Design study for the transportation of heavy cargo on Hatch cover of a MPV

EMship Master Thesis

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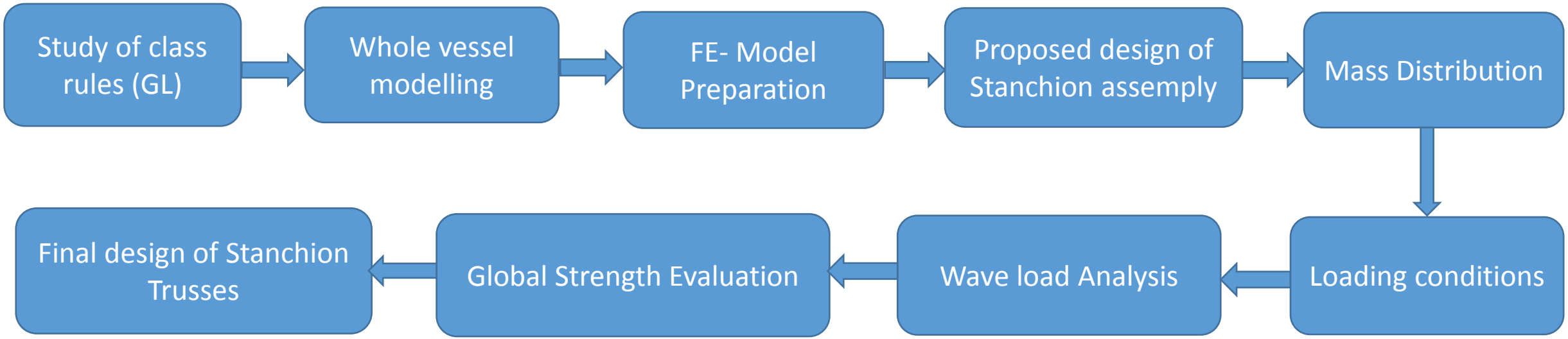
Background

- PK116
- Offshore equipment
- Scandinavian region
- Good Performance

Goal

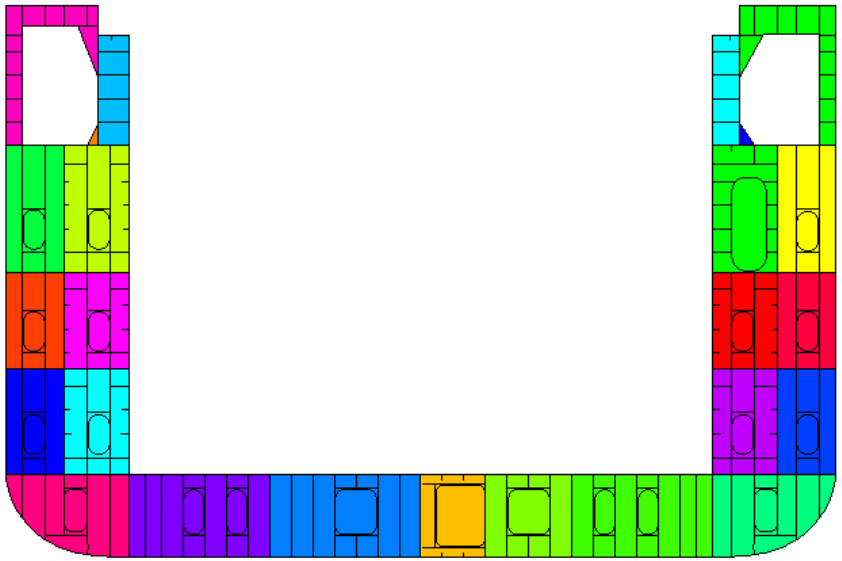
- To Propose a design for the stanchion(pillar) assembly between weather deck and tanktop

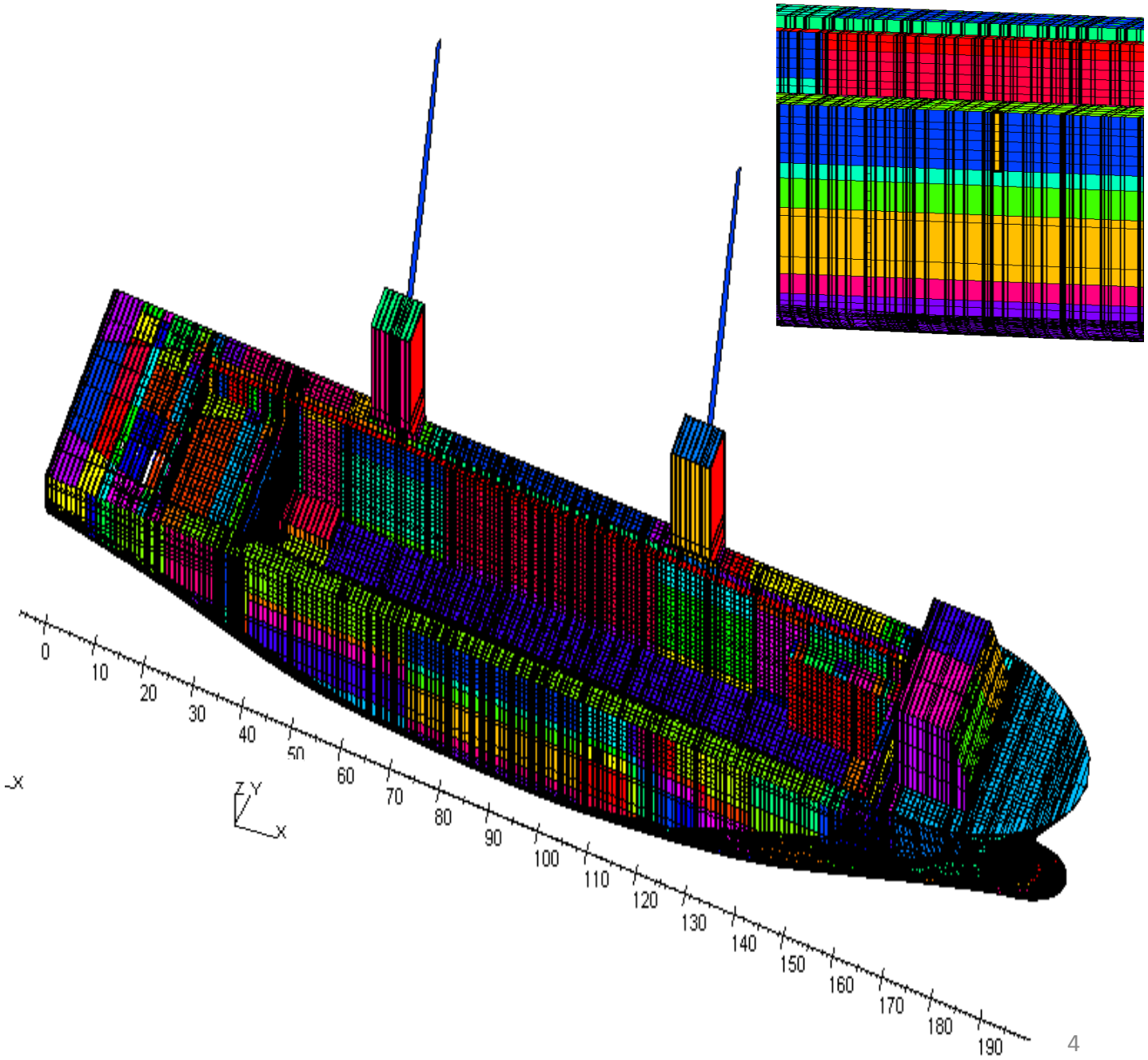
Overview


Study of class rules (GL)
Whole vessel modelling
FE- Model Preparation
Proposed design of Stanchion assemply
Mass Distribution
Loading conditions
Wave load Analysis
Global Strength Evaluation
Final design of Stanchion Trusses

Structural Modelling

- GL-Poseidon
- Material Properties
- Major Functional element
- Holes and cutouts



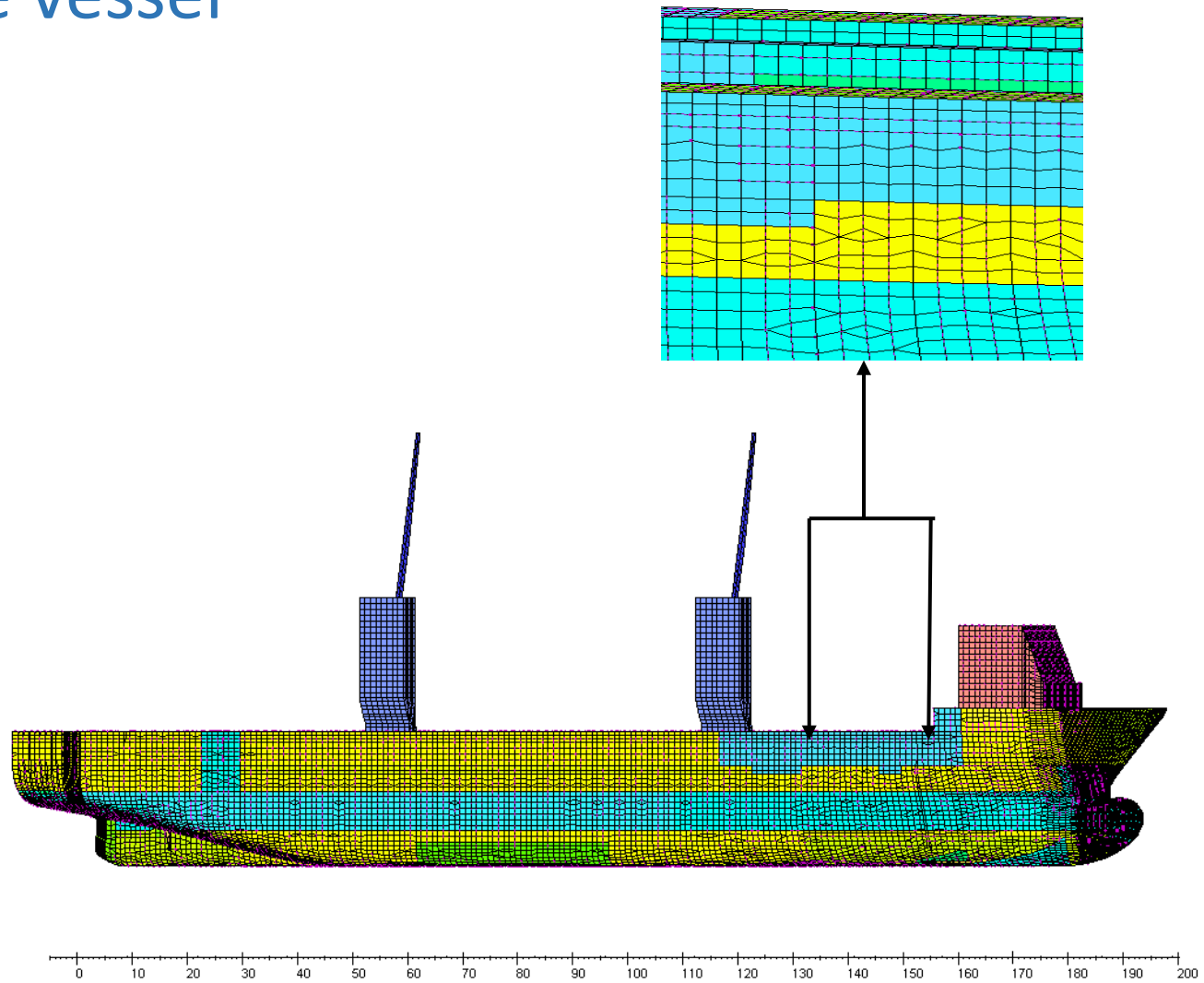


FE Model Preparation – Whole vessel

- FEA software - Poseidon
- In Cargo hold region

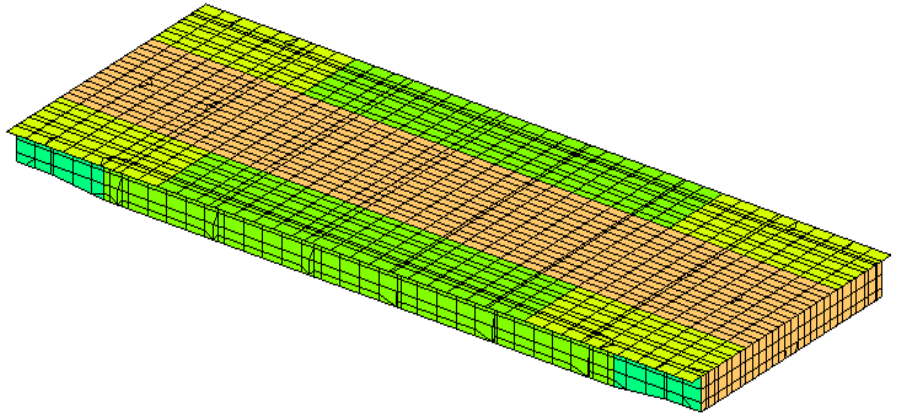
  - Minimum mesh size – 350 mm

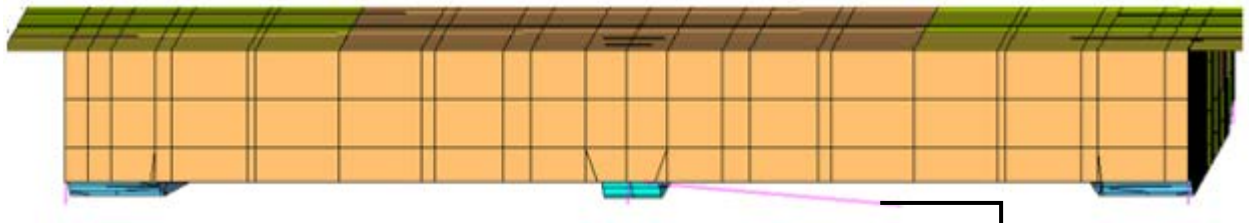
  - Maximum mesh size – 700 mm



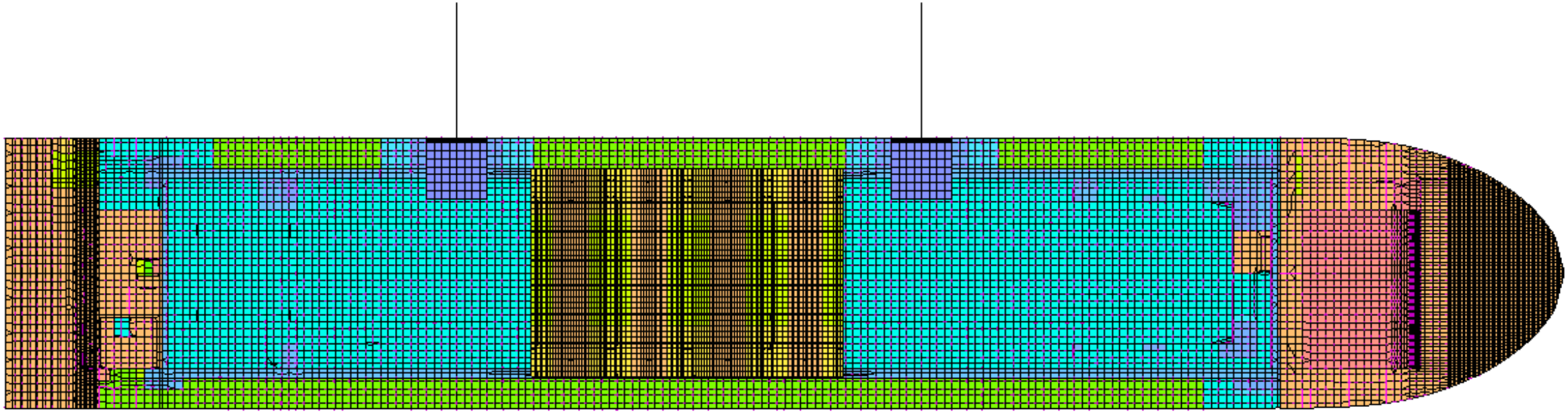
No. of Nodal points - 131676

Hatch Cover FE Model Preparation





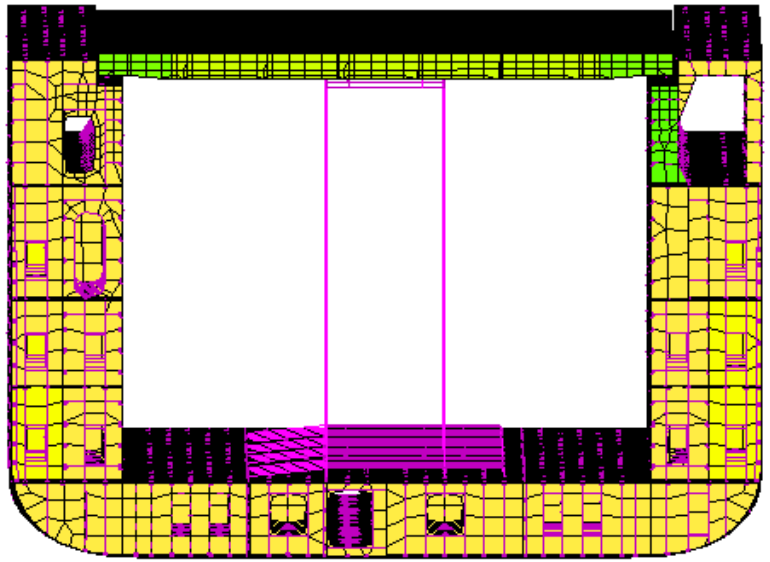
Hatch cover securing in x direction at port side

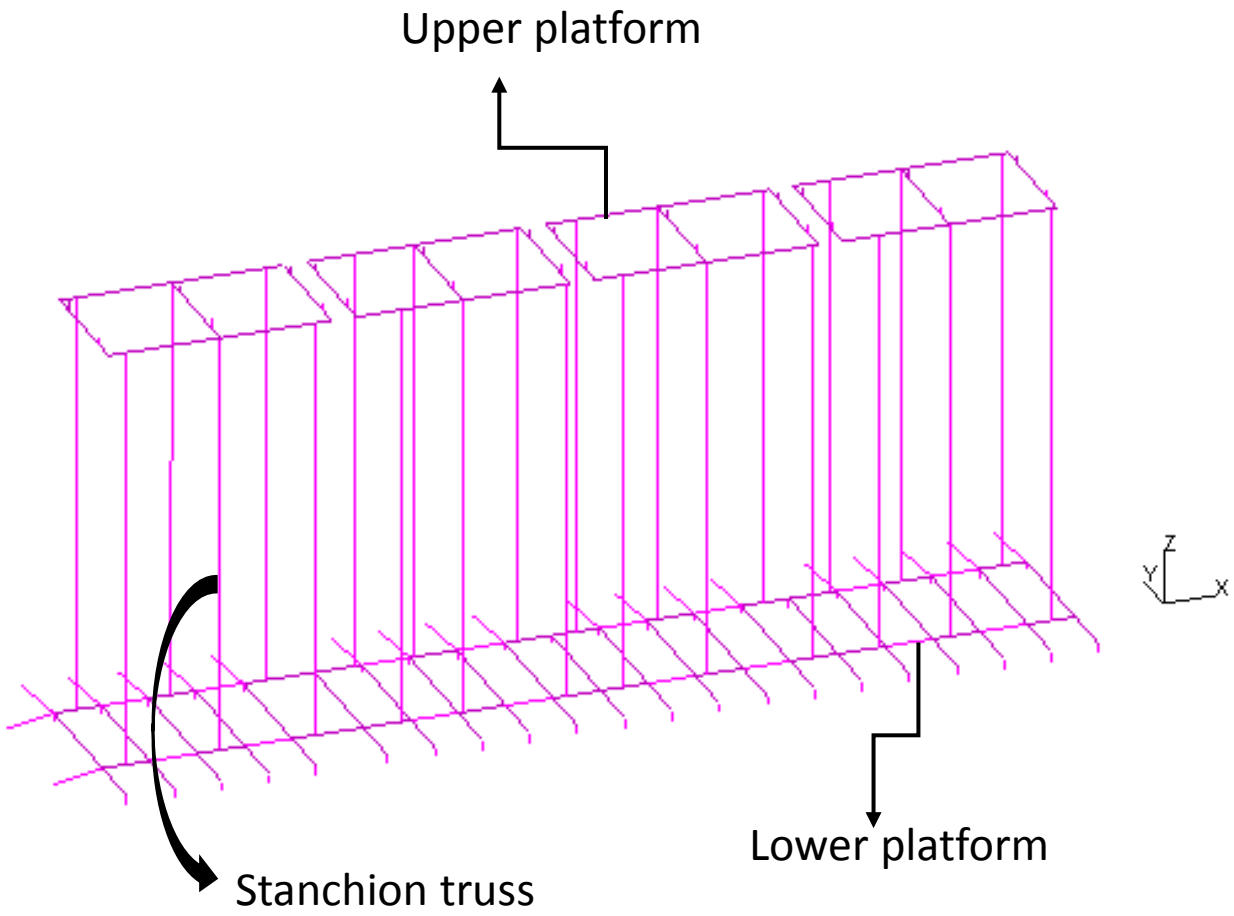


Mesh size – 500 mm

Proposed design of Stanchion Assembly

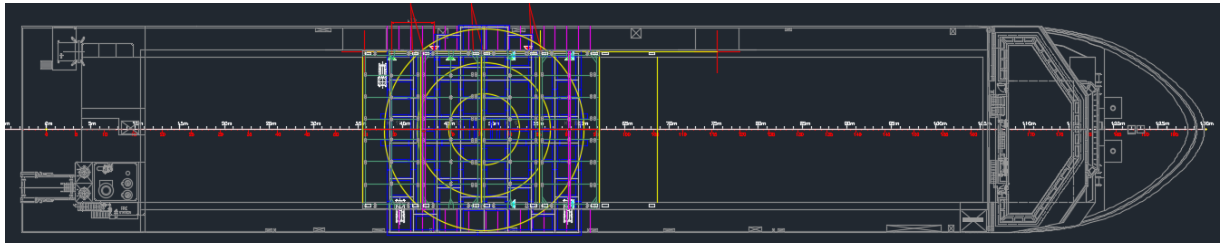
- Between Hatch cover and tank top
- Material properties
- Stanchion (pillar) Trusses
- Upper and lower Platform

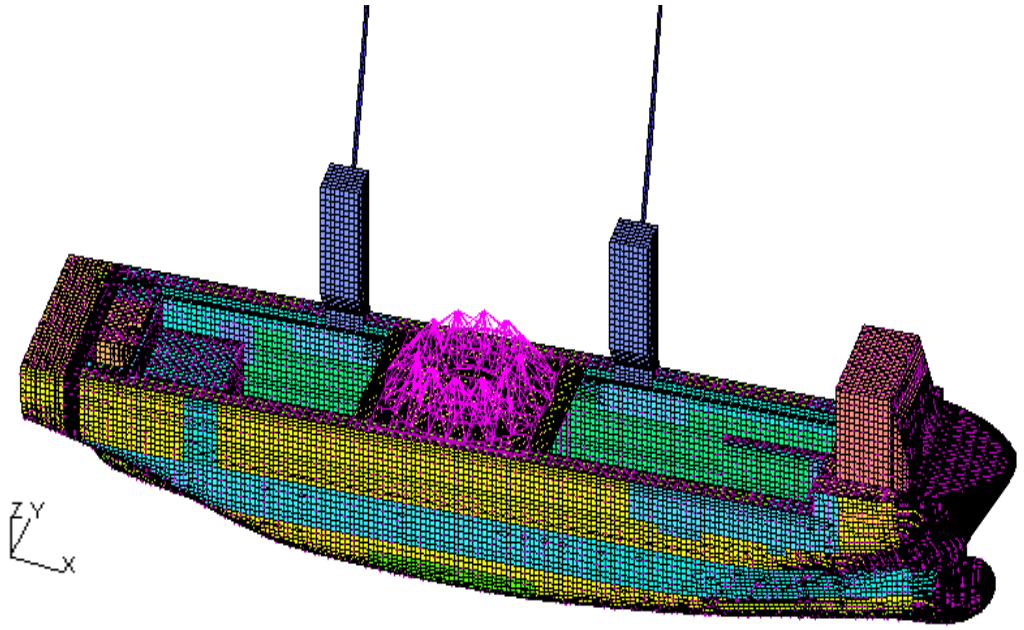


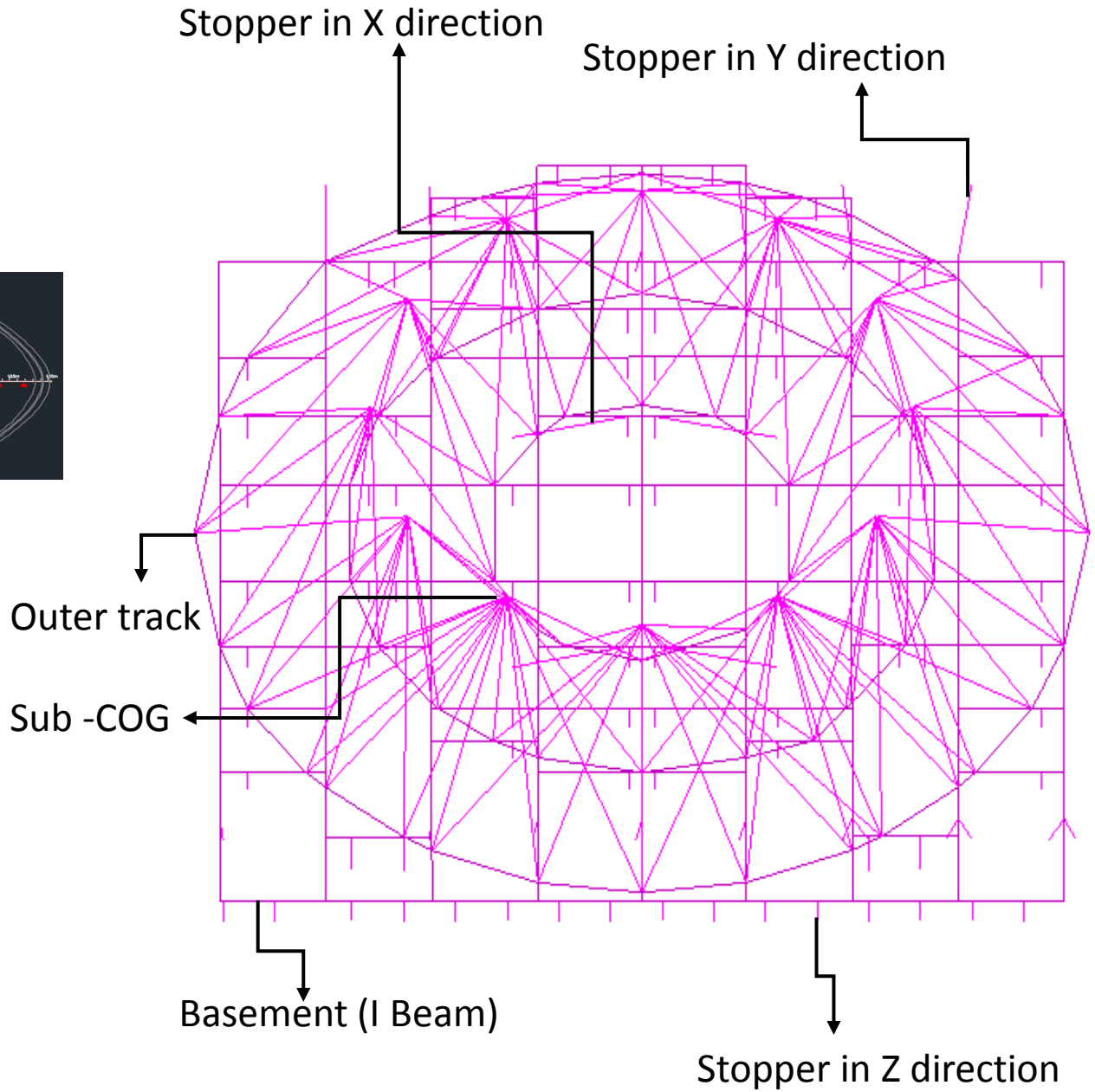


Modelling of Cargo/Auxiliary System

- Carousel Assembly

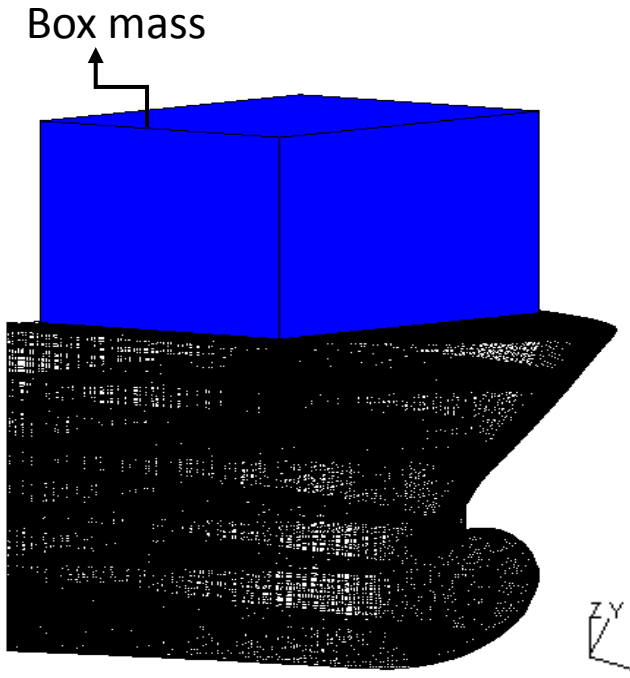


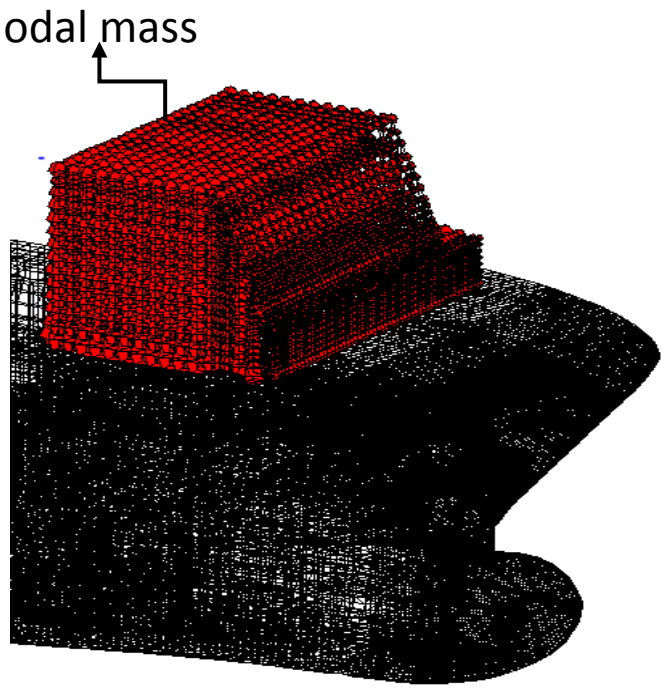


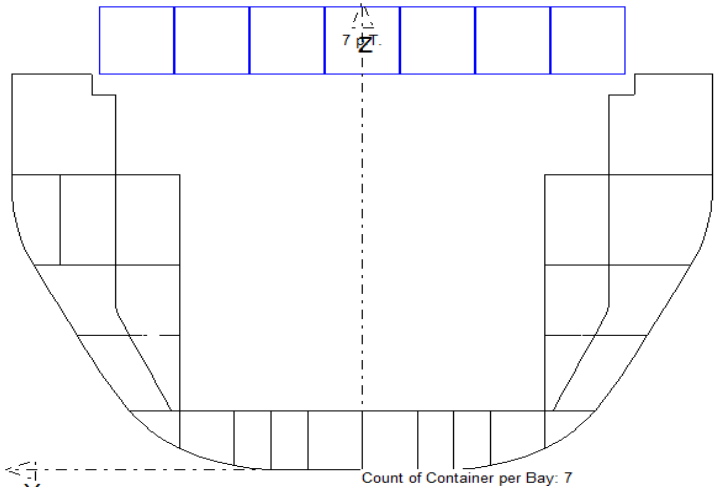


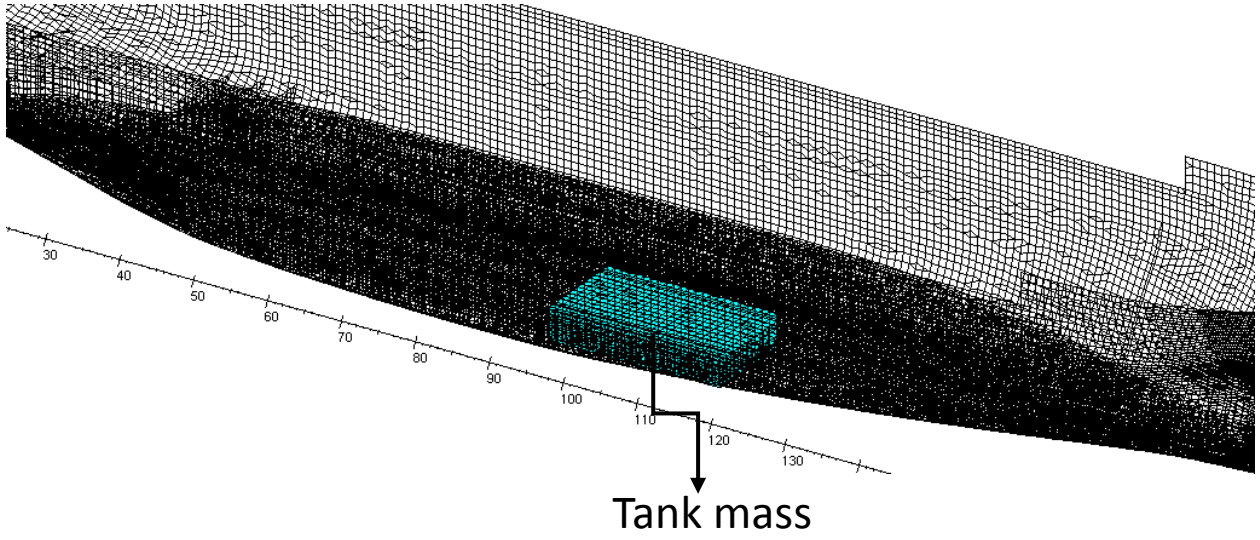
Mass Distribution inside vessel

- GL- Shipload
- Box mass distribution
- Nodal mass distribution
- Tank mass distributuon
- Container mass





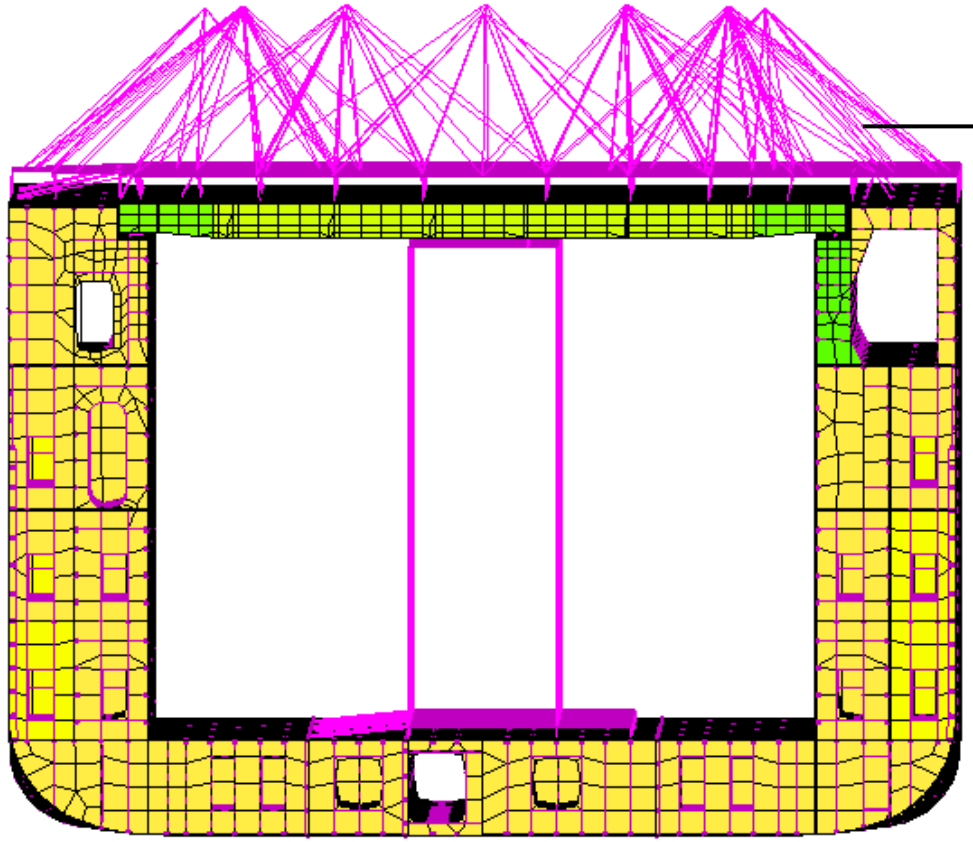


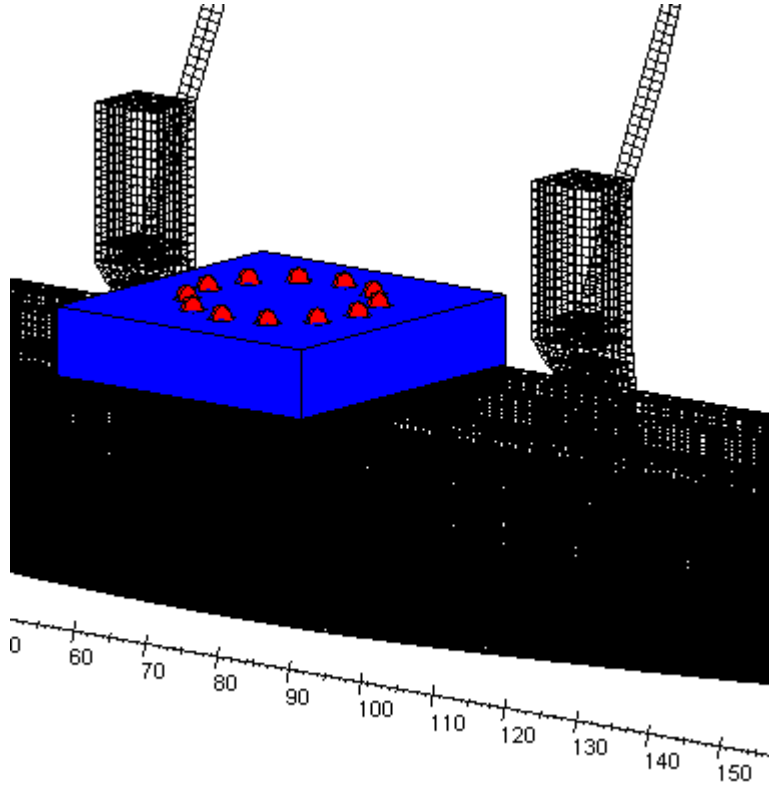


Mass Distribution on Top of Hatch cover

- Heavy cargo mass on Hatch cover

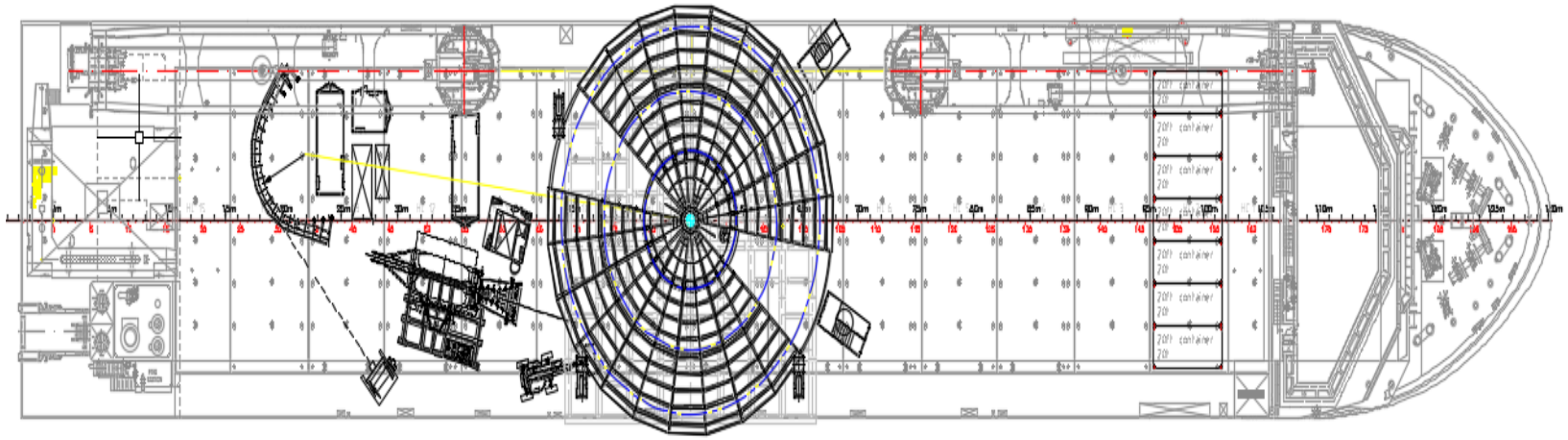
  - Box mass (2800 tons)



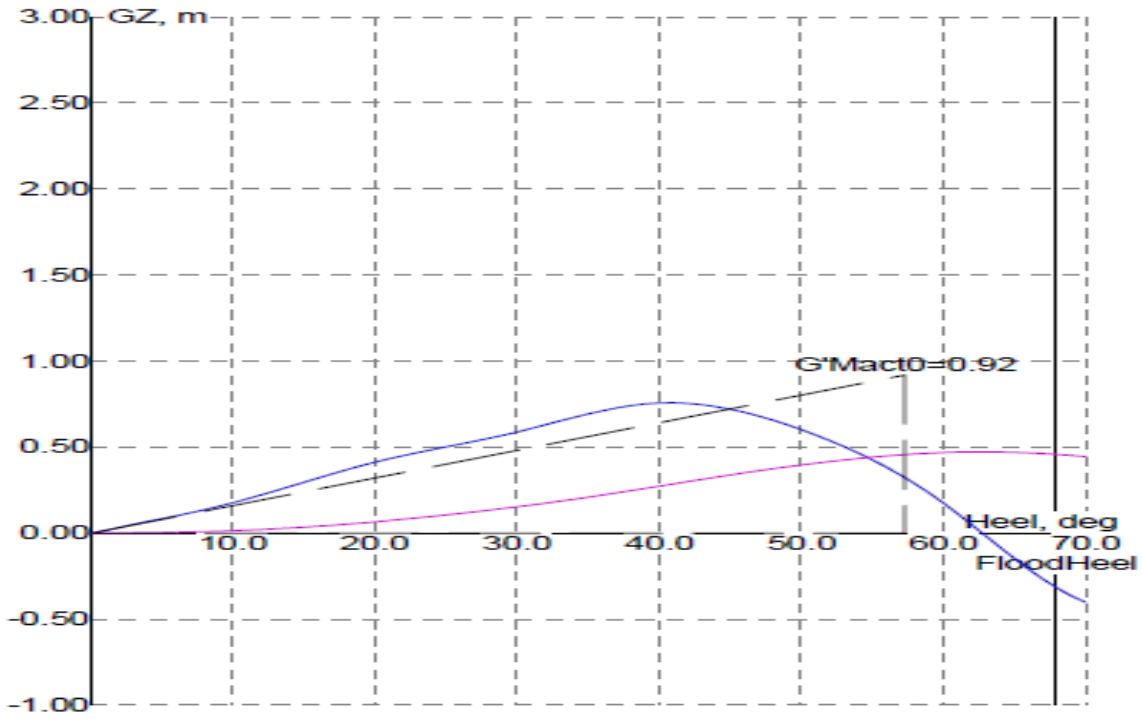


Auxiliary system of Heavy cargo load on top of hatch cover

Loading conditions and Stability Analysis

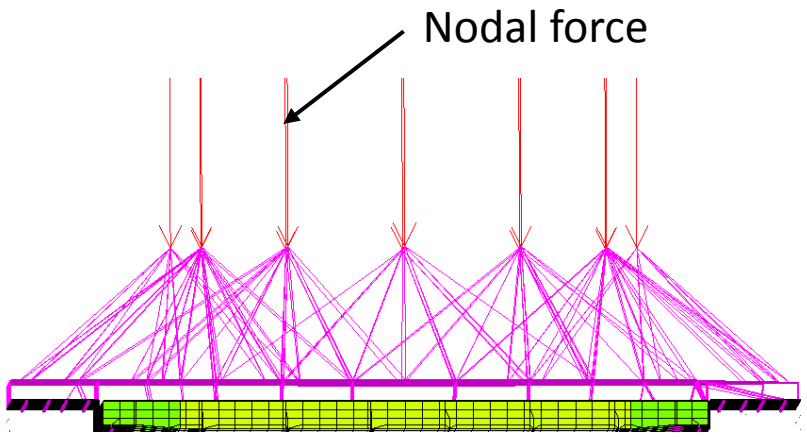


- Load Master software
- Stowage plan
- GZ- Curve
- GM = 0.92 m



Critical Wave loading case for Pk-116

- ABB Octopus
- Nodal force generation
- Model import for GSA

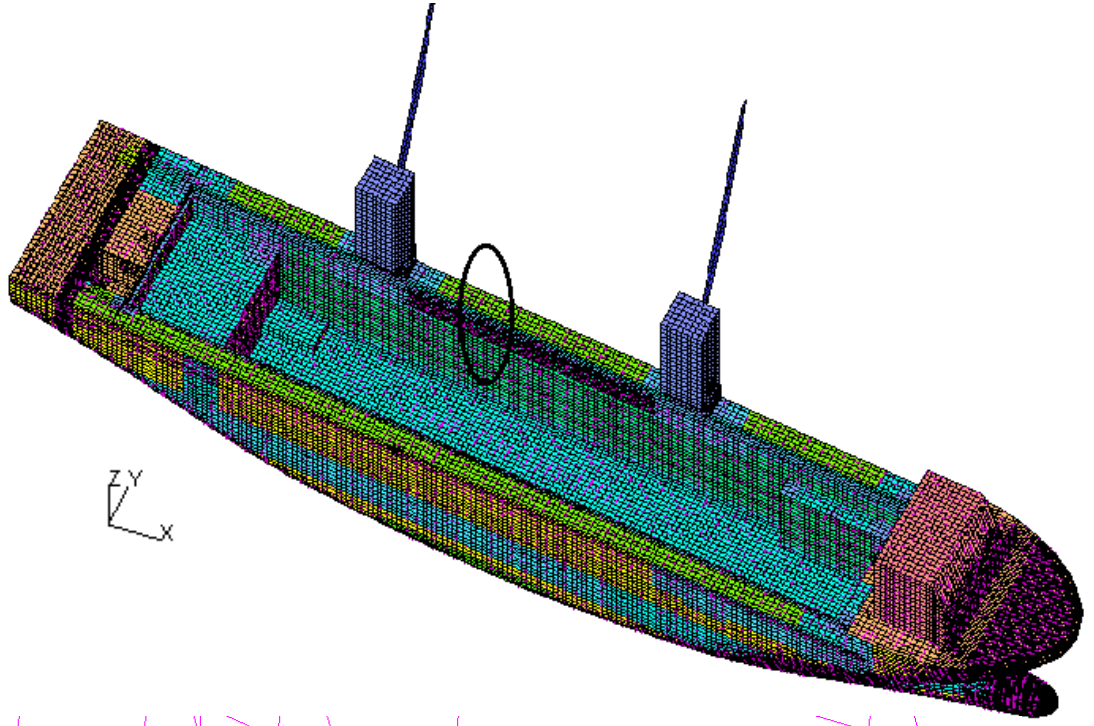


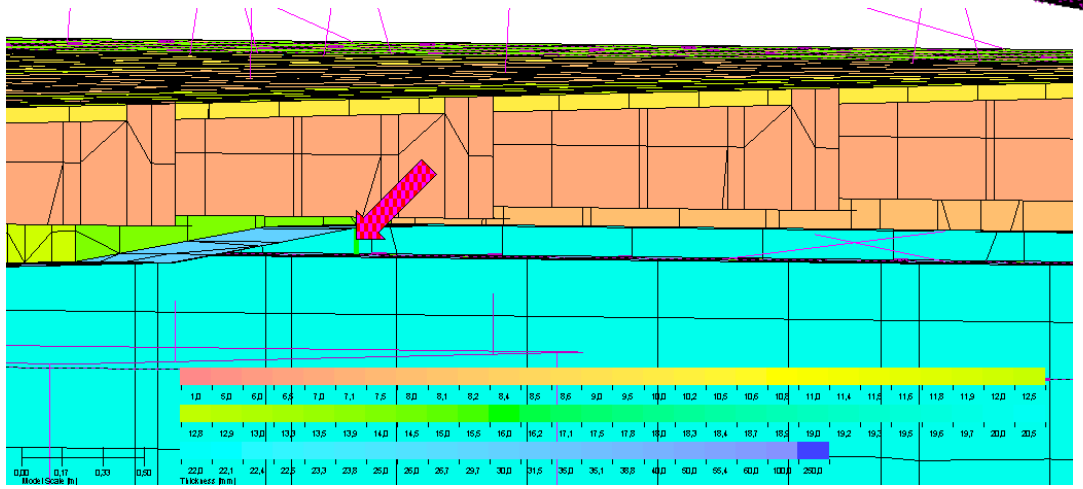
Crtical wave loading cases				
Title	Wave amplitude (m)	Wave direction (°)	Wave phase angle(°)	Velocity (Knots)
Beam sea	9.59	90	216	0
Head sea	5.71	180	216	12.75

Comparison of Acceleration for heavy cargo mass		
Title	Beam sea(y direction, m/s^2)	Head sea(z direction, m/s^2)
Octopus	2.61	3.09
Shipload	2.65	3.19
Deviation (%)	1.5	3.2

Feasibility Check for Proposed stanchion assembly design

Results obtained			
Item	**Load case**	**Direction**	**Maximum load (KN)**
Stanchion Truss	**Head sea**	**Z direction**	**-1295**
Carousel Basement	**Beam sea**	**Y direction**	**3264**
Hatch cover securing system	**Head sea**	**Z direction**	**-1600**

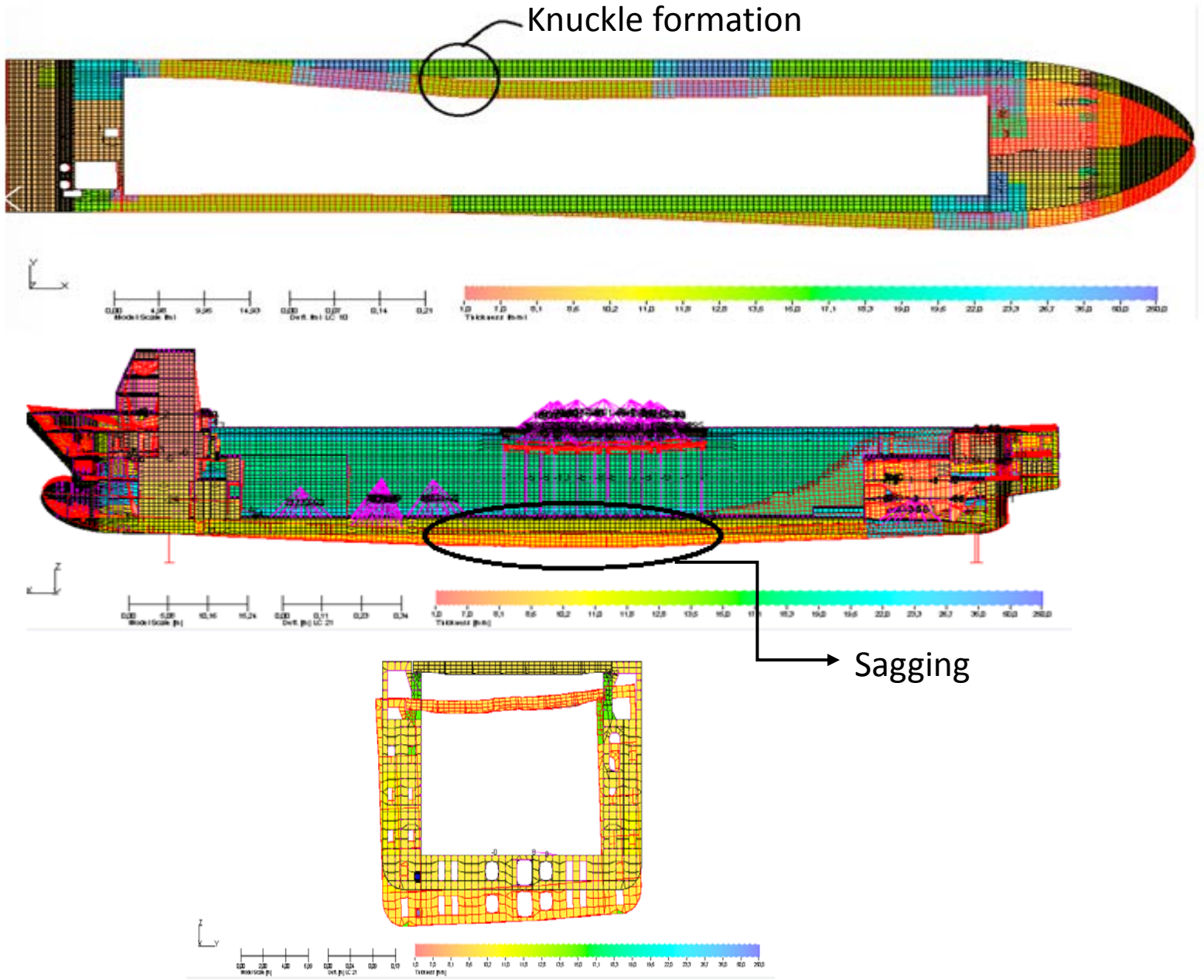




Results of GSA

Deformation check of Vessel

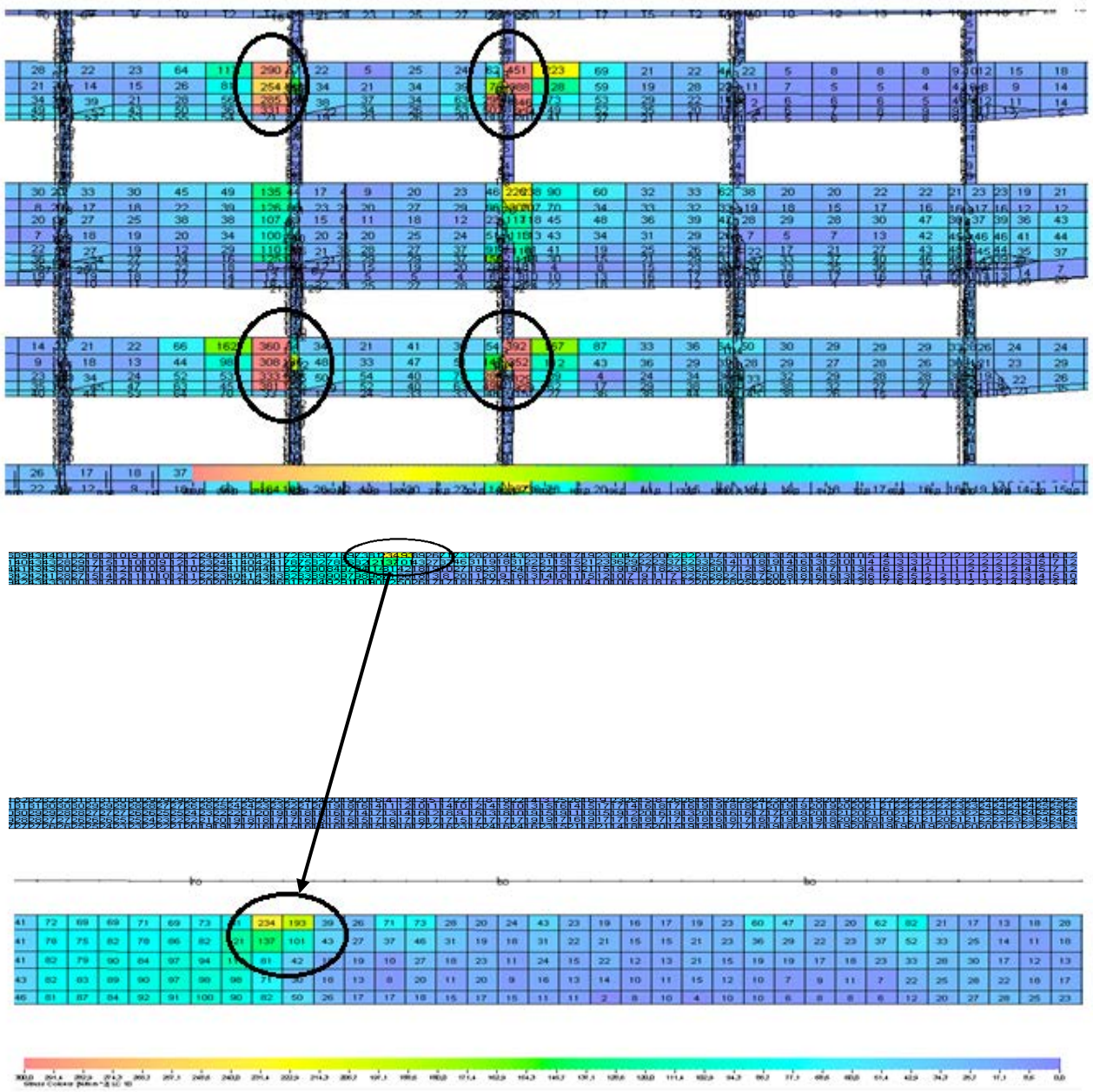
- Scale factor - 50
- Head Sea was more critical
- Average deformation was 40-50 mm measured on model scale



Results of GSA

High Yield stress check

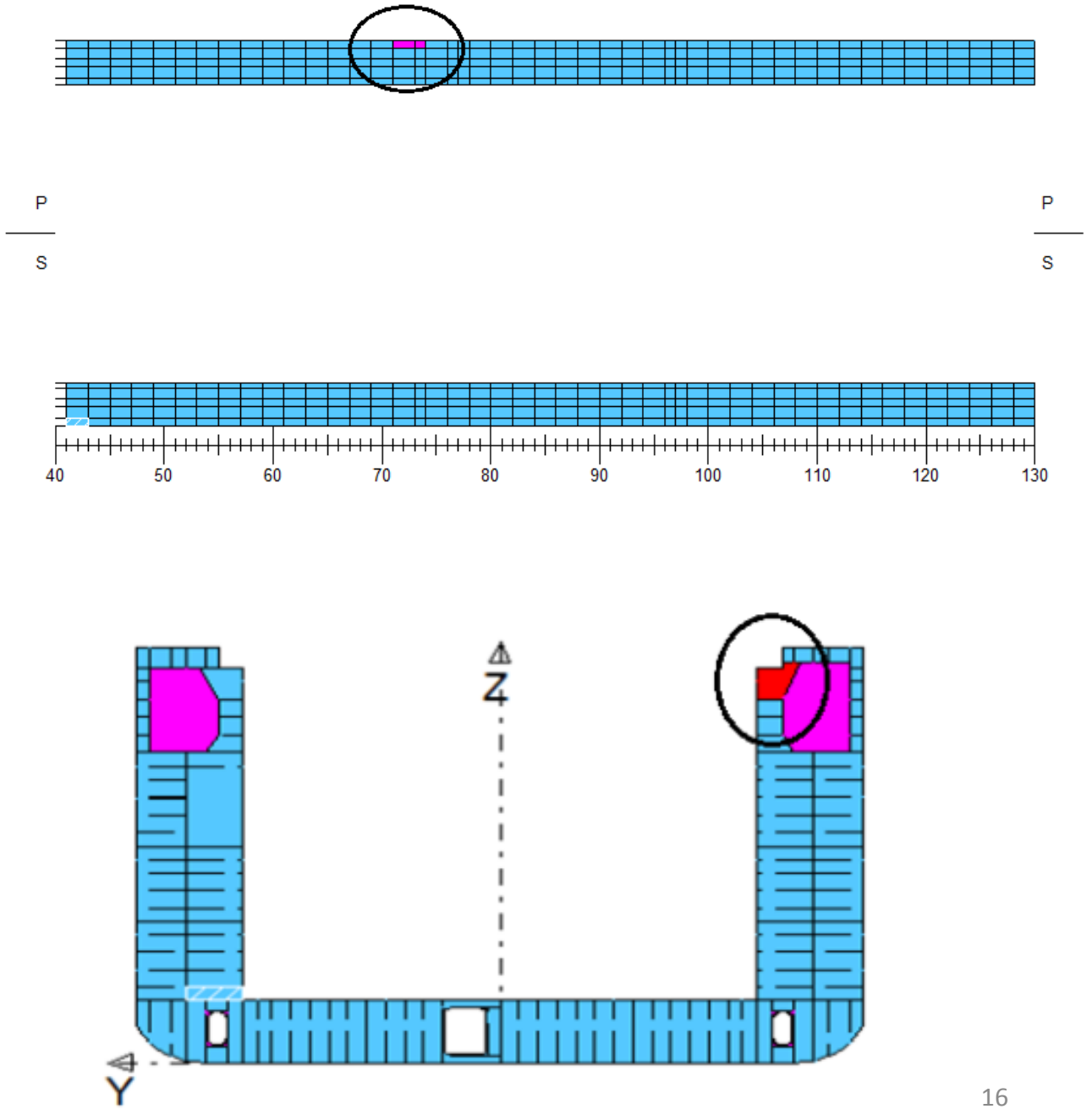
- High stress area on Hatch cover girder in Head sea case
- High stress area on Deck-A in Beam sea case



Results of GSA

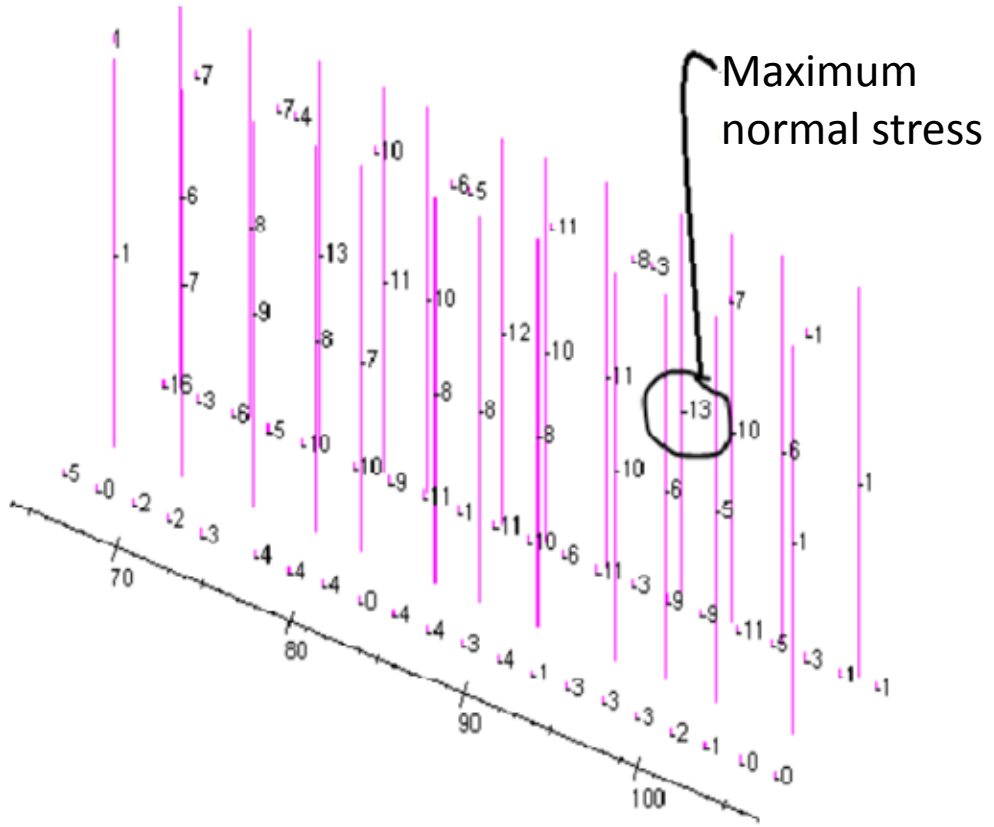
Buckling check

- Displacement method
- DECK- A, high stress zone
- Frame -76 High stress zone in red color



Final Design of Stanchion Truss

- Required Scantling area of stanchion truss was calculated using GL Rules
- Final scantling area to be implemented inside the model – **47.4 cm²**



Conclusion

- Proposed design of stanchion assembly was very efficient and transfers about 50 % load from weather deck area to the tank top area in head sea case and about 55% load in beam sea case.

- The final design value for the stanchion truss and its capability to transfer load from top to bottom was very good and it can be considered for the real implementation in the future.

- Double bottom of the vessel was able to withstand heavy loading from stanchion truss without showing any high stress areas.

Thank you !