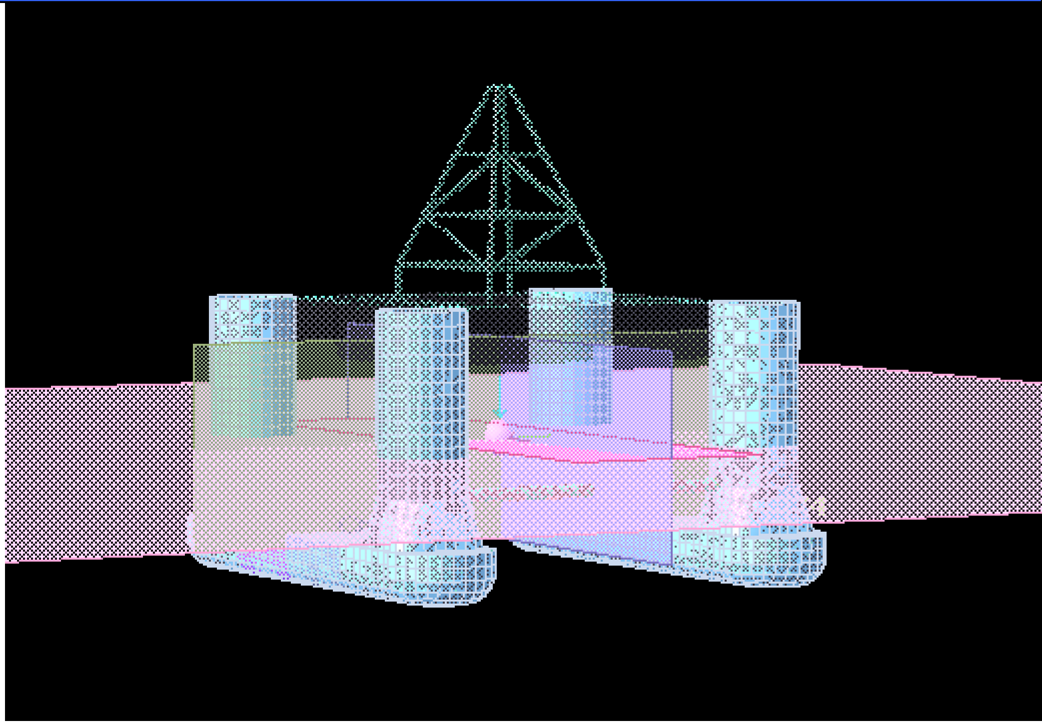
- Beam Elements
- Morison Theory



Structural Mesh Model

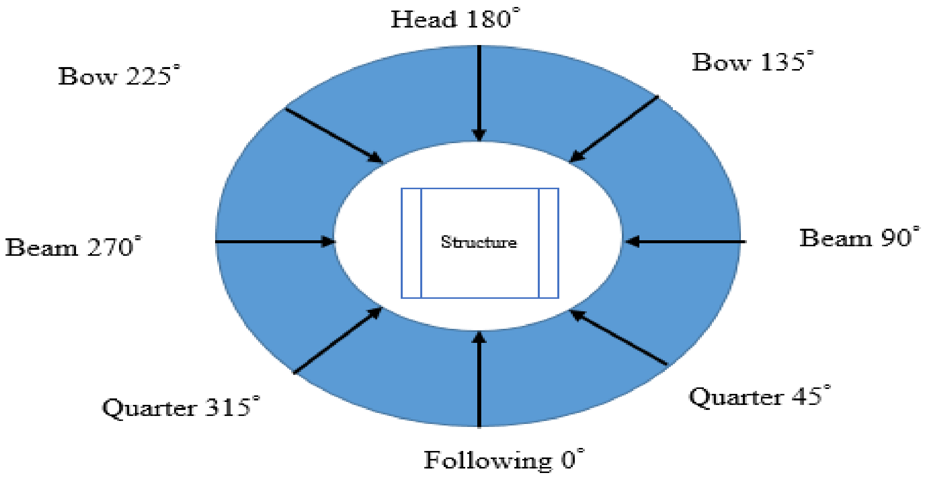
- All structural Components
- Panel+Morison+Deck structure

Hydro-Model to compute Wave Loads



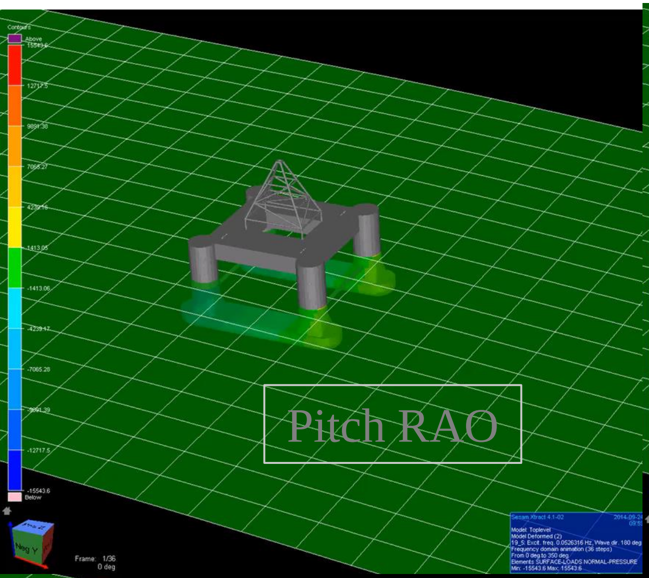
Analysis Setup

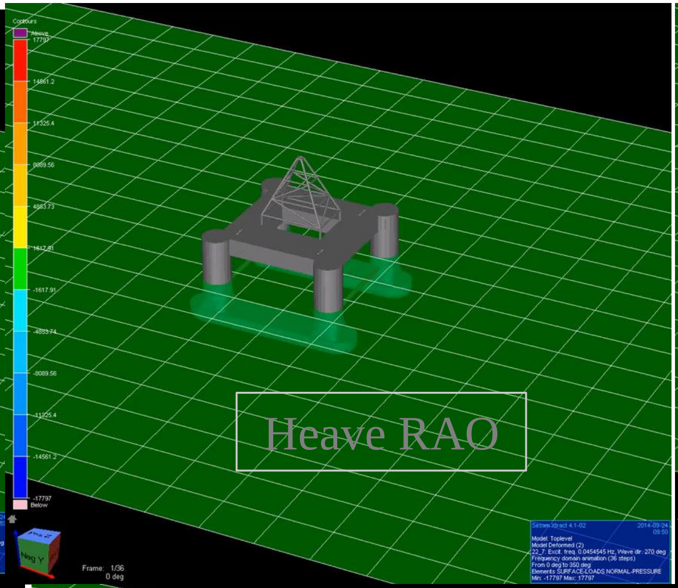
- Direction 0 to 315 with step value 45
- Period is set between 0.5 to 25 sec
- Bretshneider spectrum with Hs=13.6m and Tp =16 s
- Design wave -North Sea with 100 year return period
- Spreading function of exponent 2 =short crested sea
- The water depth=300 m and Operating Draft 13.5 m

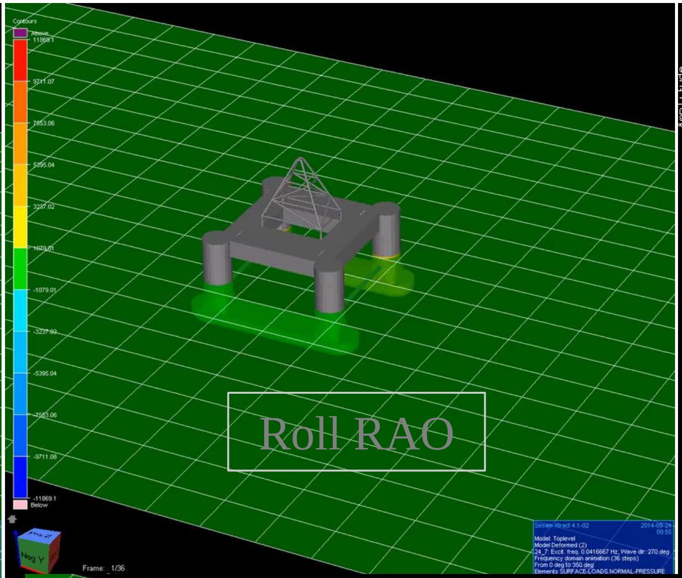


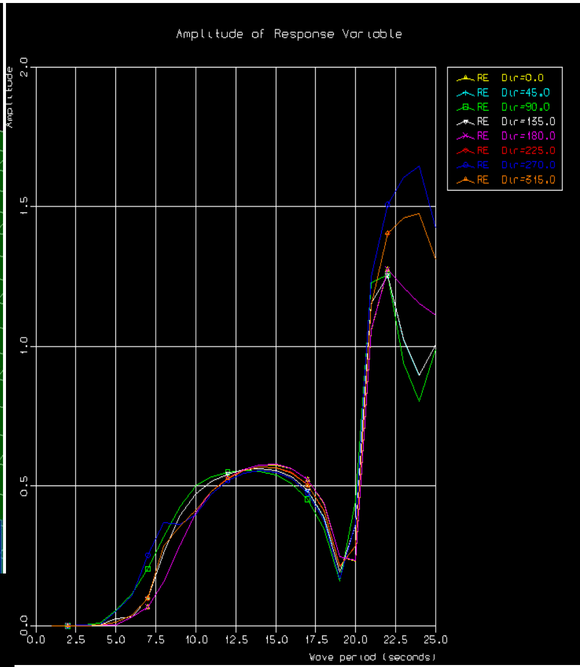
Peak Response Range f= 0.041-0.047 Hz or T= 21-24 sec

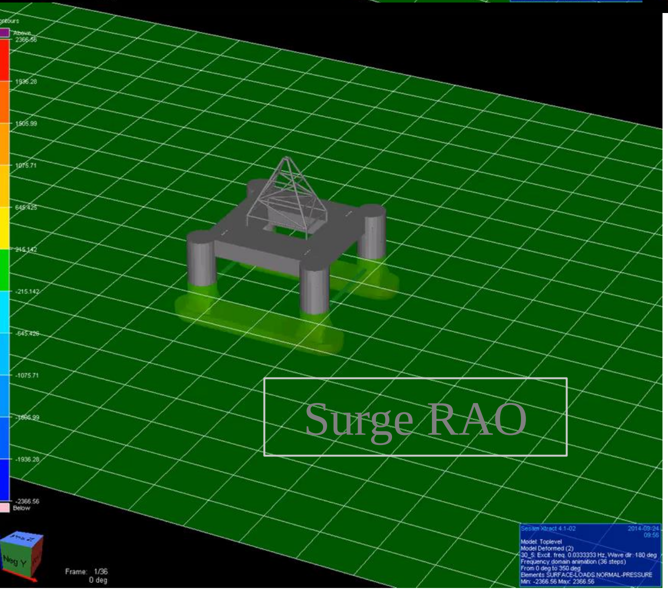
Worst direction– 270 and 180 degree

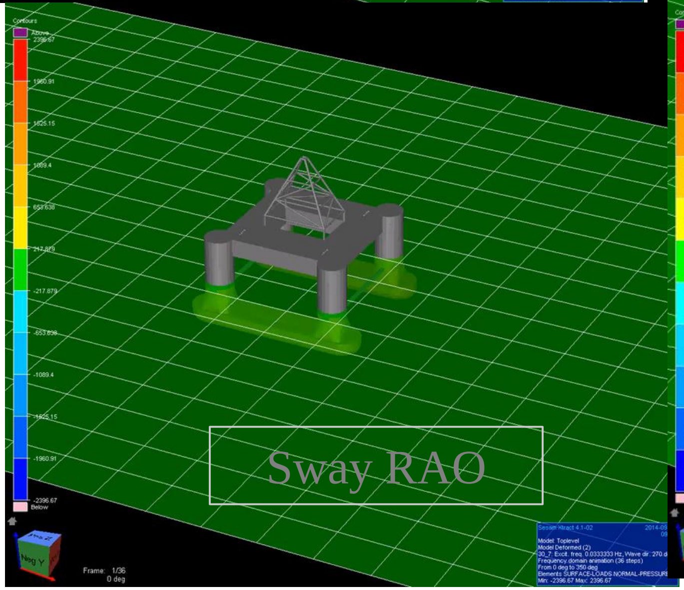


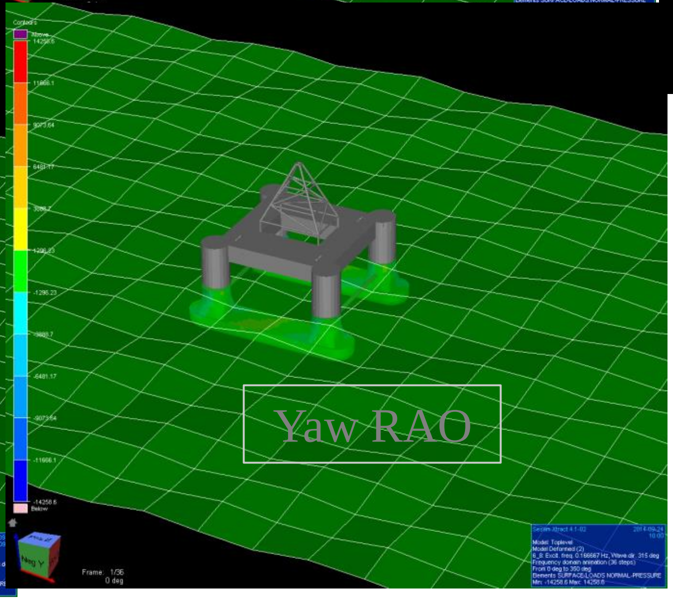








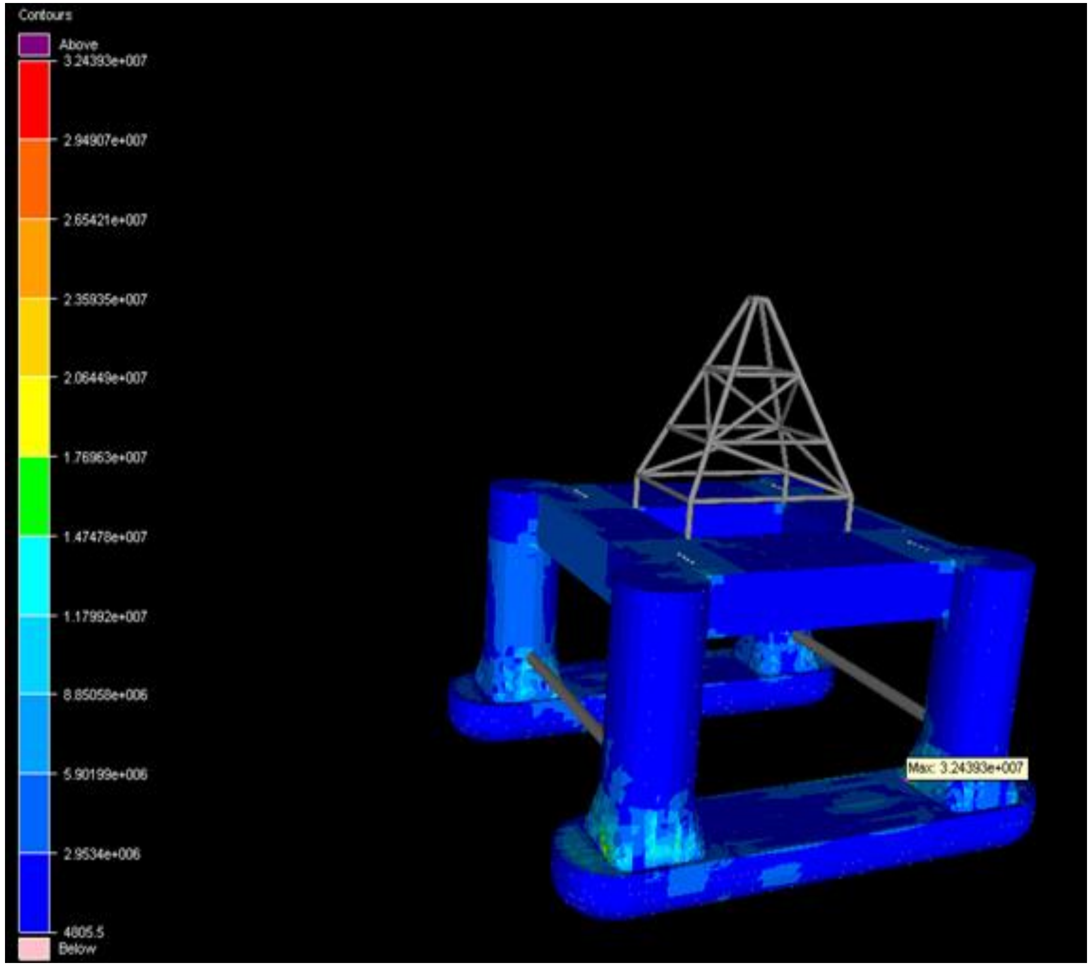




Hydro-dynamic load’s transferred to Structural Model

Load cases :

- Self-weight
- Equipment’s
- Hydrodynamic loads
- Mass points on Derrick
- wind and current loads (negligible)



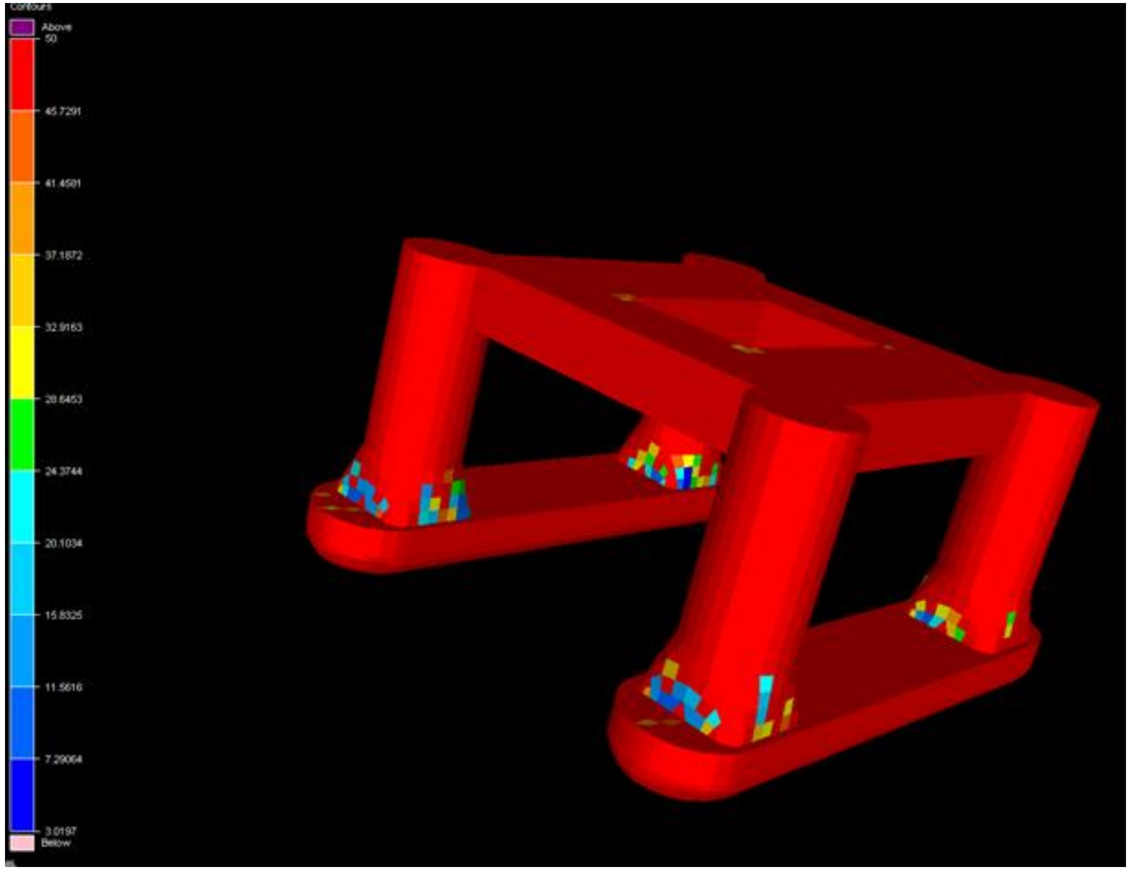
Critical Location: Pontoon-column connection (Max.Von-Mises Stress)

Spectral Fatigue Analysis

Inputs

- SN-Curve (DNVC-I)
- Scatter Diagram (North Atlantic)
- Response Spectrum

Connections	Fatigue Life (Years)
Deck to Column	Above 50
Column to Pontoon	Around 30
Column to Brace	Above 50
Deck to Derrick	Around 40



Fatigue Life (years)

- Column to pontoon connections showed the worst fatigue life.
- The worst wave direction is found at 270 and 180 degrees.
- Maximum stress due to wave induced loading occurs in frequency range f= 0.041-0.047 Hz or T= 21-24 sec
- Heave is most significant motion response for the structure

- Analysis for local models can be performed
- More detailed non- linear finite element analysis and consideration of mooring lines & riser system can be done
- Other sources of excitation could be taken into account
- The effect of the weld can be considered

- *Guidelines to Assess High-Frequency Hull Girder Response of Container Ships* by DNV-GL, 2014
- "*Analysis and Design of Ship Structure*", Chapter 18, Philippe Rigo and Enrico Rizzuto
- "*Probabilistic Fatigue of offshore structures*", G. Sigurdsson, University of Aalborg, Sohngaardsholmsvej 51, DK-9000 Aalborg, Denmark

THANK YOU