Hull girder failure under combined global and local loads

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Presentation contents

EMship Advanced Design

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2. Analysed ships
3. Methodology
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7. Conclusions

Subject of the thesis

1. FE progressive collapse analysis of bulk carrier and of container ship

2. Camparison with Poseidon software that uses Smith's method

3. Influence of the local loads

Capesize bulk carrier

Lpp = 280,8 m app. 170 000 dtw

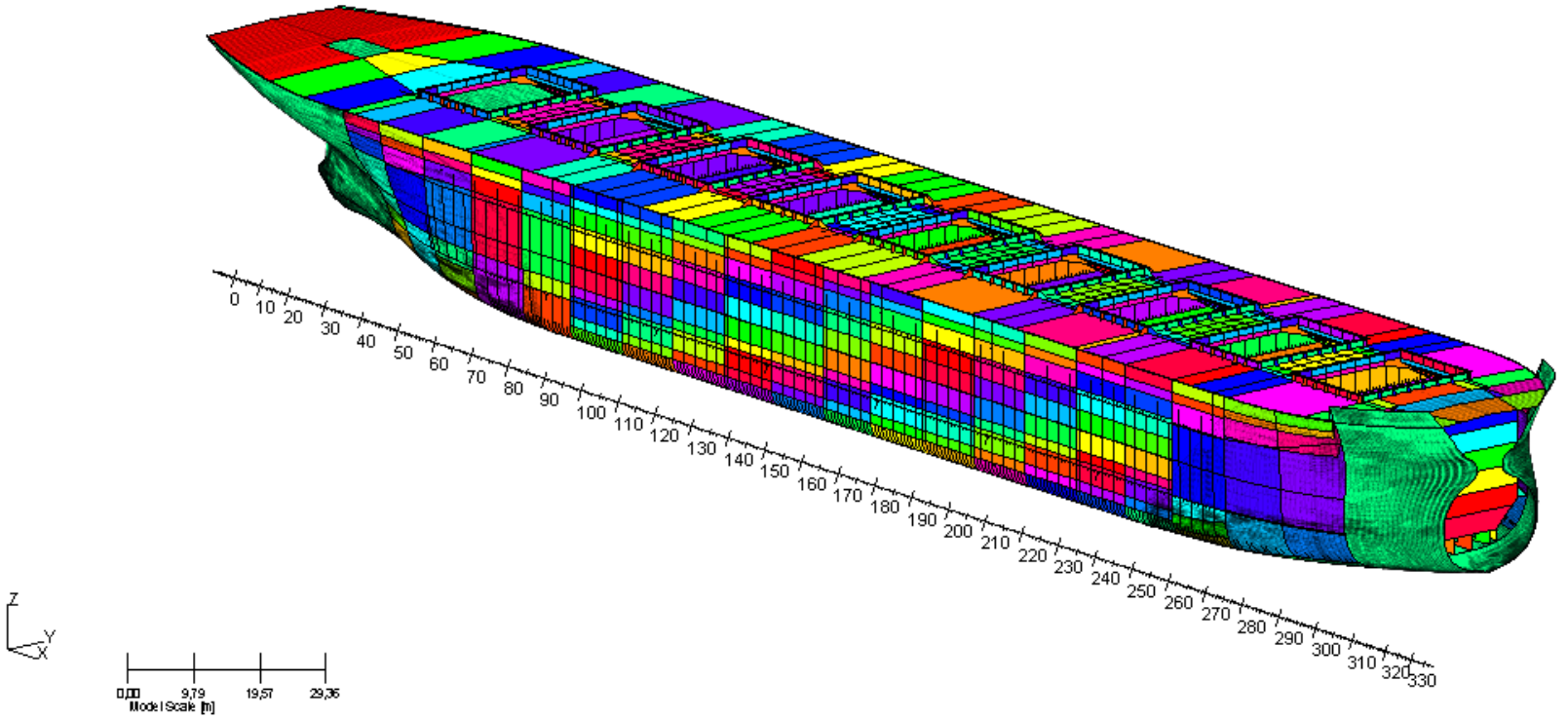


Fig. 1 Example of the bulk carrier model given in the GL - Poseidon

Container ship

Lpp = 349,5 m app. 14 000 teu

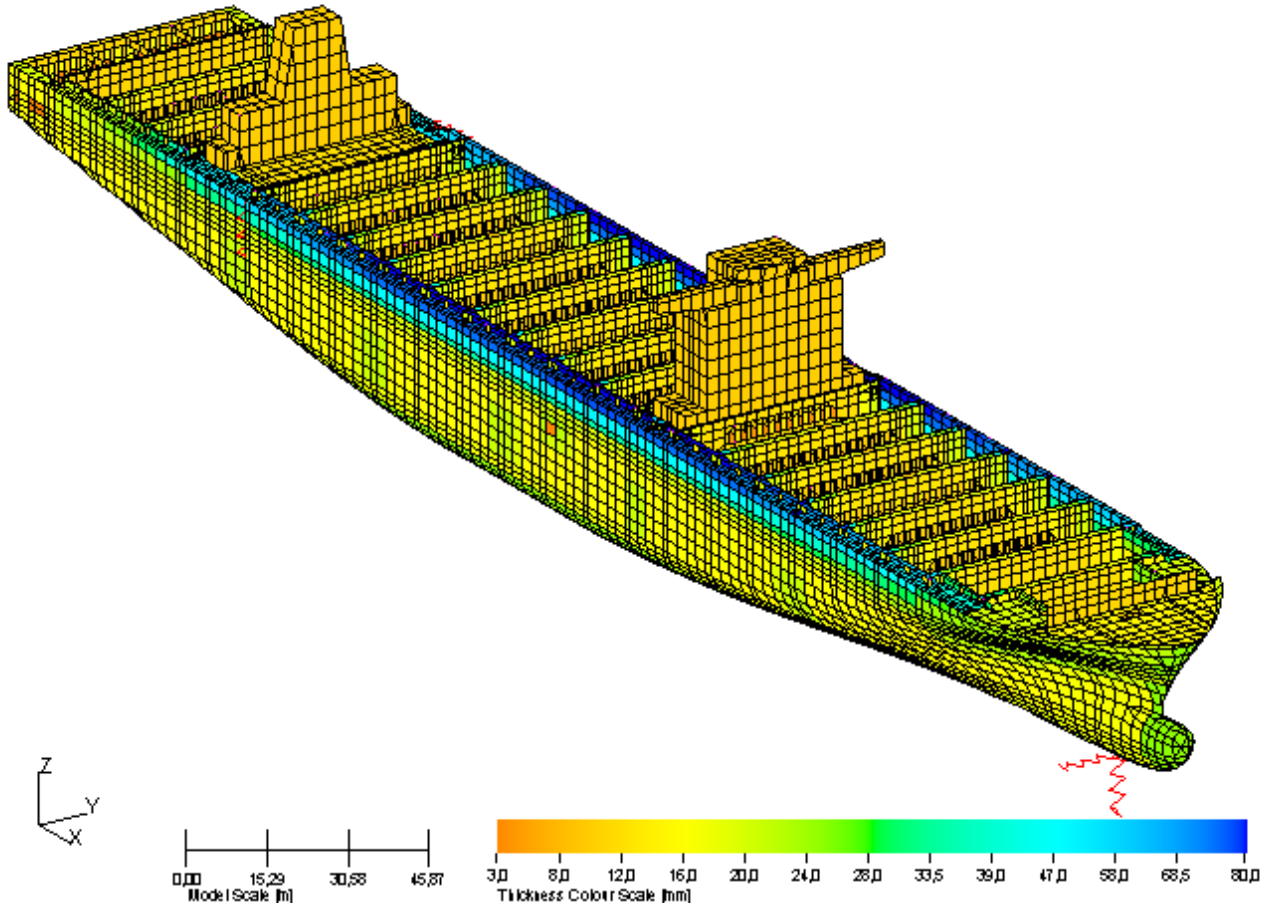


Fig. 2 Example of the container ship model given in the GL - Poseidon

Methodology

Progressive collapse

1. Applying curvature
2. Calculating strain in the elements
3. Calculating stresses
4. Change of the neutral axis
5. Moment acting
6. If Mu not reached repeat the steps with increased curvature

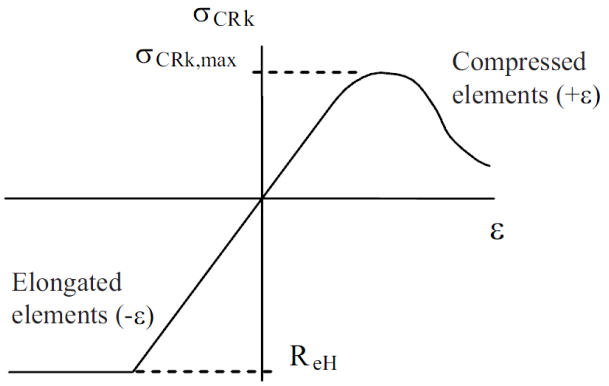
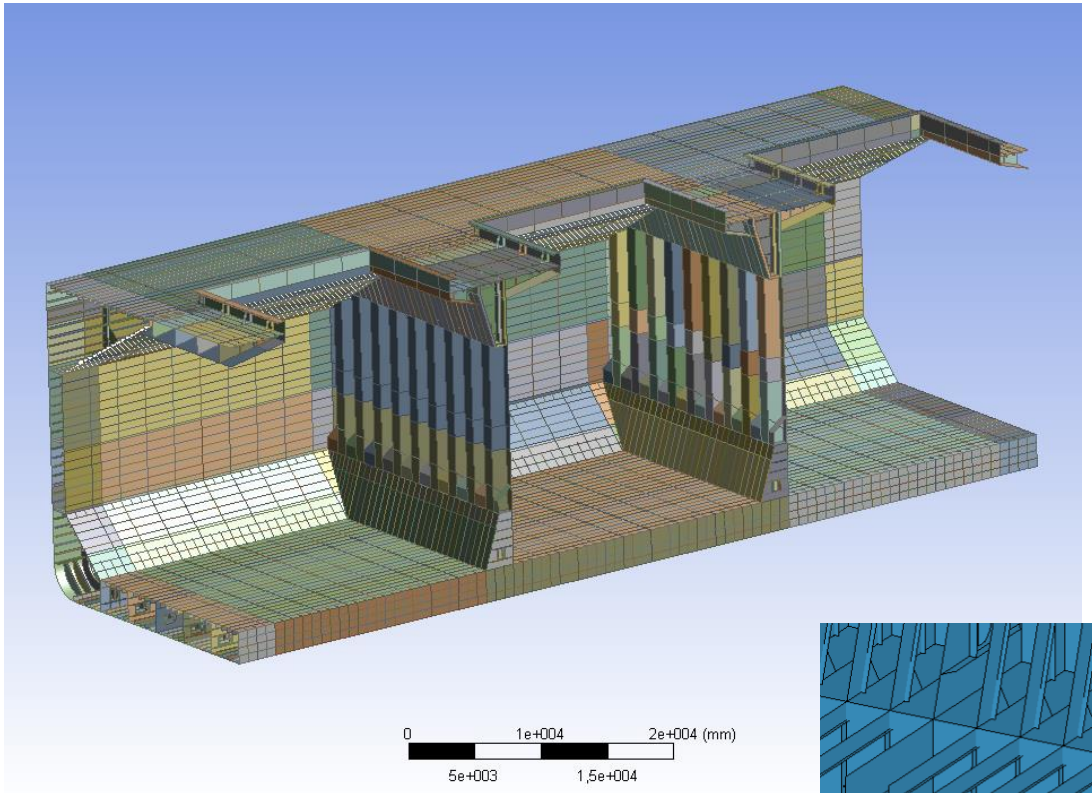


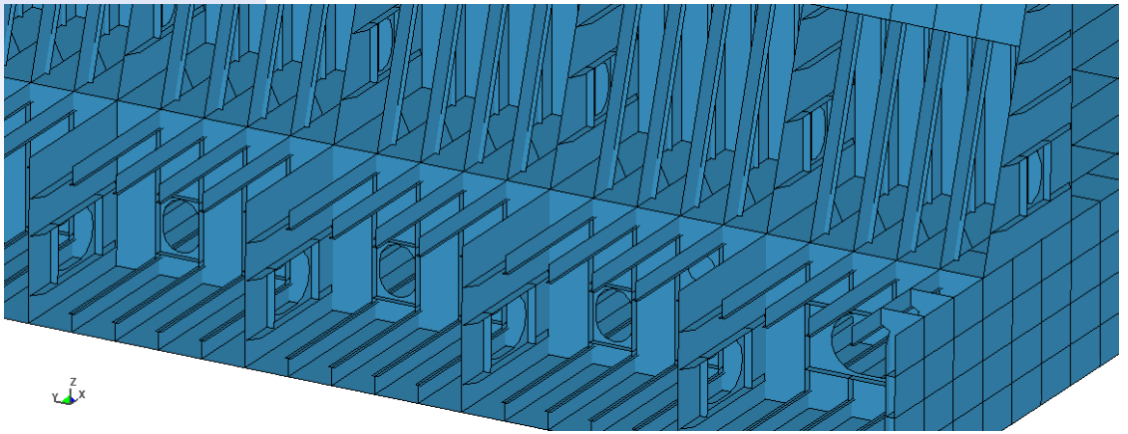
Fig. 3 Stress – strain curve

Bulk carrier – Finite element model

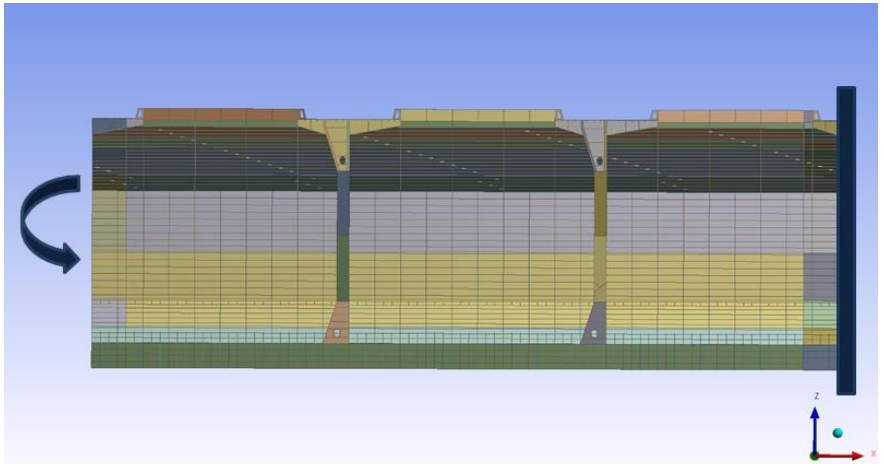


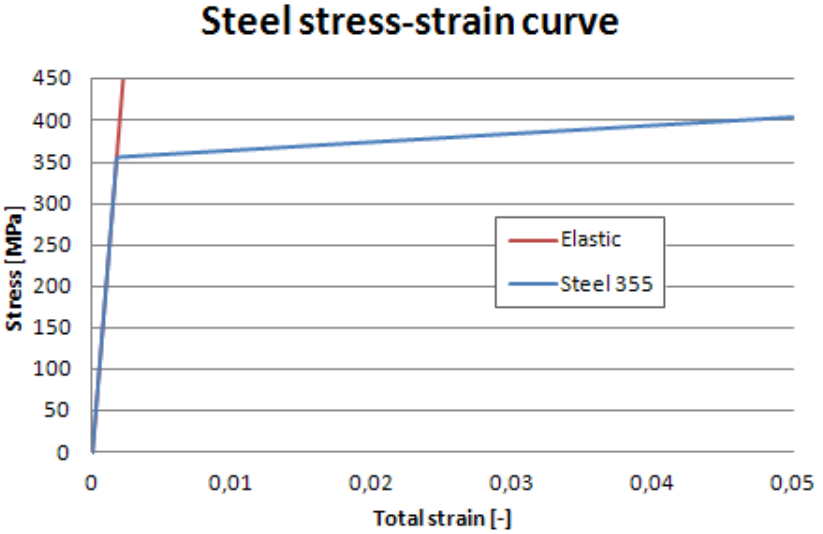
Build in Ansys Workbench

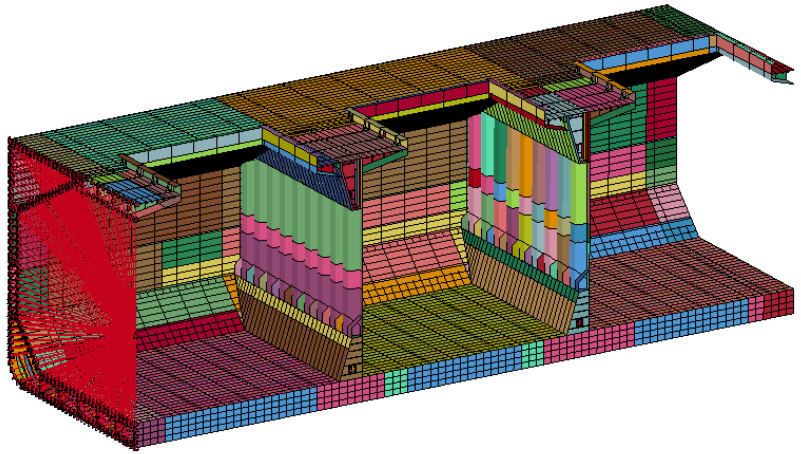
3 cargo holds, Fr.109 -196

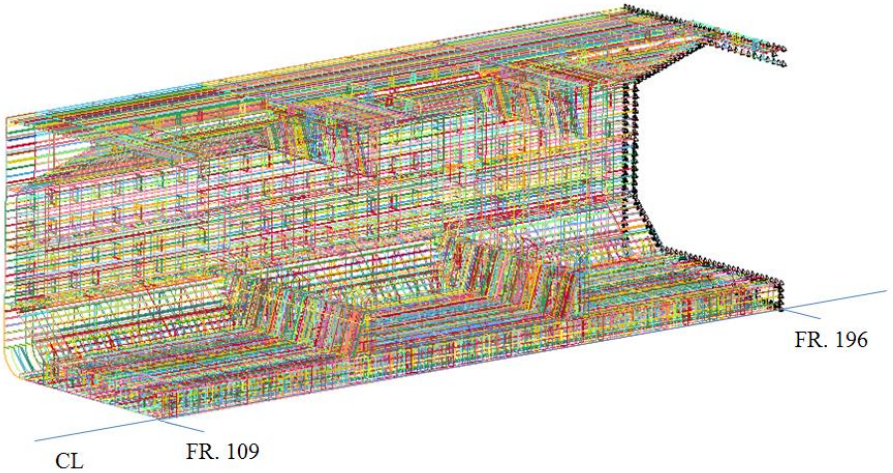


Methodology







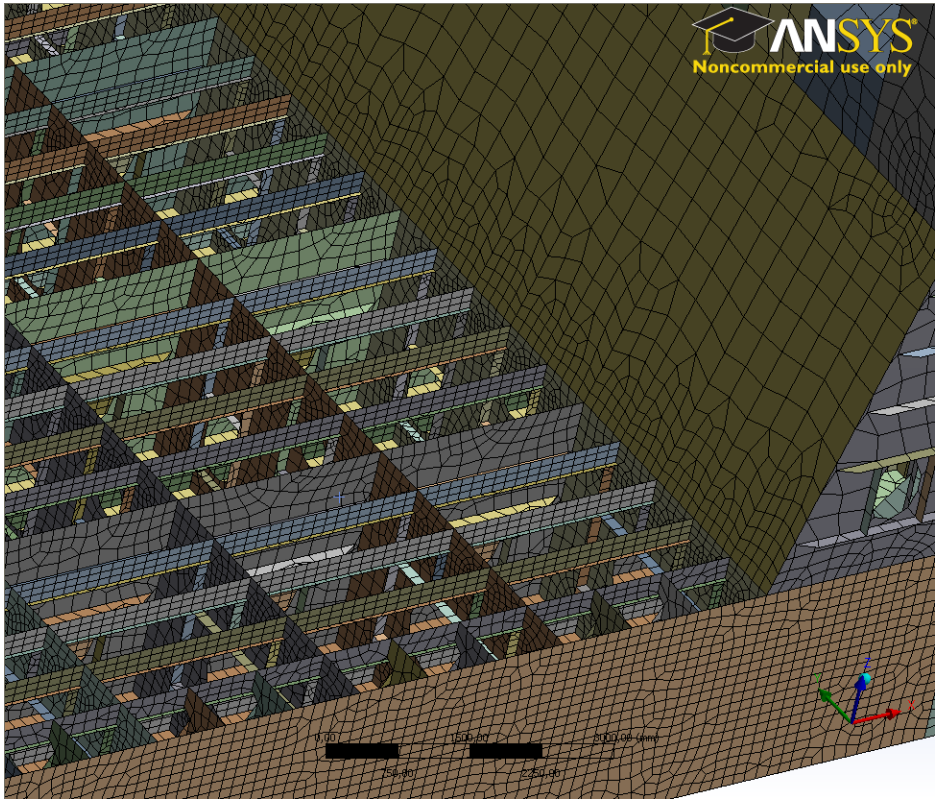


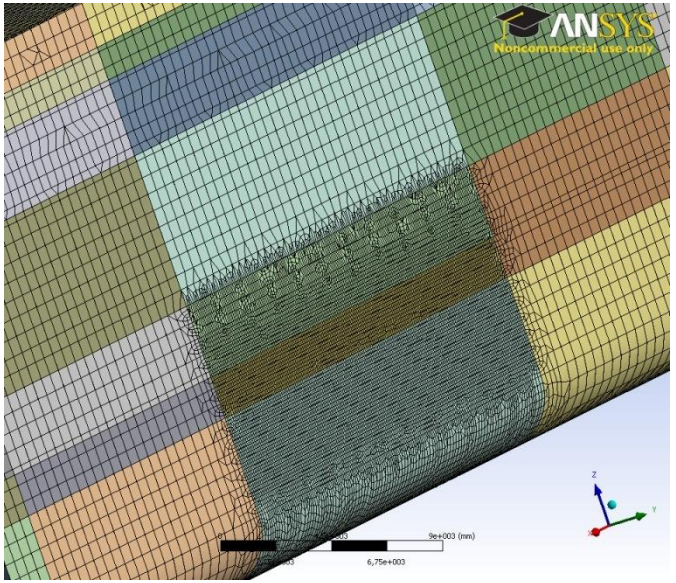
Mesh convergence

Mesh 1 – 350 mm

Mesh 2 – 300 mm

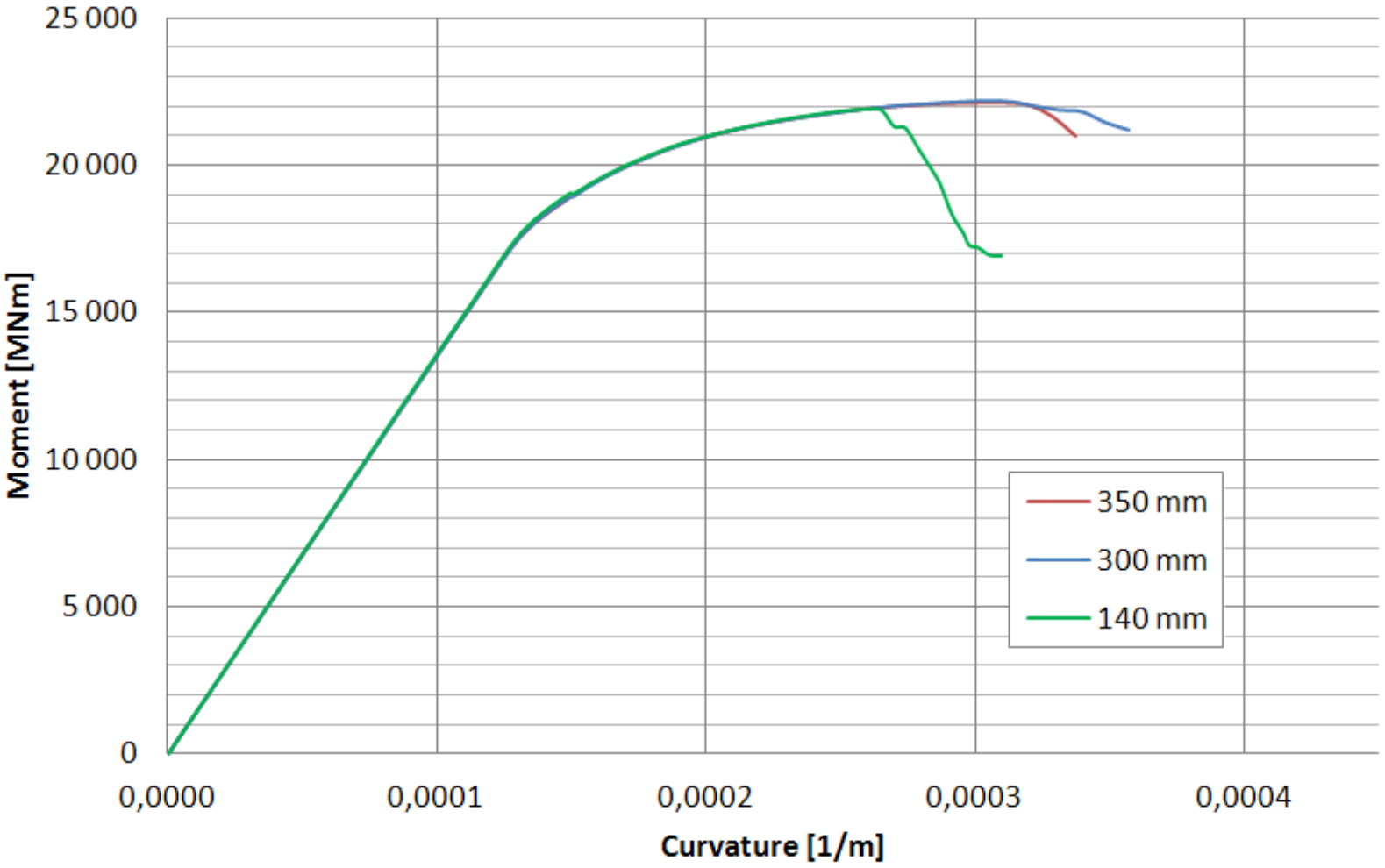
Mesh 3 – 140 mm





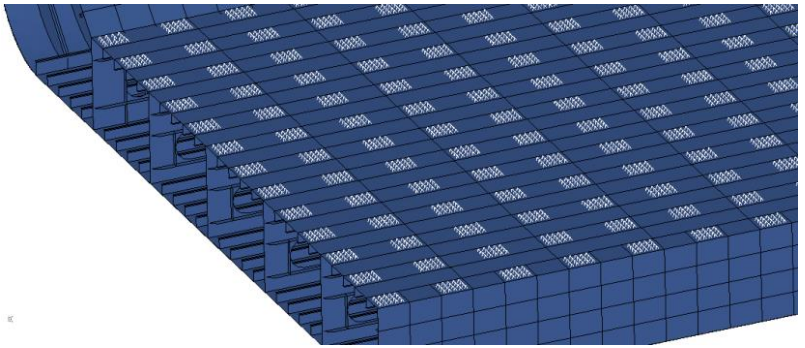
Mesh convergence - results

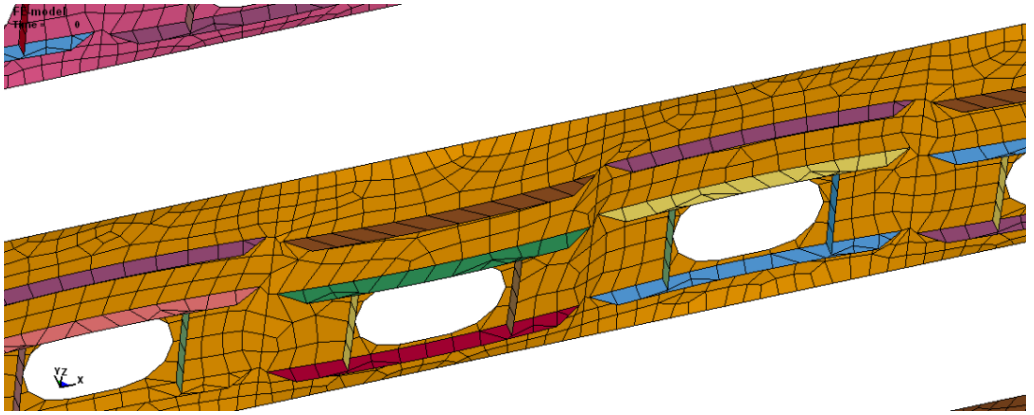
Ultimate strength

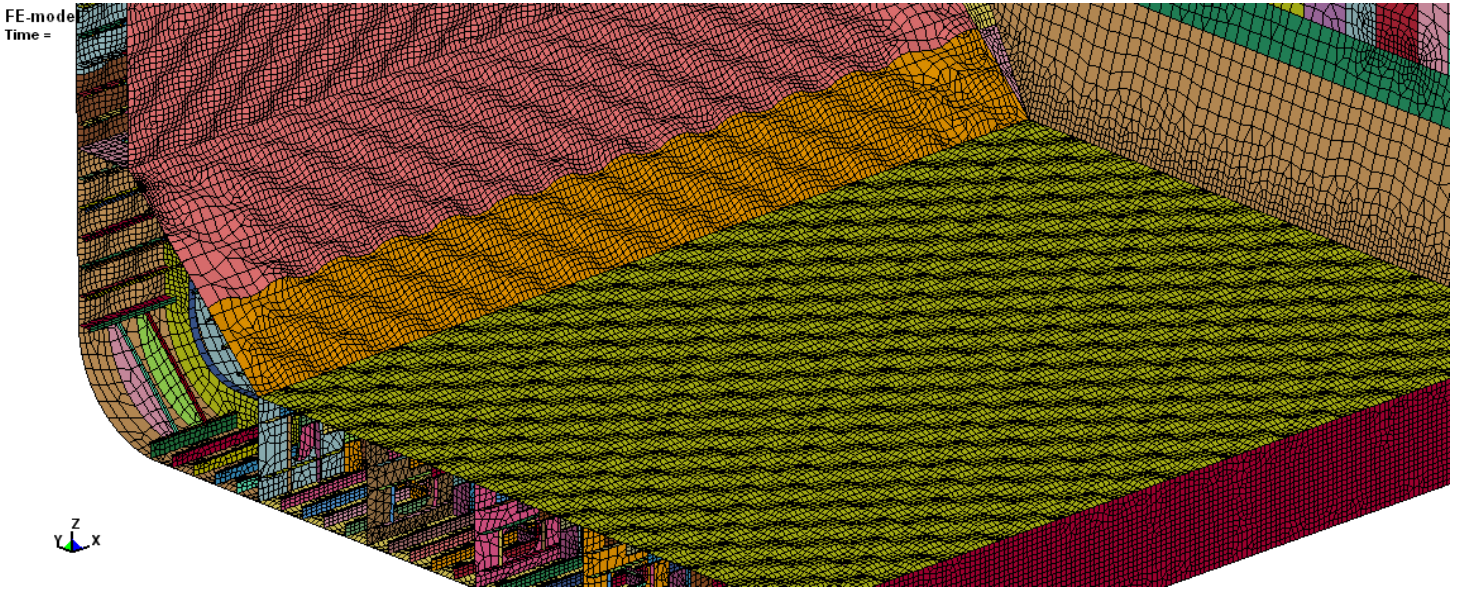


Imperfections

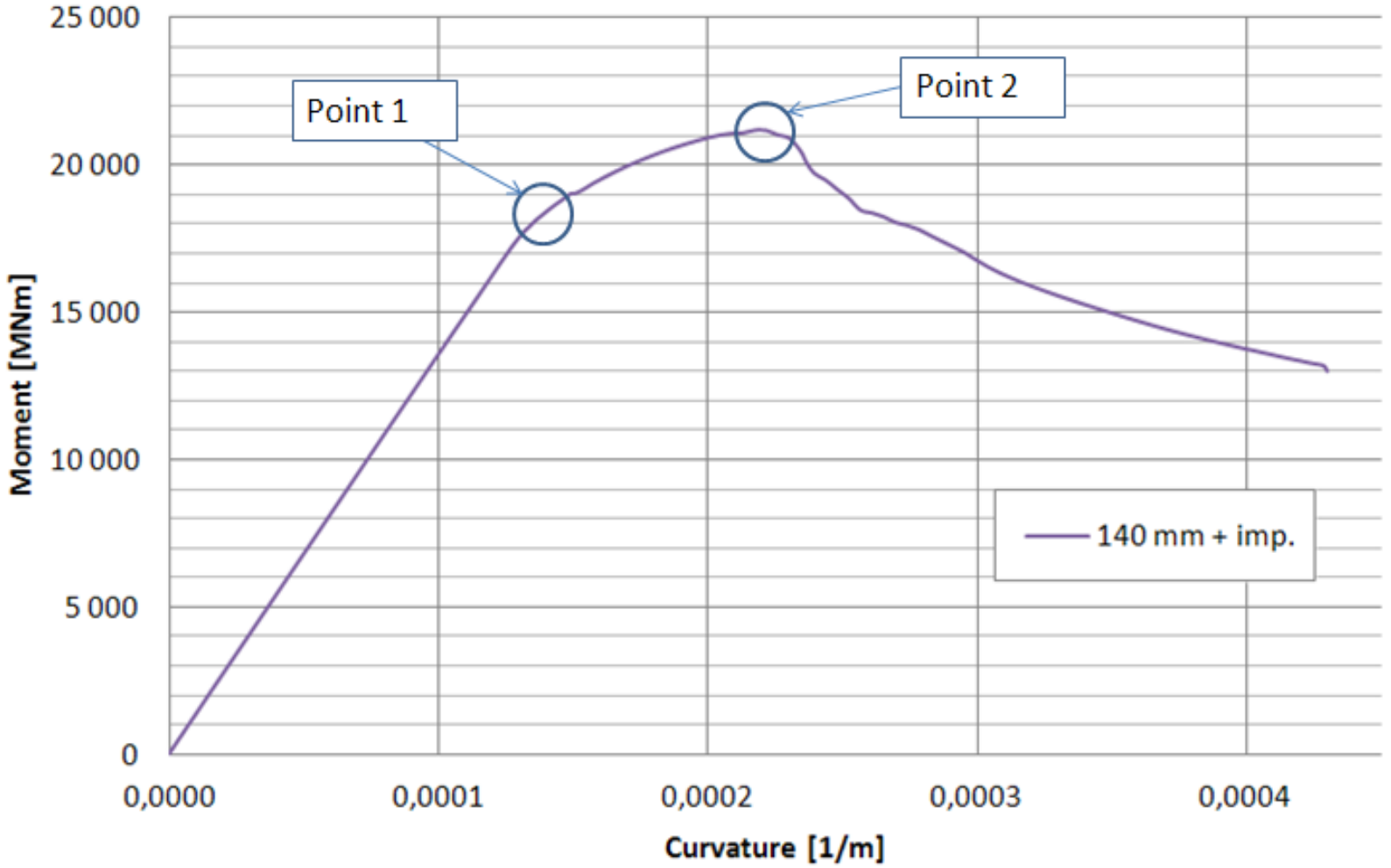
Around 3 mm for plating thickness 18,0 mm

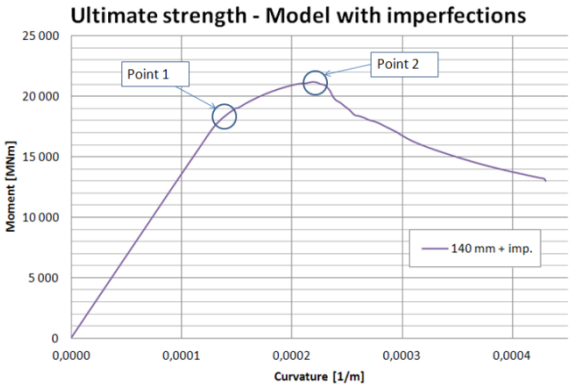


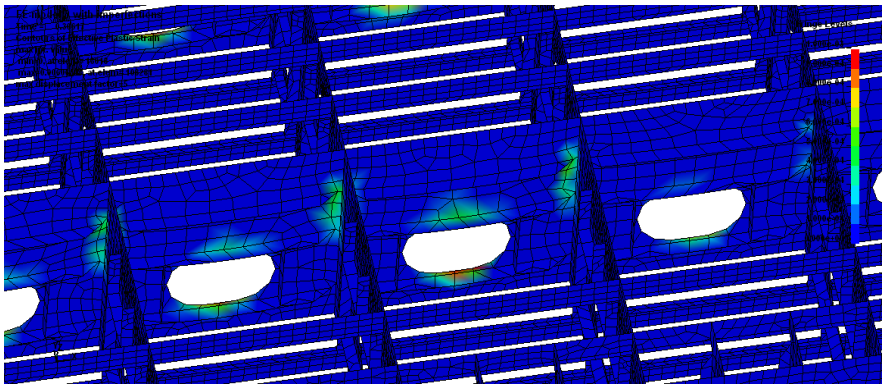




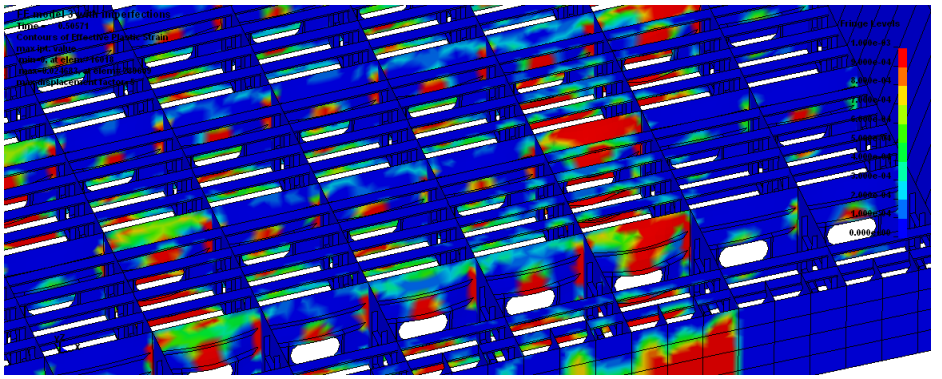
Ultimate strength – Model with imperfections



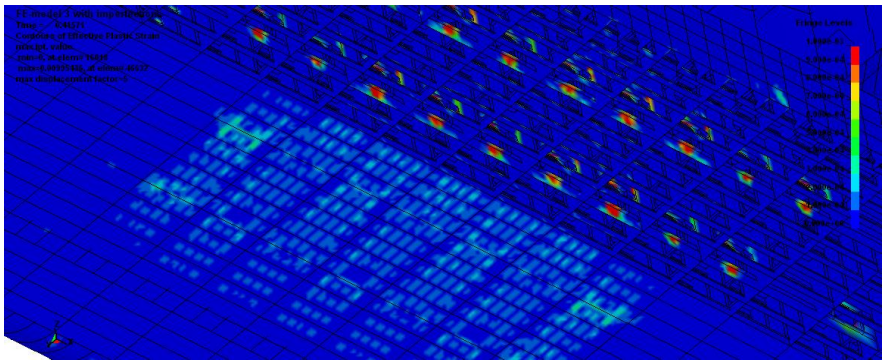




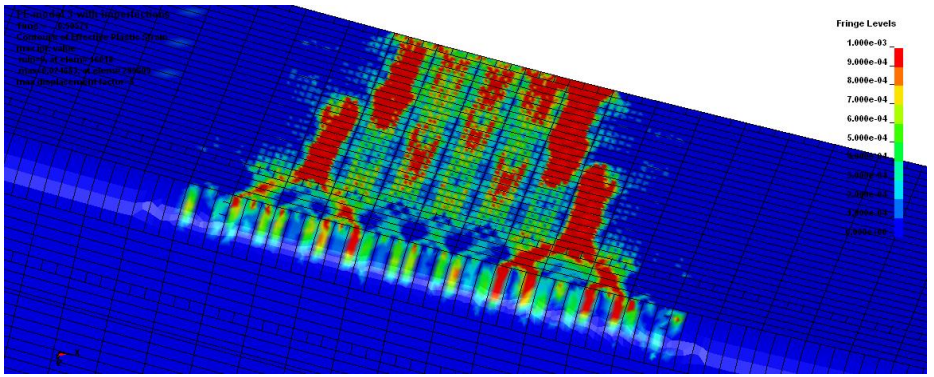
Plastic strain in girders for Point 1



Plastic strain in girders for Point 2



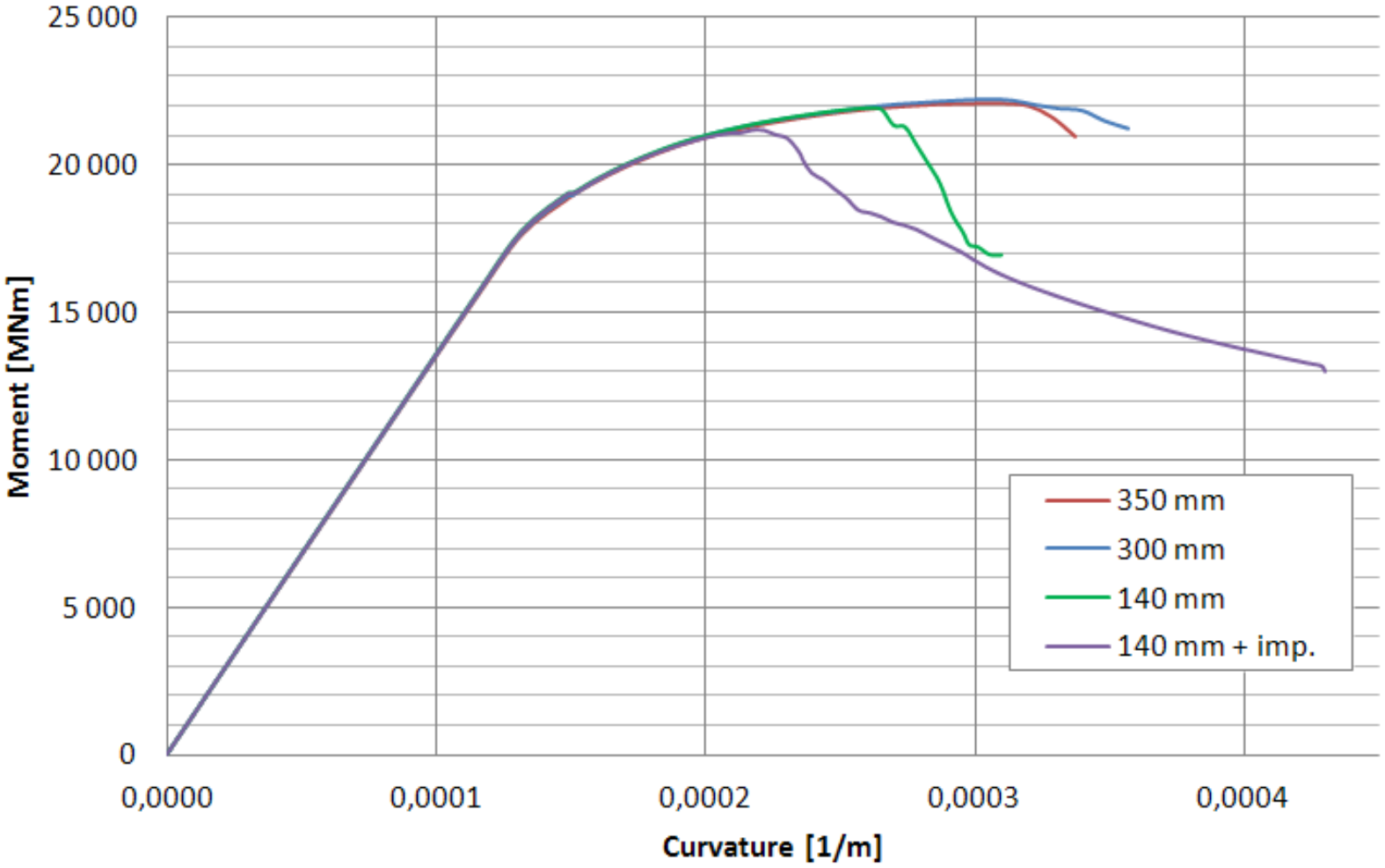
Plastic strain bottom plating after Point 1



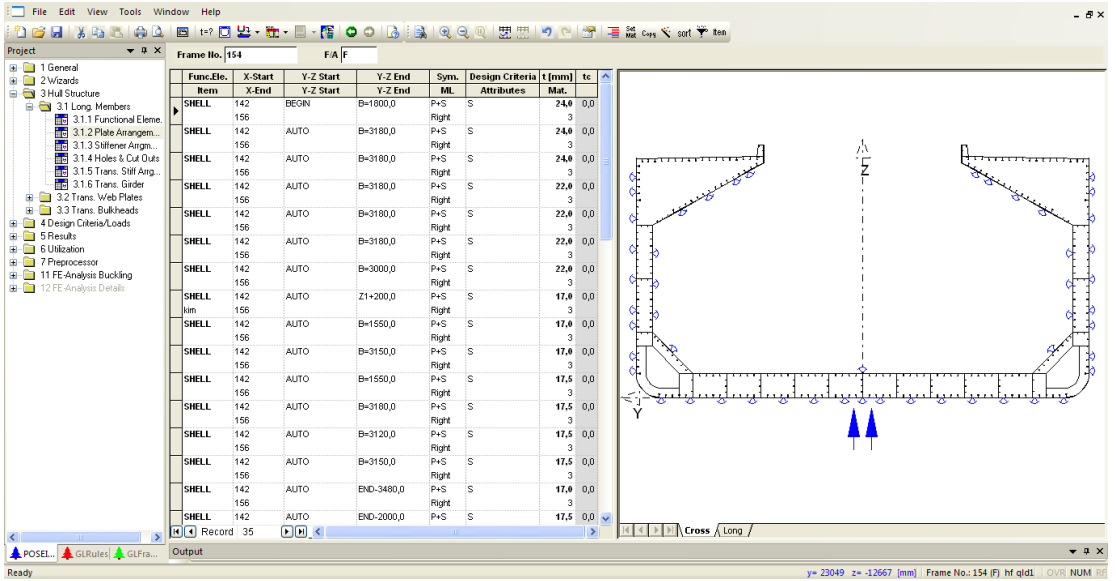
Plastic strain in bottom plating for Point 2

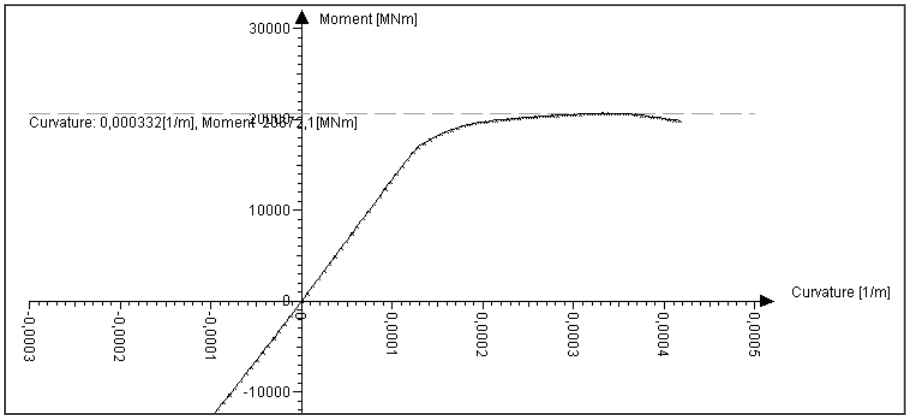
Comparing results

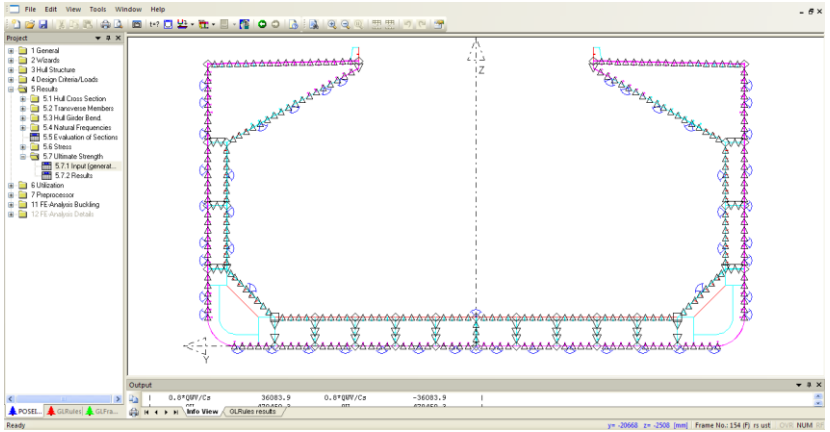
Ultimate strength



Bulk carrier - Poseidon model

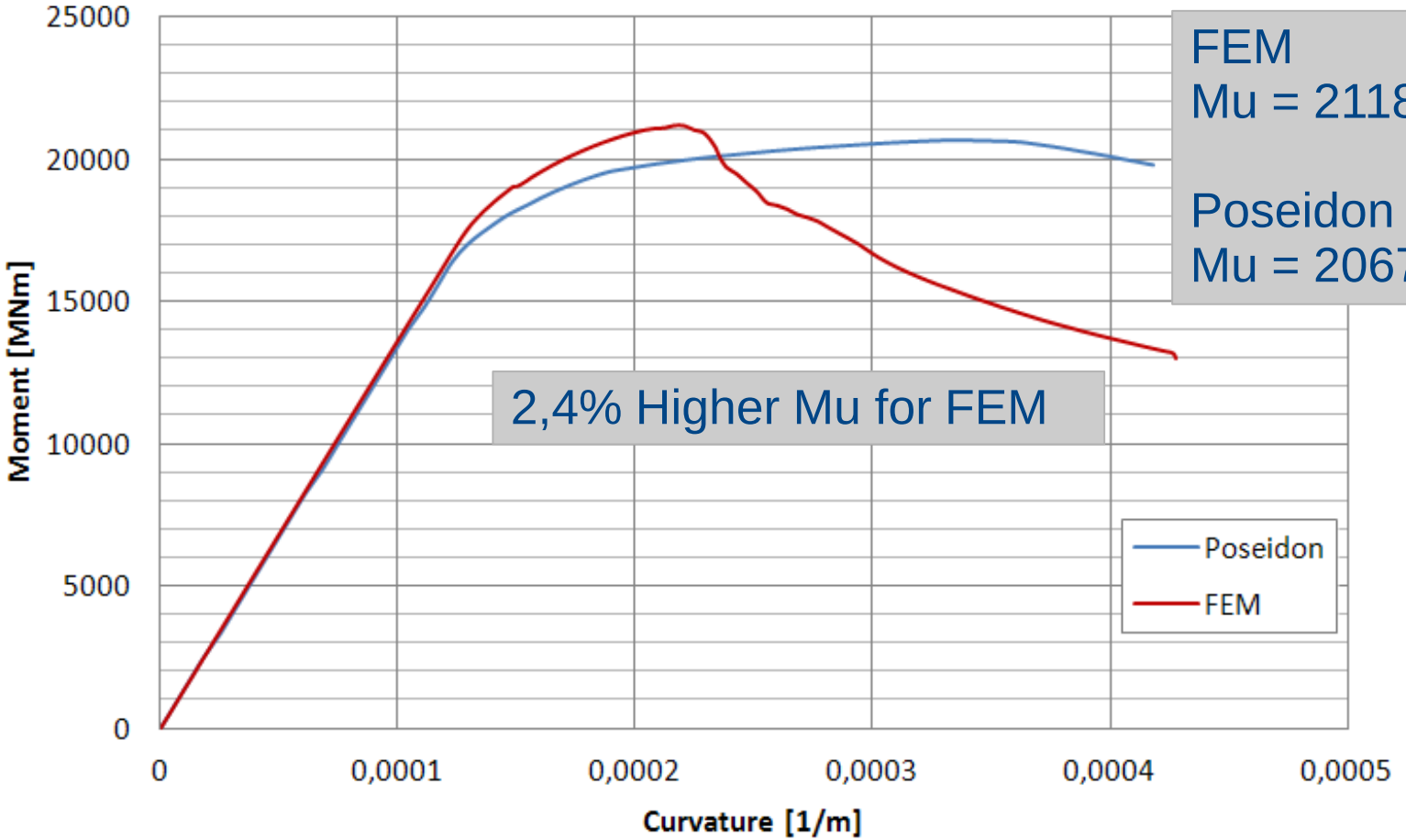






Comparison FE analysis - Poseidon

Ultimate strength



FEM
Mu = 21180 [MNm]

Poseidon
Mu = 20670 [MNm]

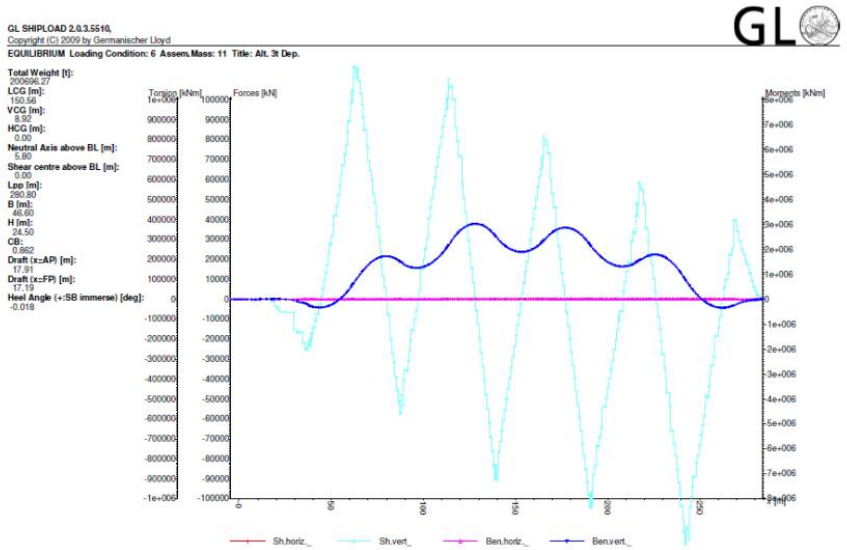
2,4% Higher Mu for FEM

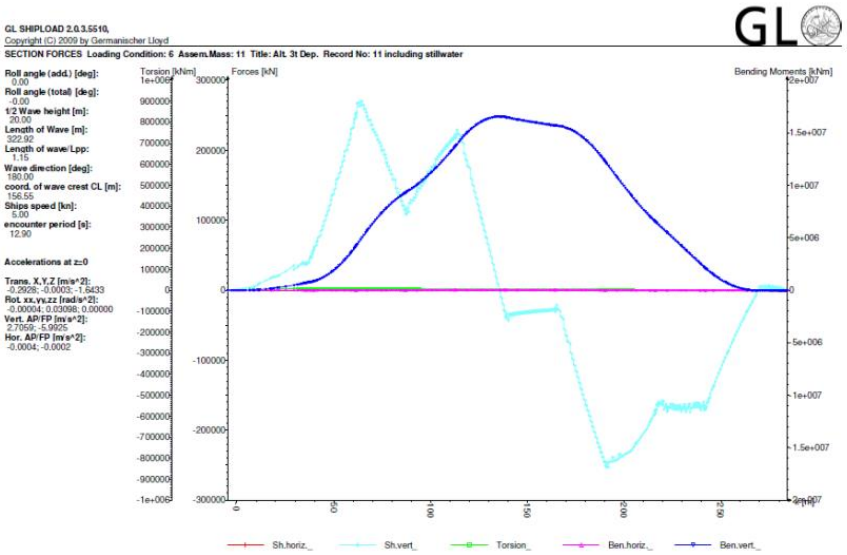
Local loads

Load case 1: Wave height 13 meters,

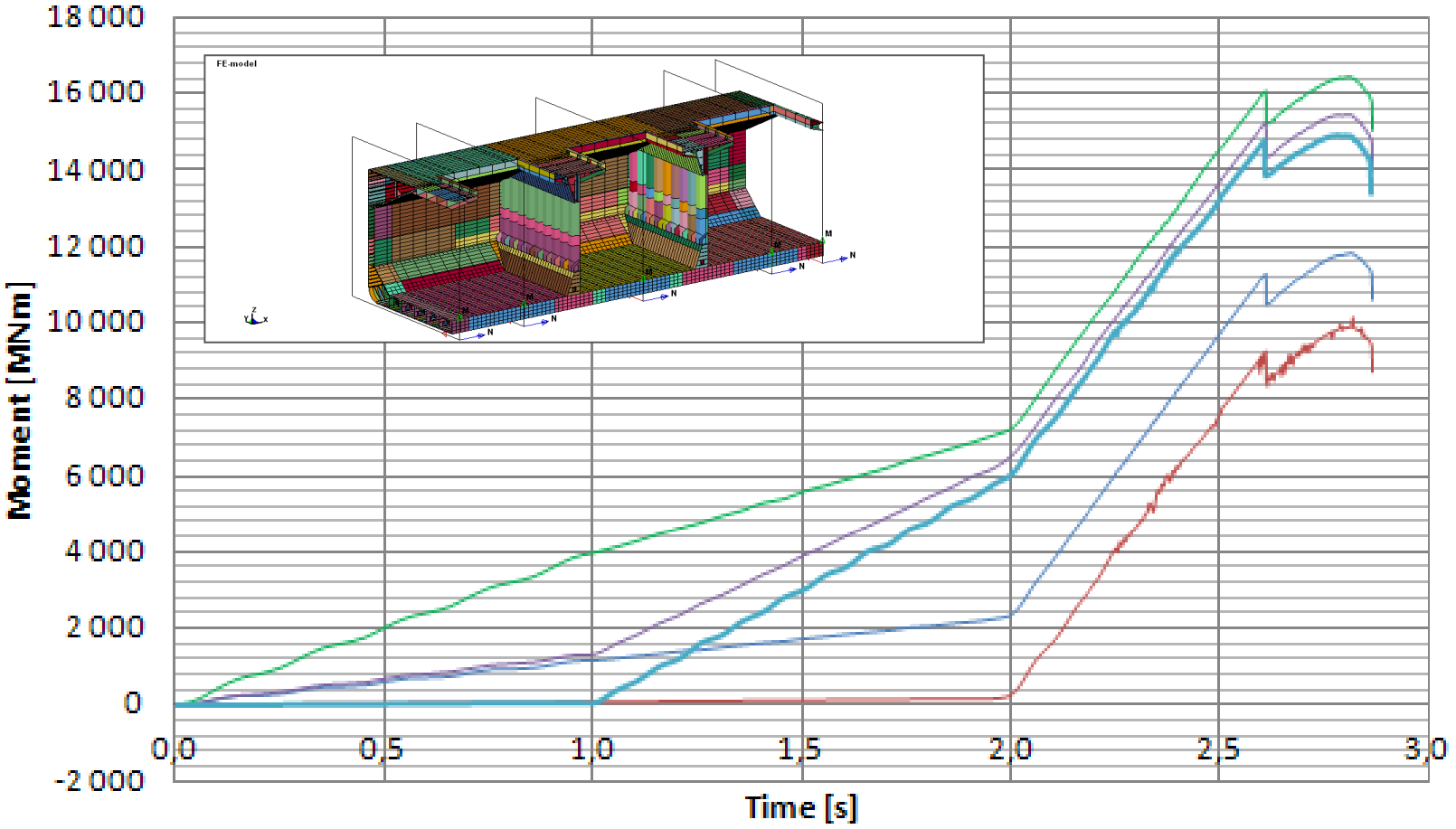
Load case 2: Wave height 15 meters,

Load case 3: Wave height 20 meters,

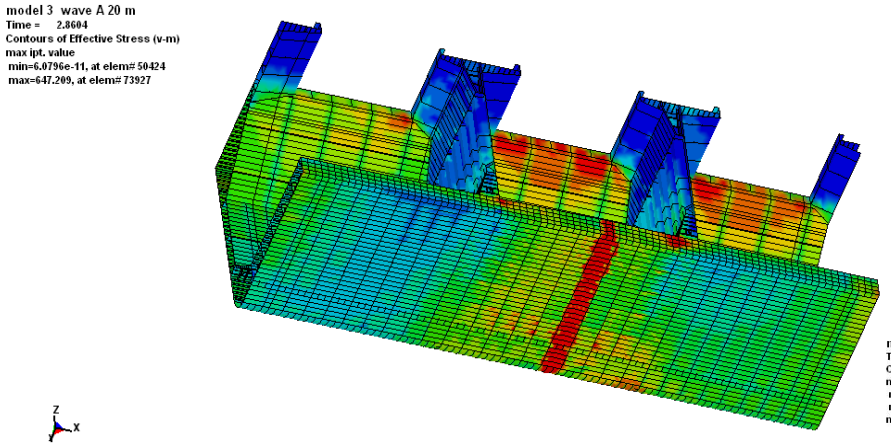


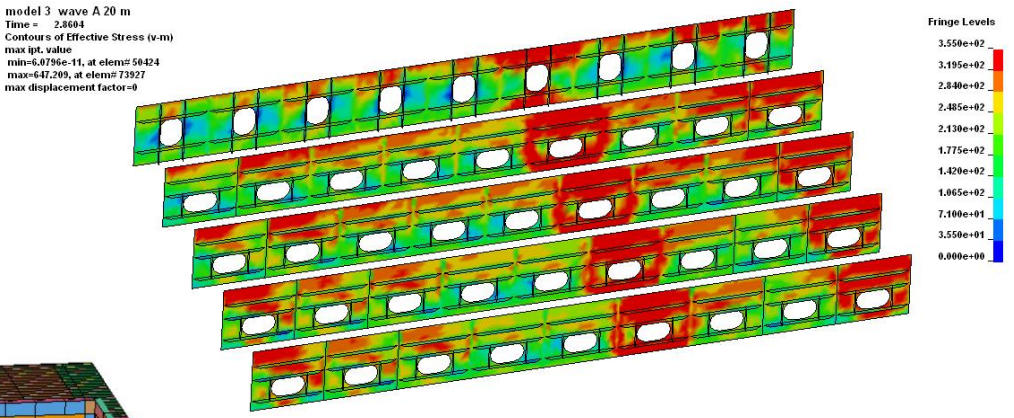


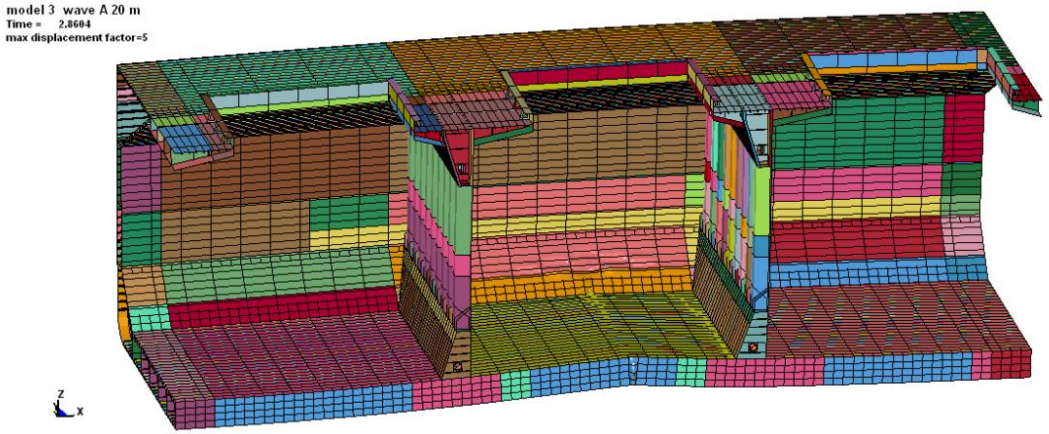
Ultimate strength 20 meters wave height



20 meters wave - results

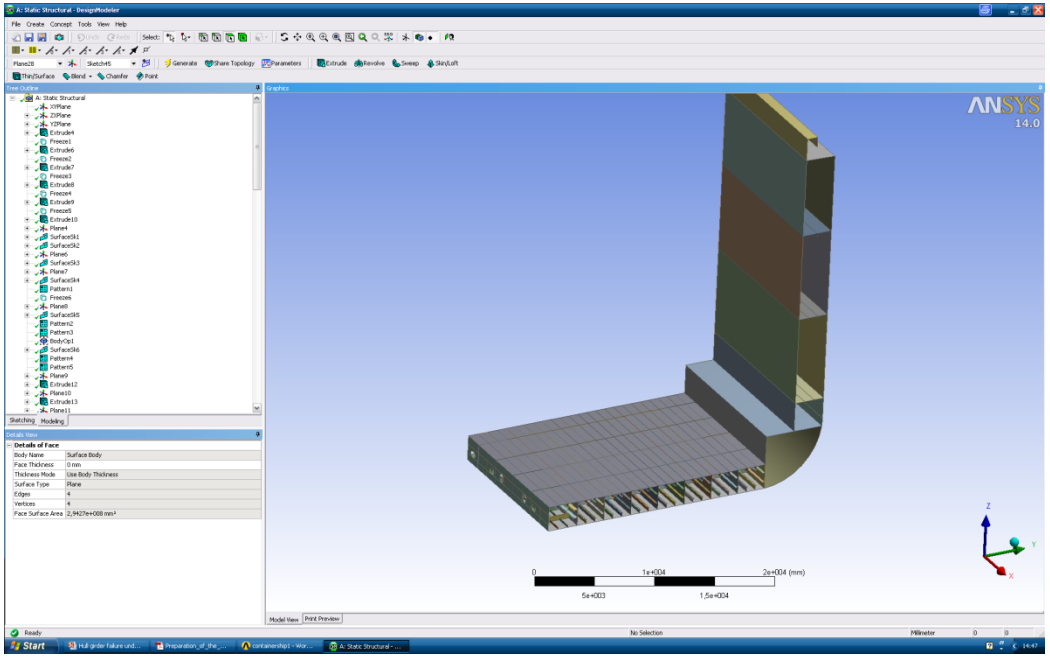


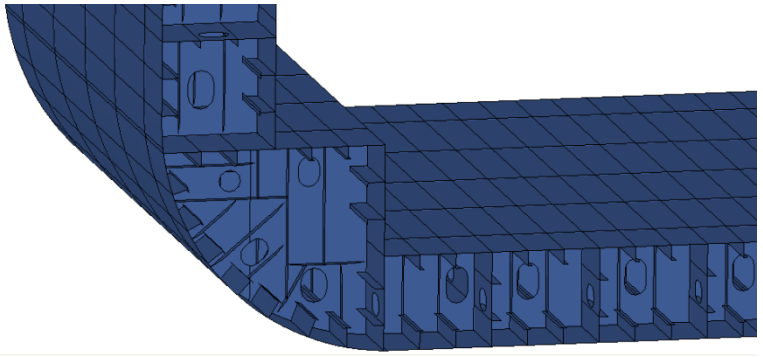


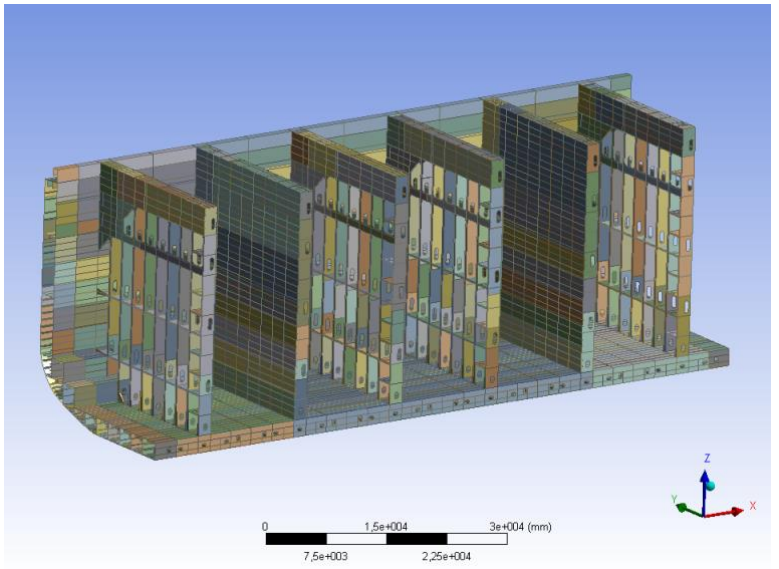


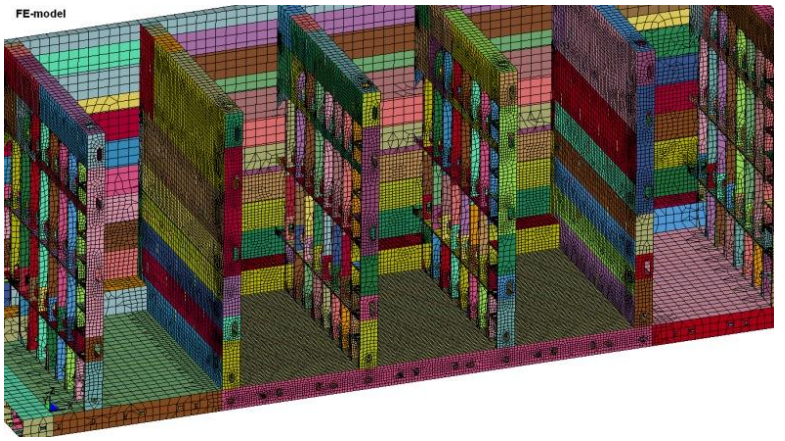
Container ship – FE model

Initial container ship model



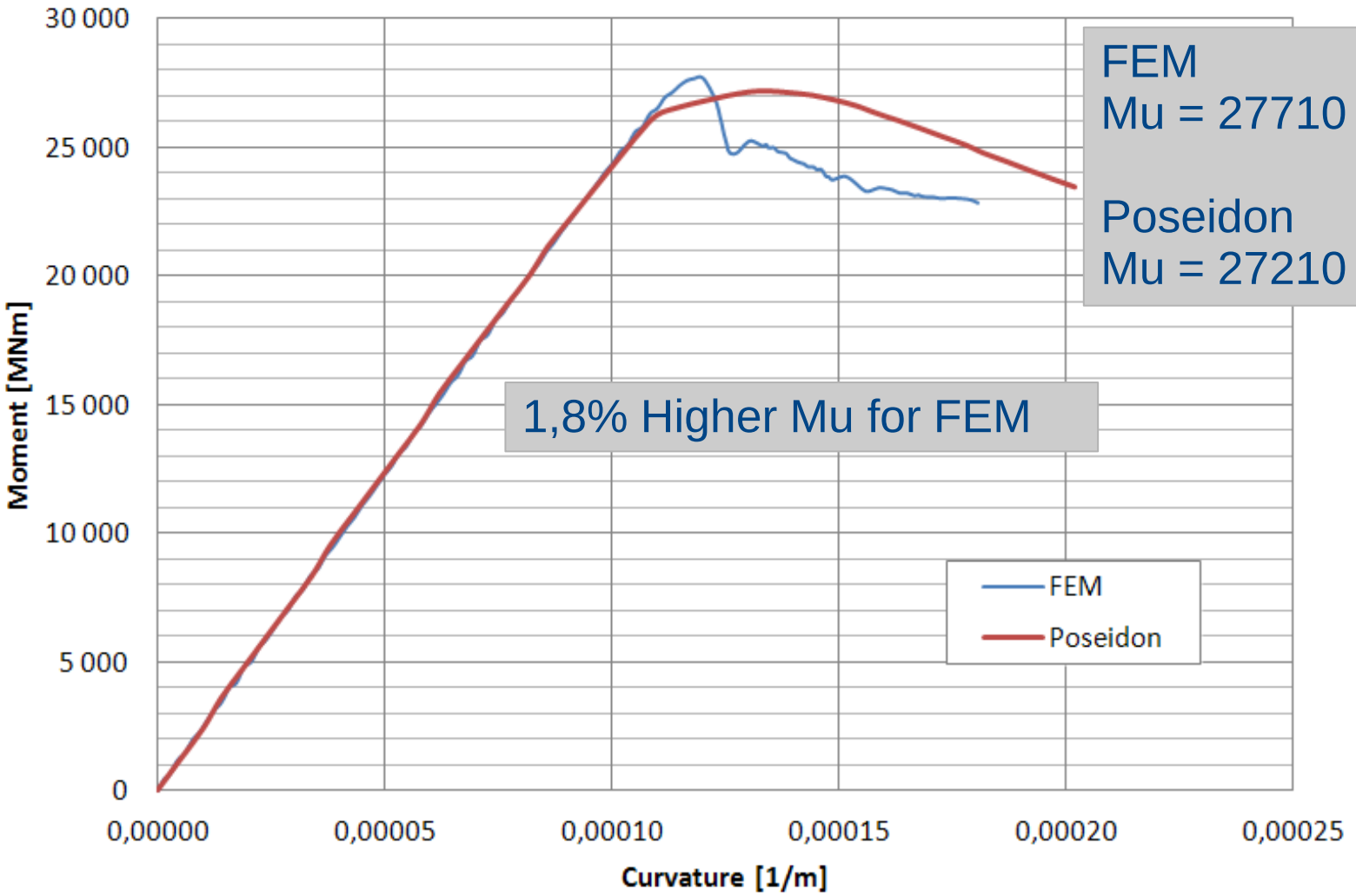






Comparison FE analysis - Poseidon

Ultimate strength



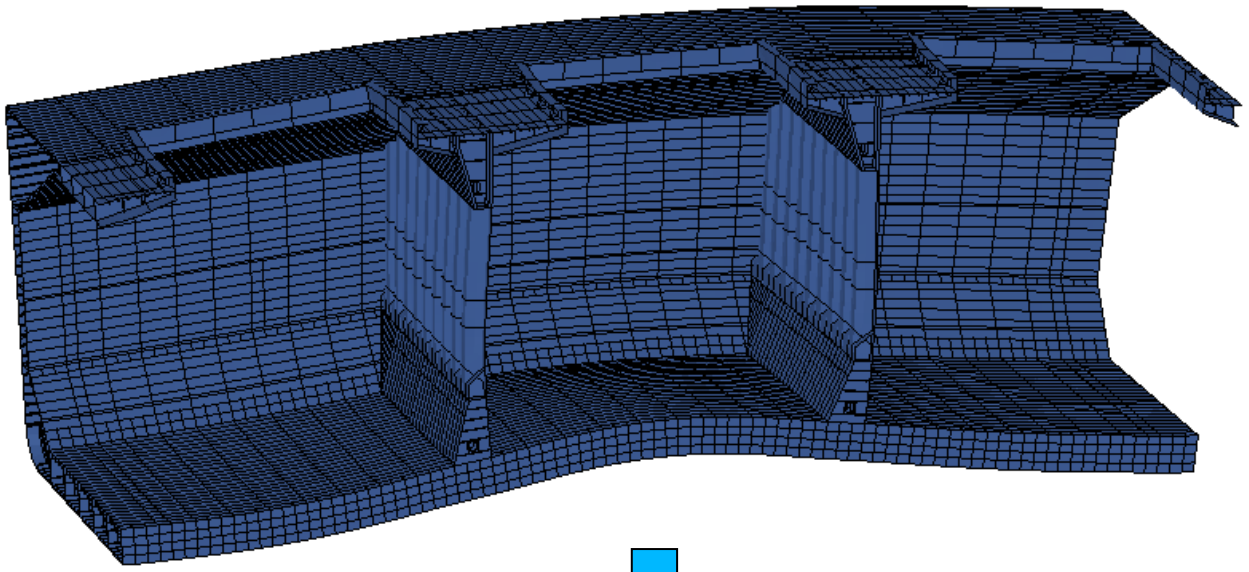
FEM
Mu = 27710 [MNm]

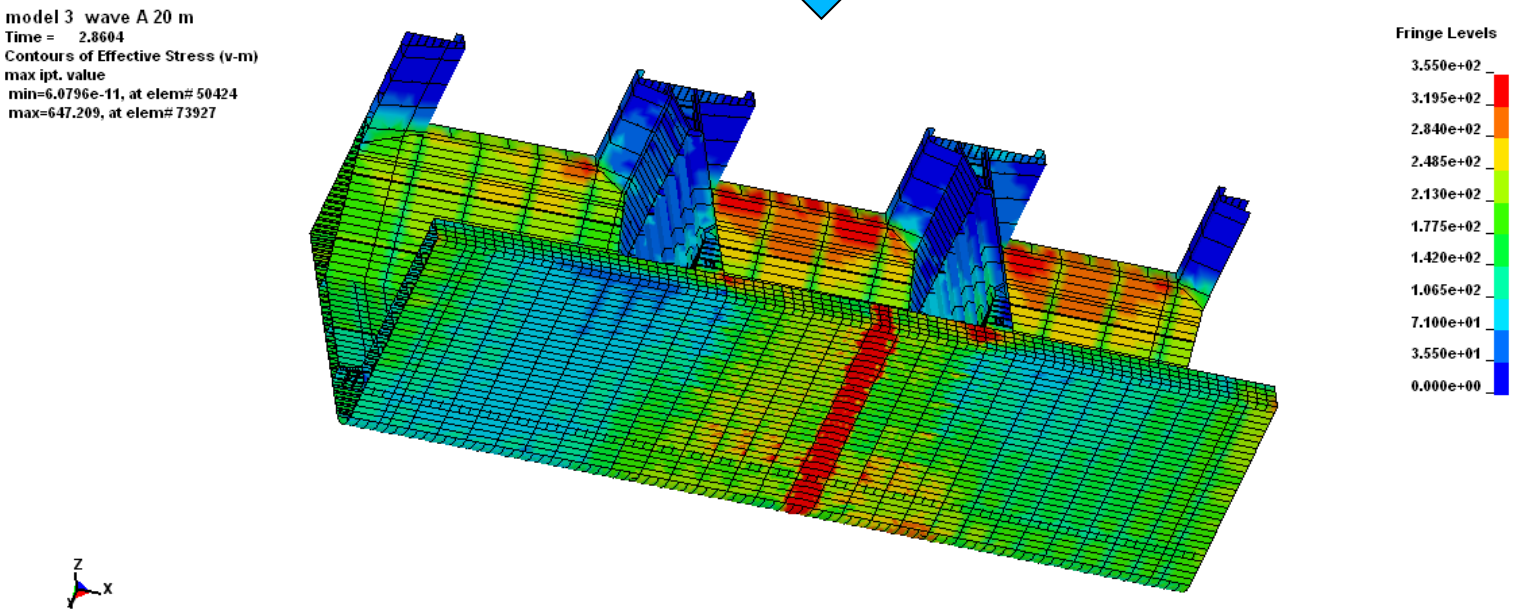
Poseidon
Mu = 27210 [MNm]

1,8% Higher Mu for FEM

Conclusions

- Progressive collapse on two FE models were performed
- Smith's method and results from FEA are comparable
- Bottom bending effects decrease ship's ultimate strength




model 3 wave A 20 m
Time = 2.8604
Contours of Effective Stress (v-m)
max ipt. value
min=6.0796e-11, at elem# 50424
max=647.209, at elem# 73927
Fringe Levels
3.550e+02
3.195e+02
2.840e+02
2.485e+02
2.130e+02
1.775e+02
1.420e+02
1.065e+02
7.100e+01
3.550e+01
0.000e+00
Z
X