STRUCTURAL DESIGN OF MEGA LNG CARRIER
by
HASAN DEEB

"EMSHIP"
Erasmus Mundus Master Course
in "Integrated Advanced Ship Design

Szczecin university
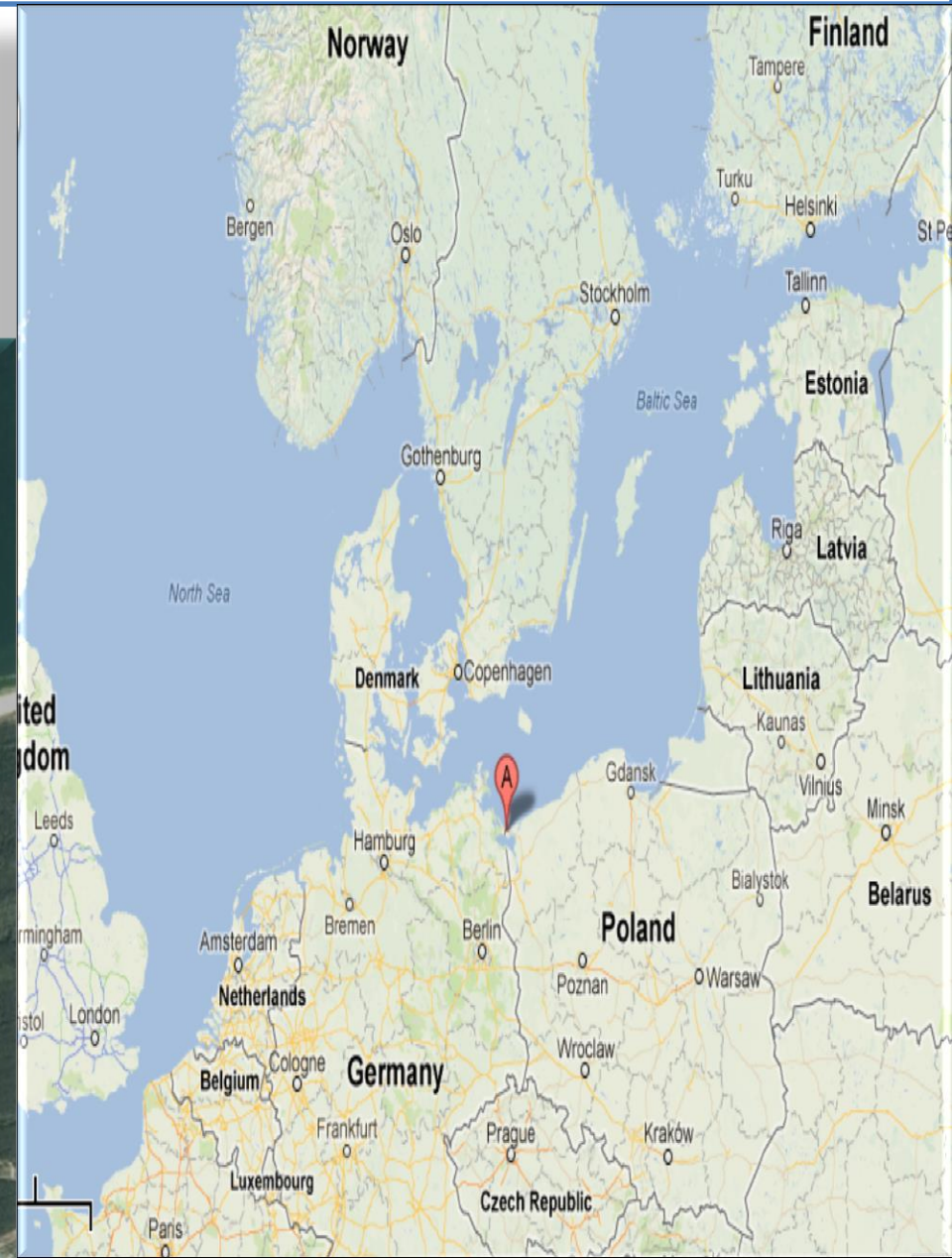Poland, 2013

LNG Carriers

LNG Carriers

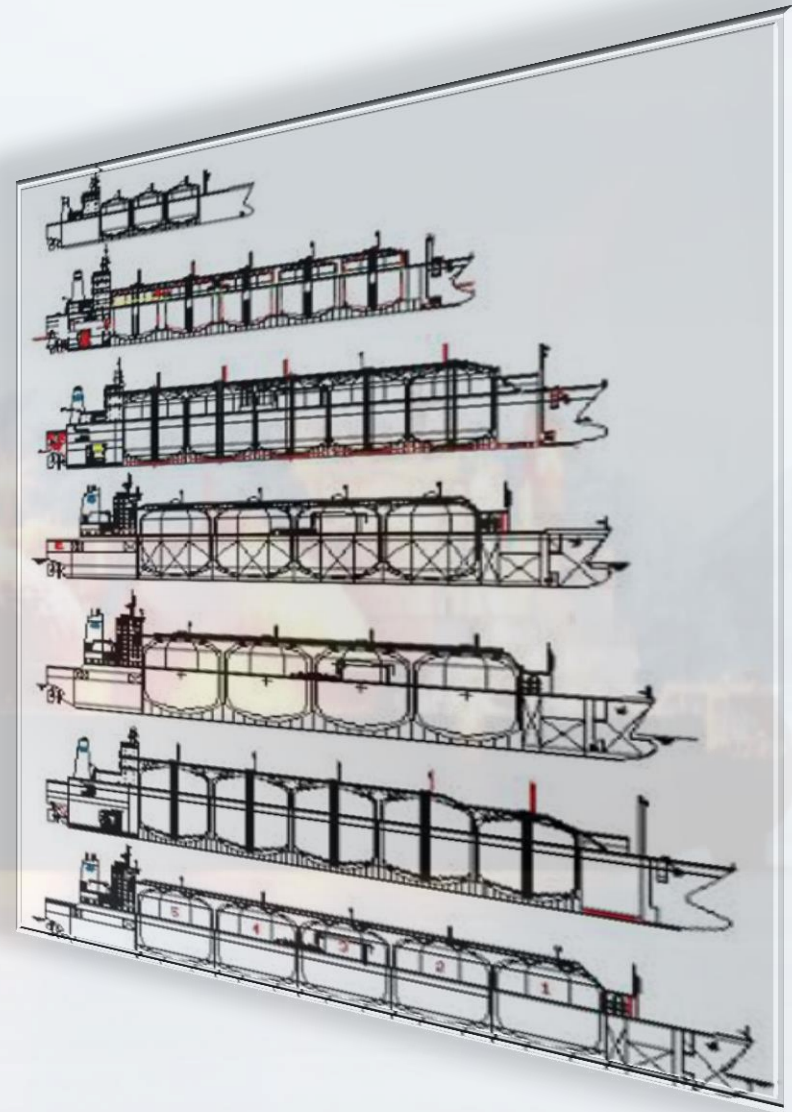LNG Terminal Świnoujściu
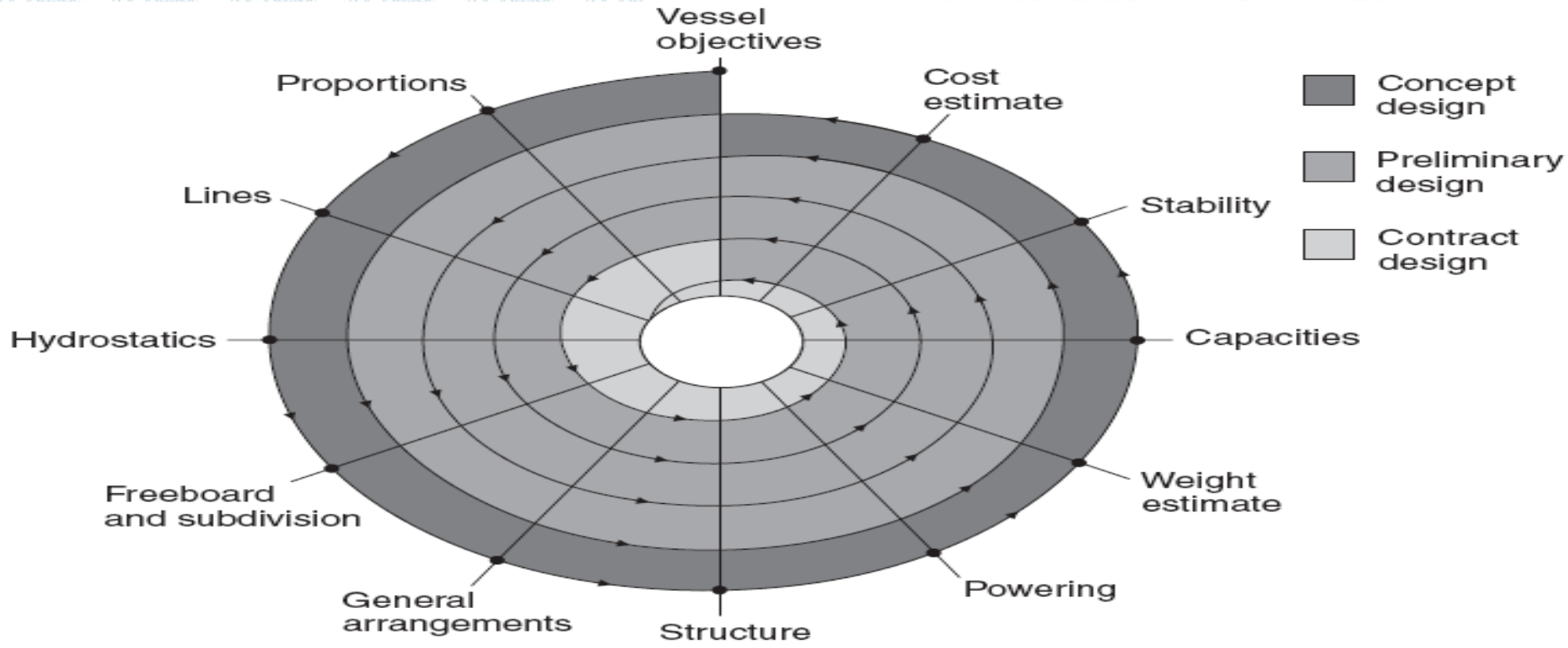strategic location and advantages

WHAT IS LNG ?

WHY LNG ?

SIZE OF THE MAKET?

1- Increasing of demand on LNG sources require building bigger and bigger ships, this make the engineers in challenge to ensure the safety of ships and ability to survive carrying this huge amount of cargo.

2- Design LNG ship which can navigate under real conditions safely and numerical verification before build it in shipyard.
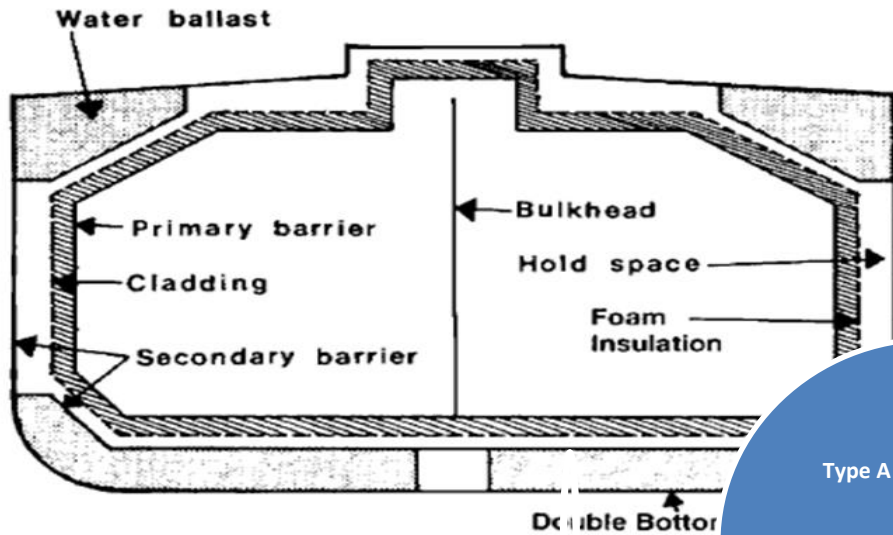
Principle Of Ship Design
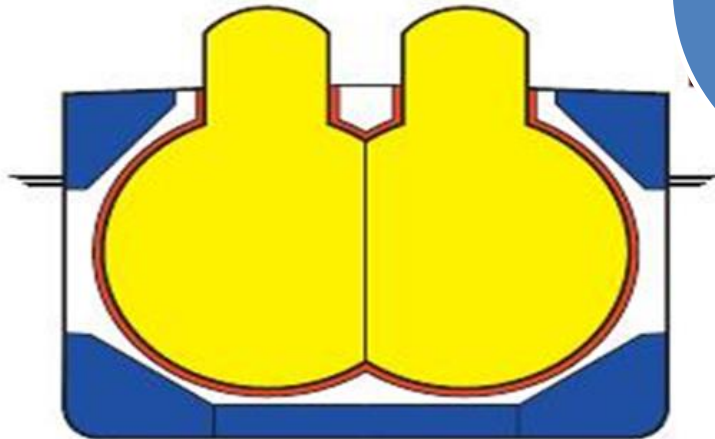
Water ballast
Primary barrier
Cladding
Secondary barrier
Bulkhead
Hold space
Foam Insulation
Double Bottom

Cover
PROTECTIVE STEEL DOME
INSULATION WITH SPLASH BARRIER
Support Pillars
TANK SHELL
CARGO TANK
SPRAY SHIELD
STIFFENED SUPPORT SKIRT
INSULATION PART WAY DOWN SKIRT
INSULATION
DRIP TRAY

Type A
Type B
Type C
membrane

Hull
Insulation
primary membrane
ballast tanks

Midship Section
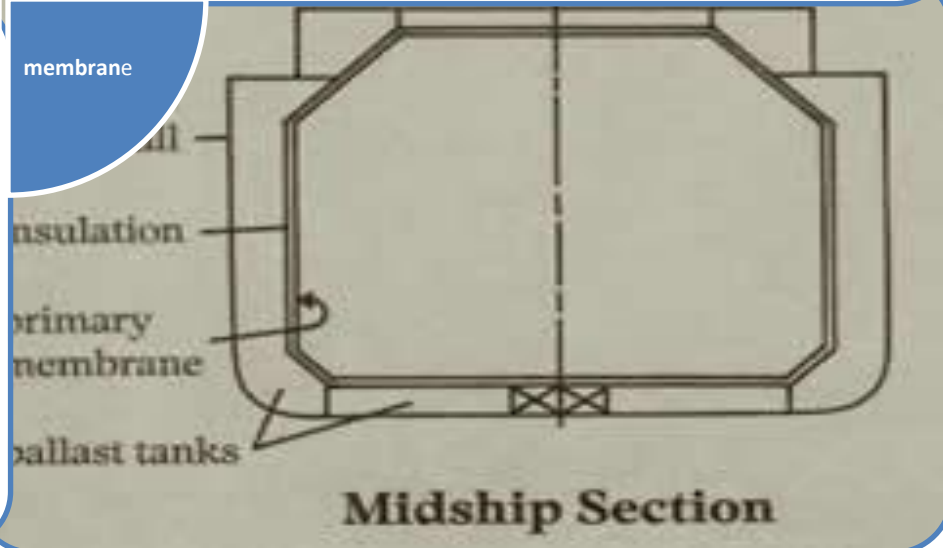
Main Characteristics

L_{oa}	293 m
B	49 m
T	12 m
D	27 m

LNG Carriers

double side shell

bottom

space of one cargo hold

Frame Number: 86
X/L=0.478
xp=137.140 [m]

AP Fr.No: 0

FP Fr.No:

3D Model In Poseidon

double transversal girder in double bottom

longitudinal stiffiner

main transversal fram

cover plat

tank plat

center column

main deck

skirt

foundation deck

Central column

tank lower plat

skirt structur

bulkheads
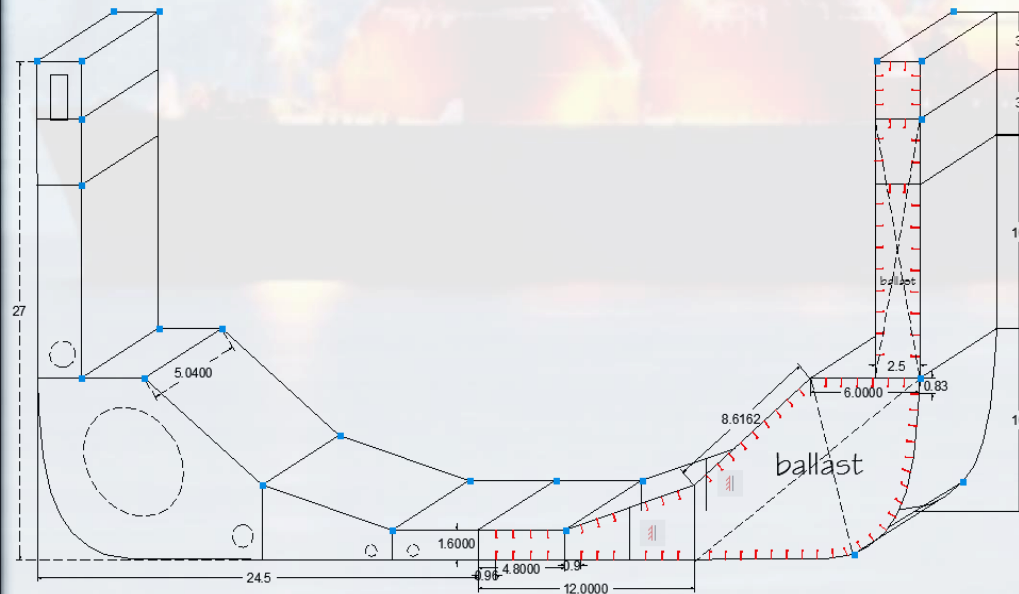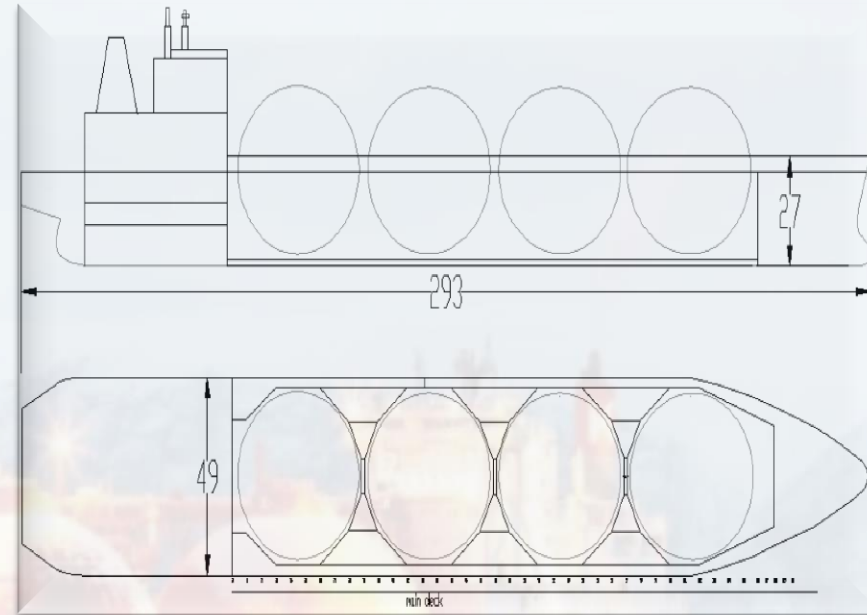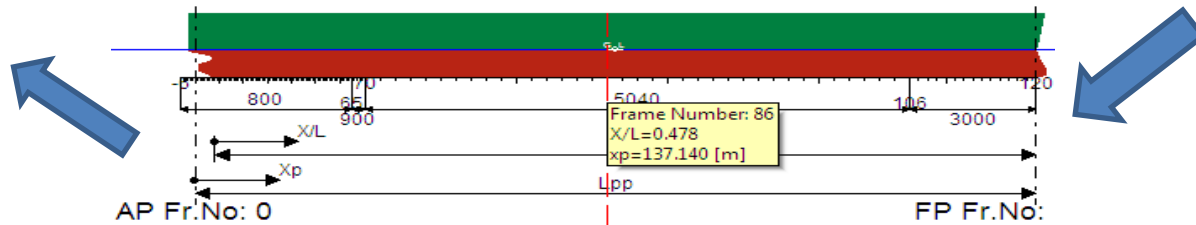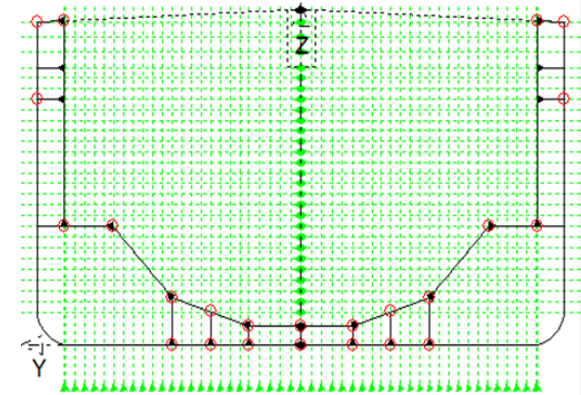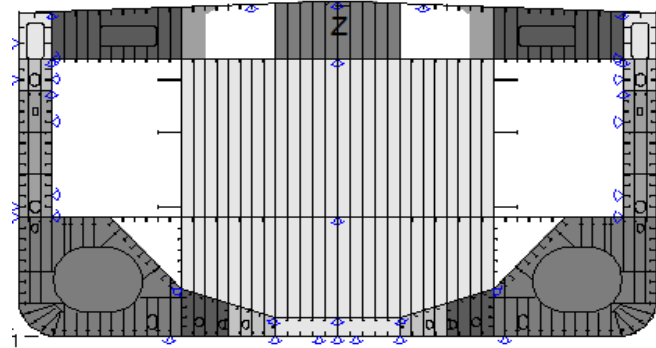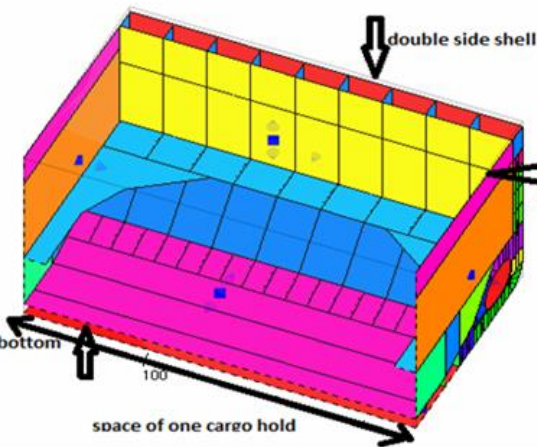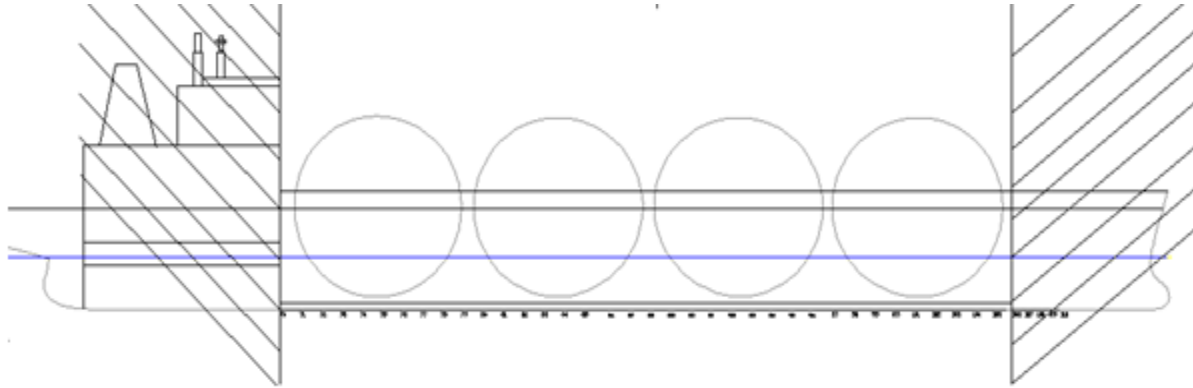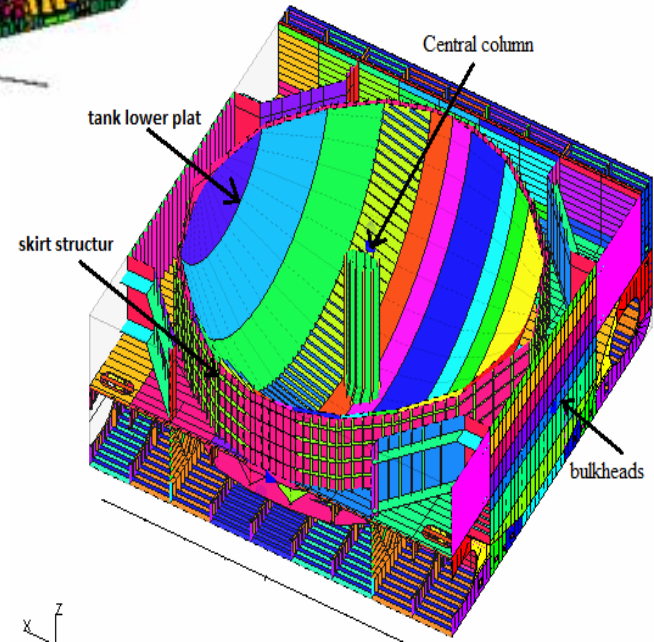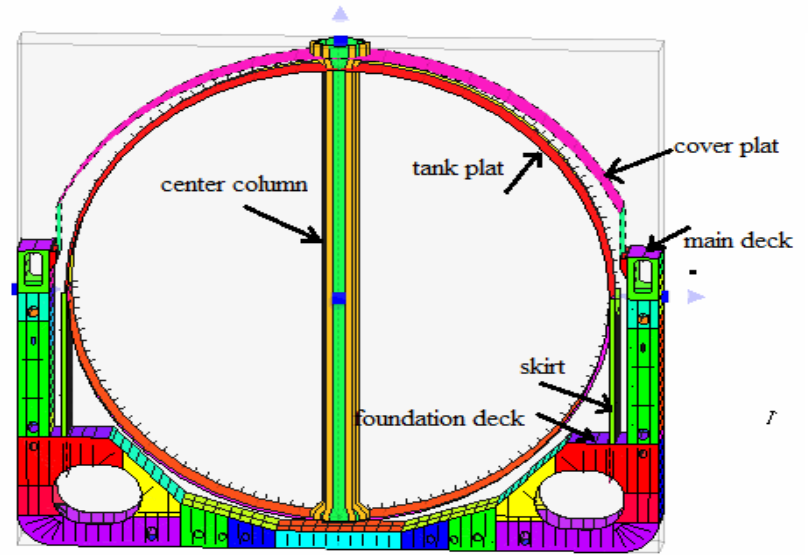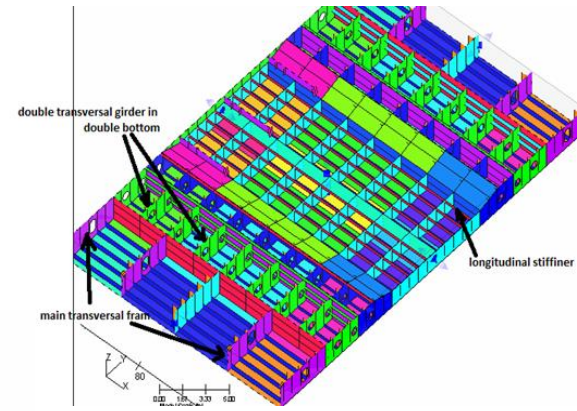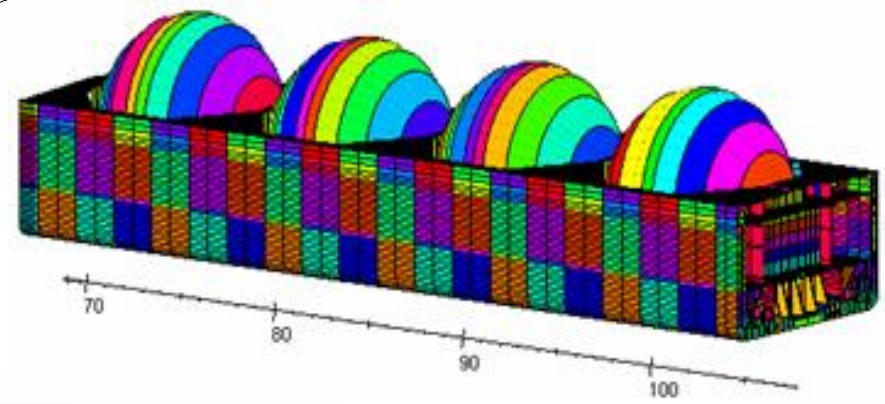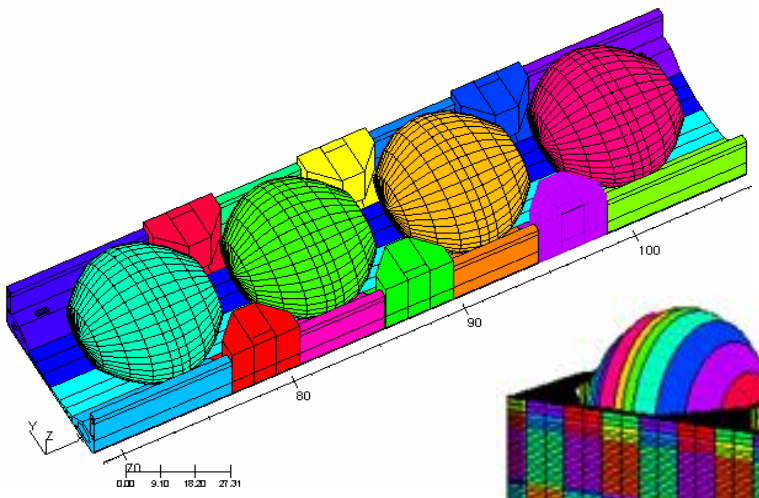
- Weight of structure of the ship
- Weight of cargo
- buoyancy

(a) VESSEL IN STILL WATER

(b) VESSEL IN SAGGING CONDITION

(c) VESSEL IN HOGGING CONDITION

Bending Moment Diagram

SF_{max}

BM_{max}

n

Shear Force Diagram

Length Overall (LOA)

SF_{min}

Scantling

STR18;
t= 16.0*
required 16.4

		Bending Moments BM		Shear Forces SF		Tors.Moment
	Frame No.	Max [kN*m]	Min [kN*m]	Max [kN]	Min [kN]	+/- [kN*m]
▶	0L	0	0	0	0	0
	0.3L	4346759	-3591816	77270	-71625	271863
	0.7L	4346759	-3591816	77270	-71625	247998
	1.0L	0	0	0	0	0
*	1.0L	0	0	0	0	0

I◀ ◀ Record 1 ▶ ▶I ◀

Design Stillwater Bending Moments and Shear Forces

- Section modulus values achieved according to results of scantling is W= 55.253 m³.
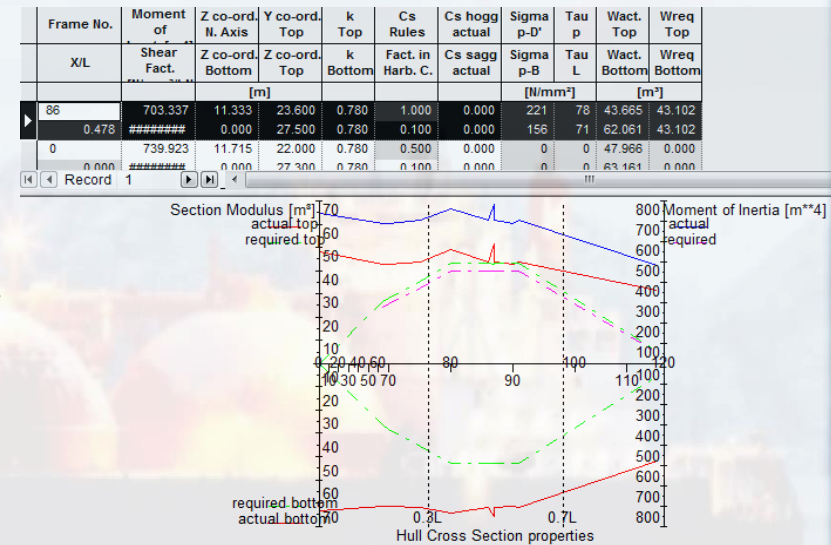- Value of midship section moment of inertia I = 454 m⁴.

- $\sigma = M / W$

- M = bending moment

- W = section modulus

- In the longitudinal girders at deck and bottom, the combined stress resulting is not to exceed 230 N/mm².

- From results maximum values is in Fr 86 : 221 Mpa in deck and 156 Mpa in bottom

  Load case 1: load caused by vertical bending and static torsional moment;
  Load case 2: load caused by vertical and horizontal bending moment as
          well as static torsional moment;
  Load case3: load caused by vertical and horizontal bending moment as
          well as static and wave induced torsional moment.

Scantling

- Results of normal stress distribution
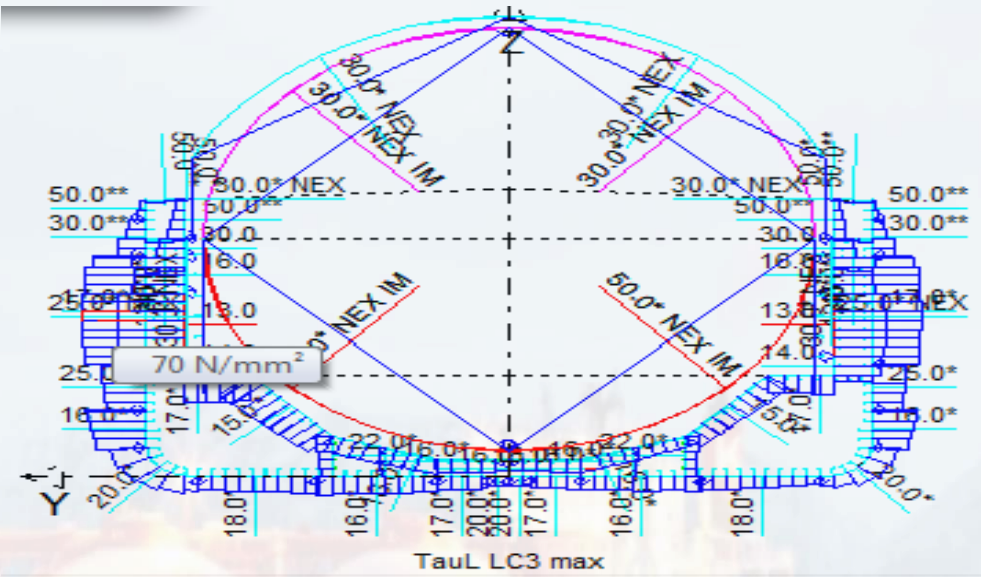- Maximum value in

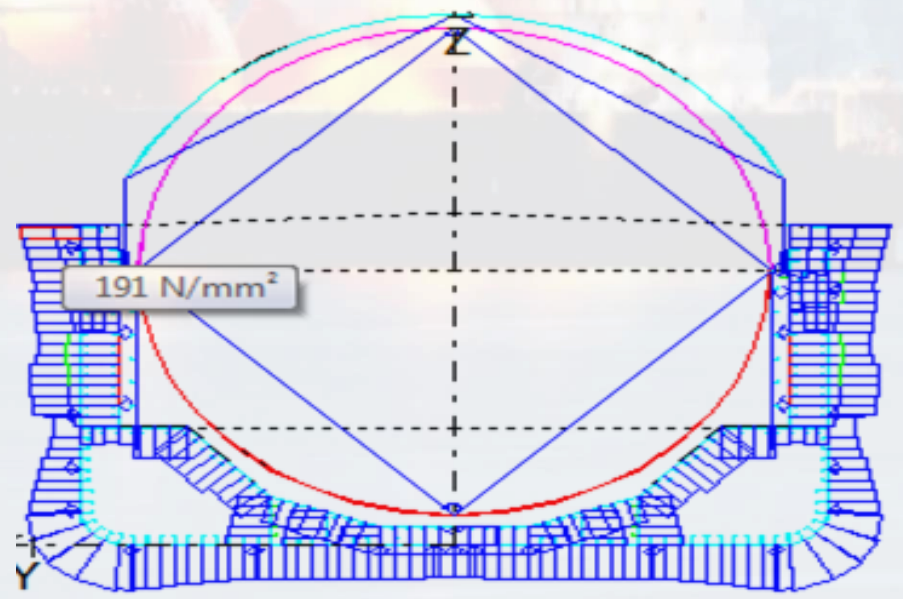Load case 1: load caused by vertical bending and static torsional moment

LNG Carriers
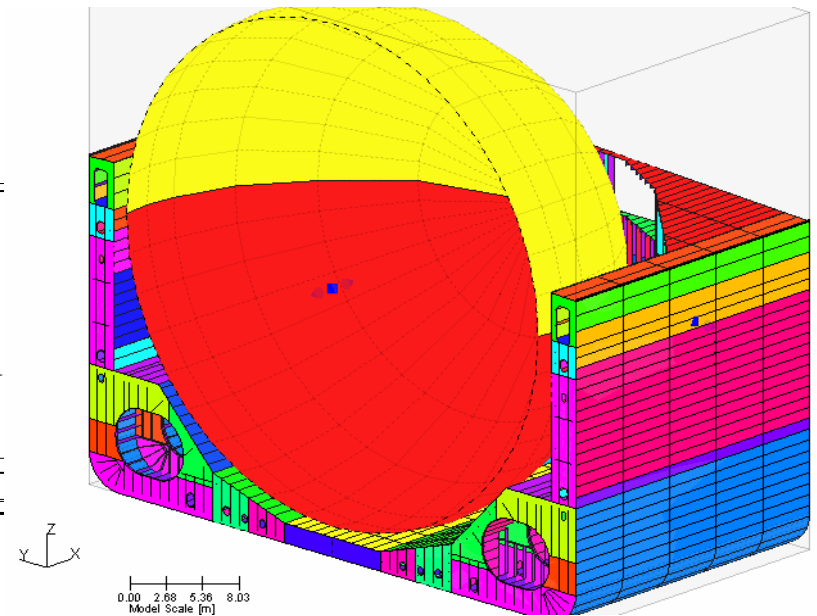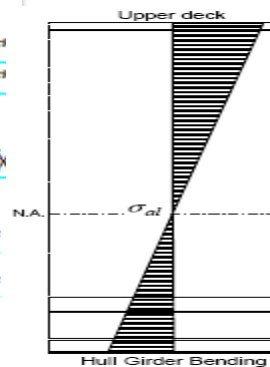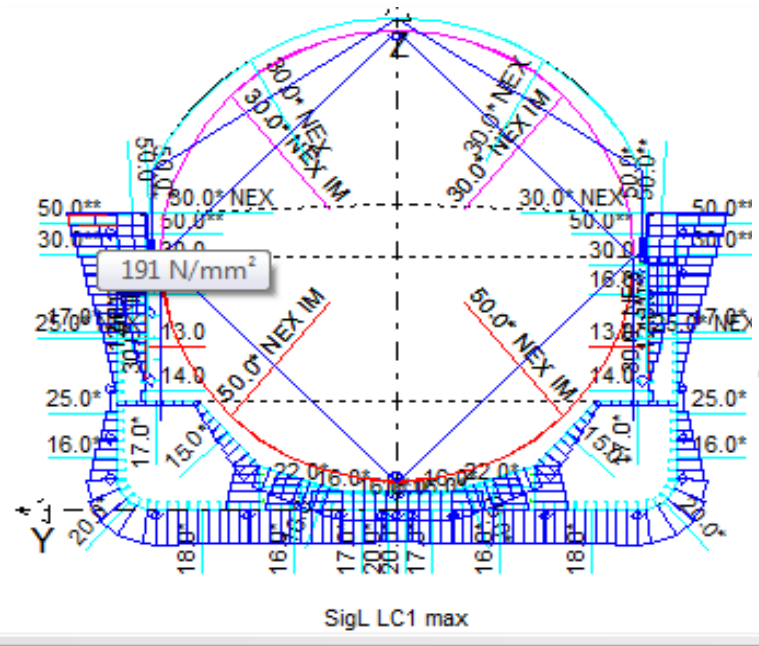
- Shear stress distribution

  maximum value in load case 3

- Von Mises stress distribution

TauL LC3 max

70 N/mm²

191 N/mm²

Estimation Of Mass
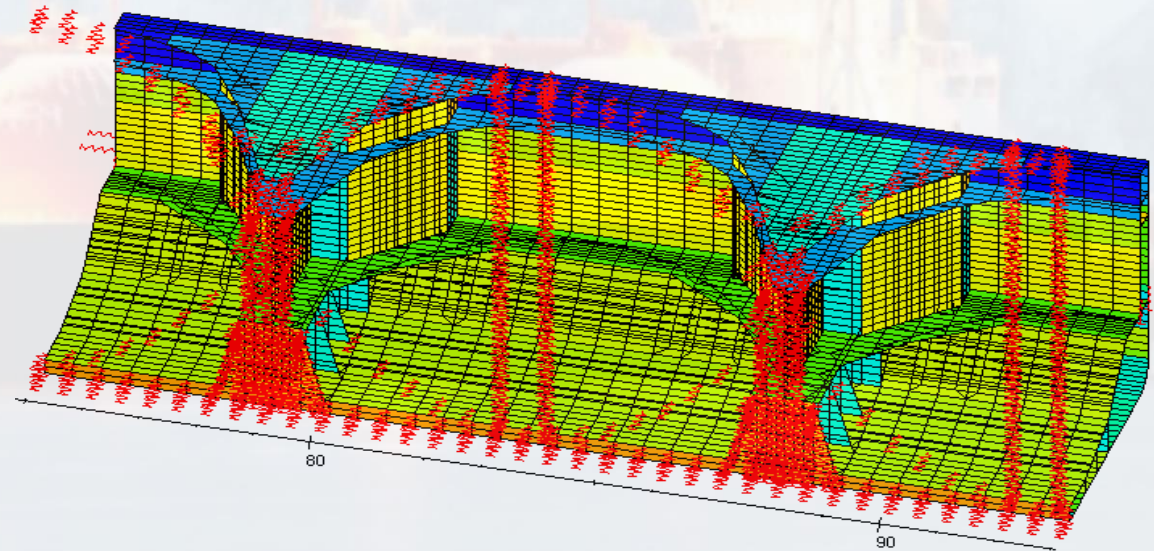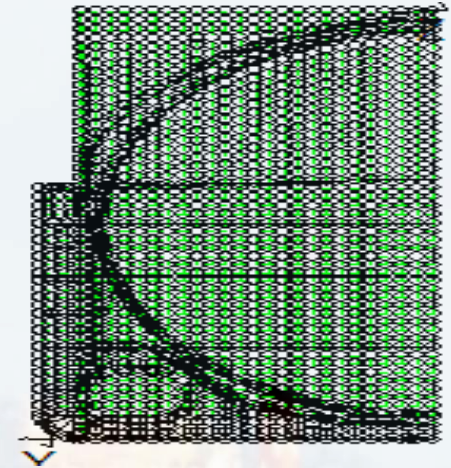
- Very important task (good results of this work will have big influence on the success of the project)
- Give an idea about the coast
- Move in the right direction for optimization

- Longitudinal plate
- Longitudinal stiffener
- Transversal plates
- Transversal stiffener and girders
- Total section weight

LNG Carriers
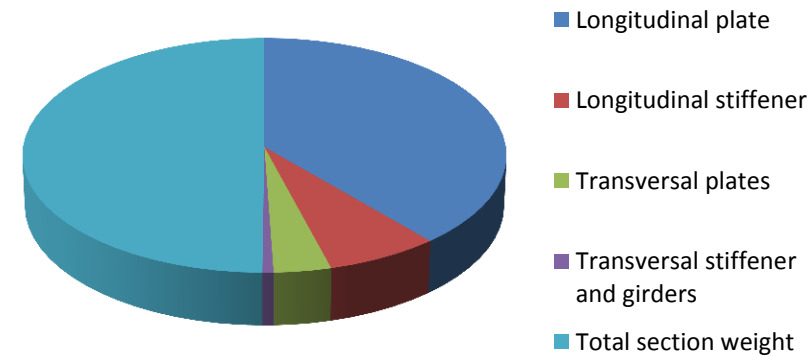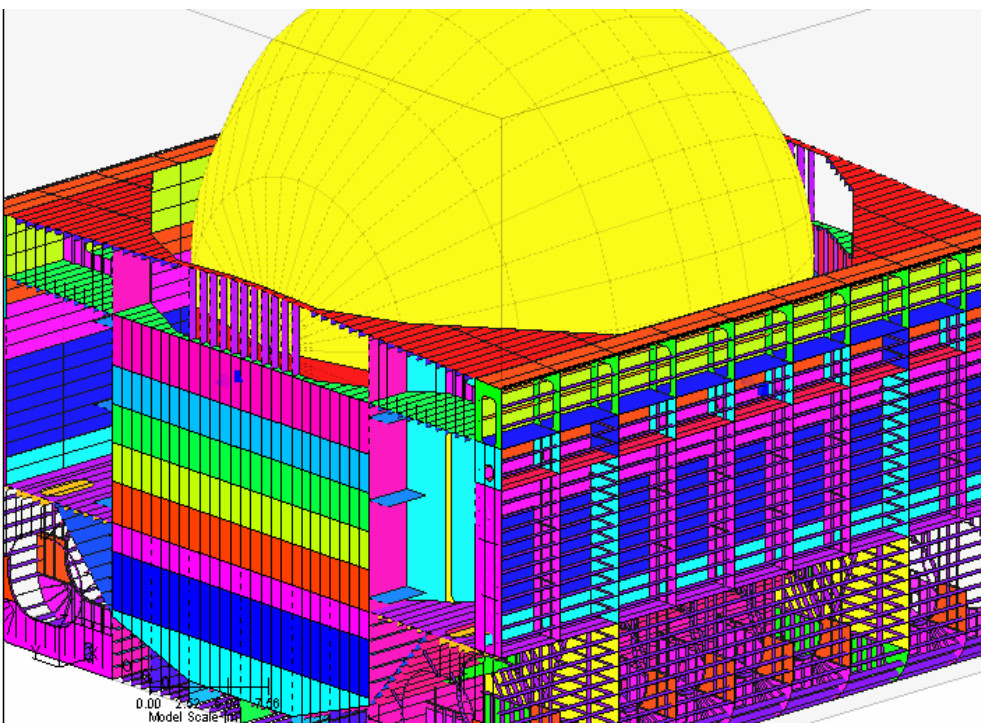
Generate FE model

1- Mesh tolerances

2- boundary conditions

LNG Carriers

Generate FE model

3- Loads specifications

		Wave Length				Position of Wave			
	Load No.	Lambda [m]	Lambda/L	Co [m]	Mue [deg]	xp/Lpp	Frame No.	xwh [m]	dx [m]
▶	1	273.54	1.000	10.61	0.00	0.500	87 -2180	68.385	0.00
	2	273.54	1.000	10.61	0.00	0.000	0	68.385	0.00
*	2	273.54	1.000	10.61	0.00	0.000	0	68.385	0.00

3-1 External loads (draft Marge, wave definitions)

3-2 Internal loads

LNG Carriers

Generate FE model

4- Selected load cases

4-1 load case 1

Studied part, load case 1
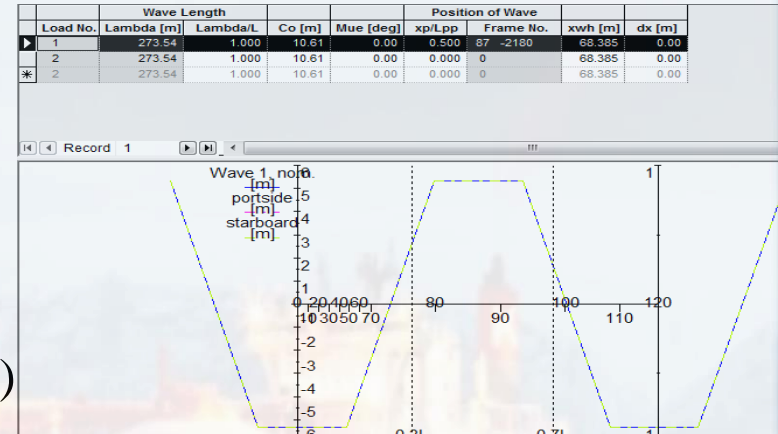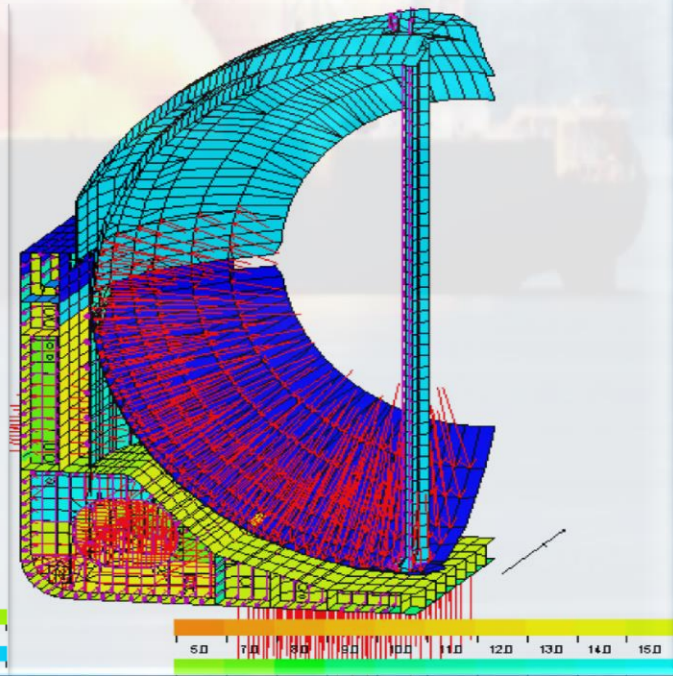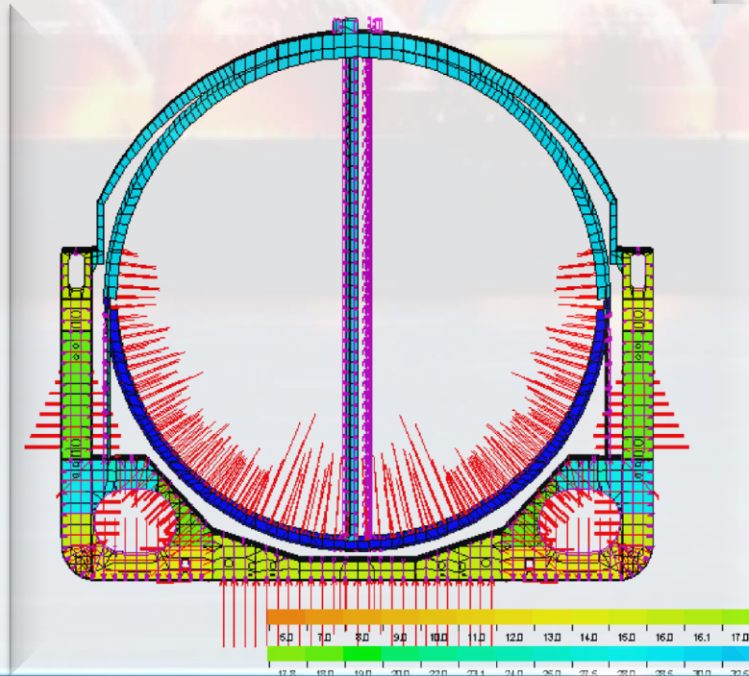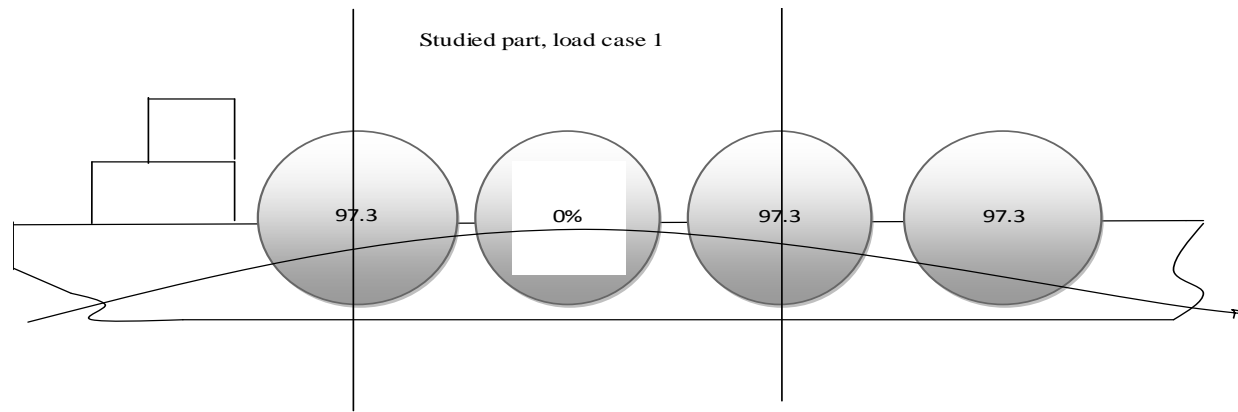
| 97.3 | 0% | 97.3 | 97.3 |

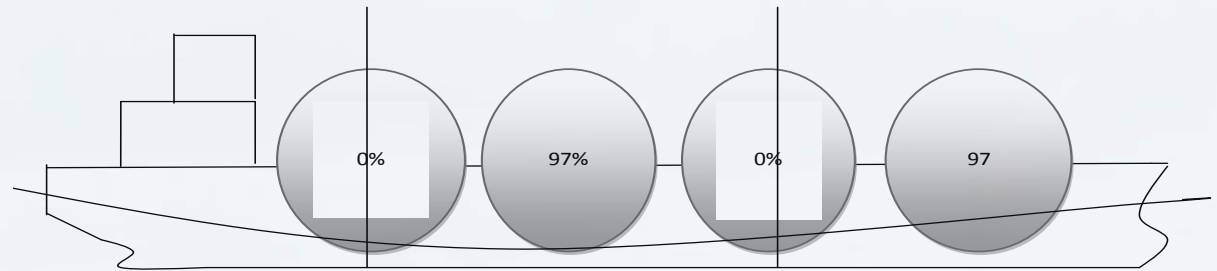| Loading condition	2 full tanks with empty tank in middle
External pressure	Hydrostatic due to static water line
Cargo pressure	Cargo pressure due to gravity
Additional applied	Rule hogging vertical design wave bending moment distribution and permissible hogging still water bending moment envelope, Msw, are to be applied.
External pressure	Local wave crest (to be applied to full length of FE model)
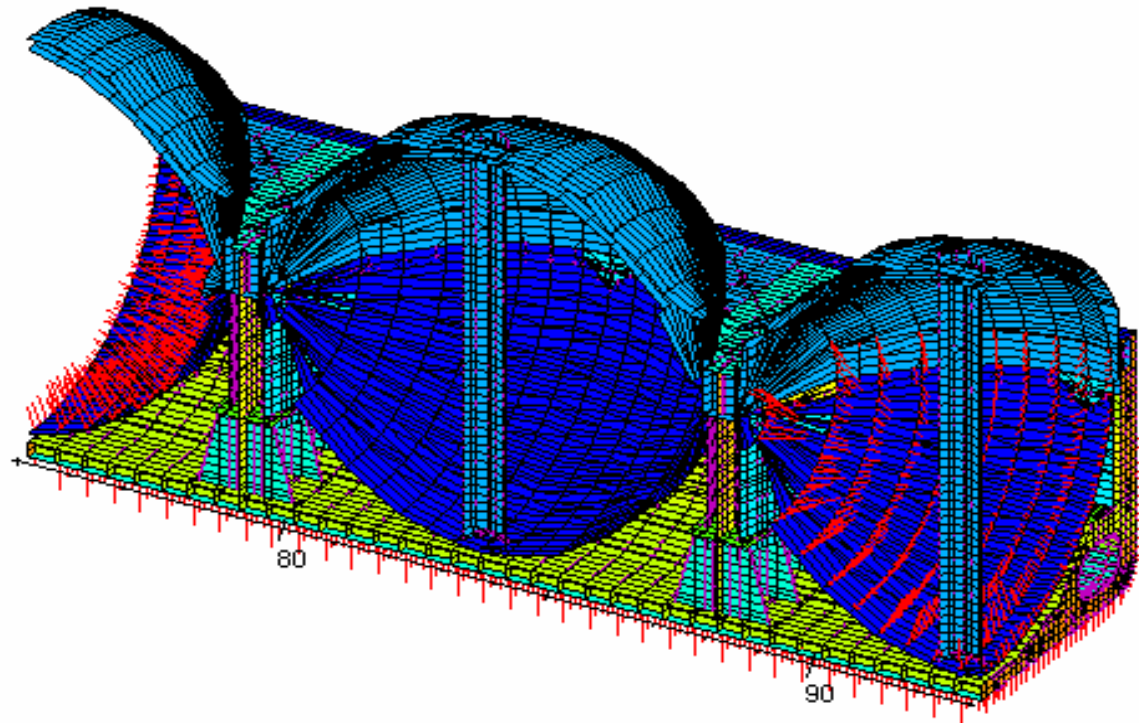
Generate FE model

4- Selected load cases
4-1 load case 2

| 0% | 97% | 0% | 97 |

| Loading condition	one full tank with two empty tanks in both sides
External pressure	Hydrostatic due to static water line
Cargo pressure	Cargo pressure due to gravity
Additional applied	Rule sagging vertical design wave bending moment distribution and permissible sagging still water bending moment envelope, Msw, are to be applied.
External pressure	Local wave crest (to be applied to full length of FE model)
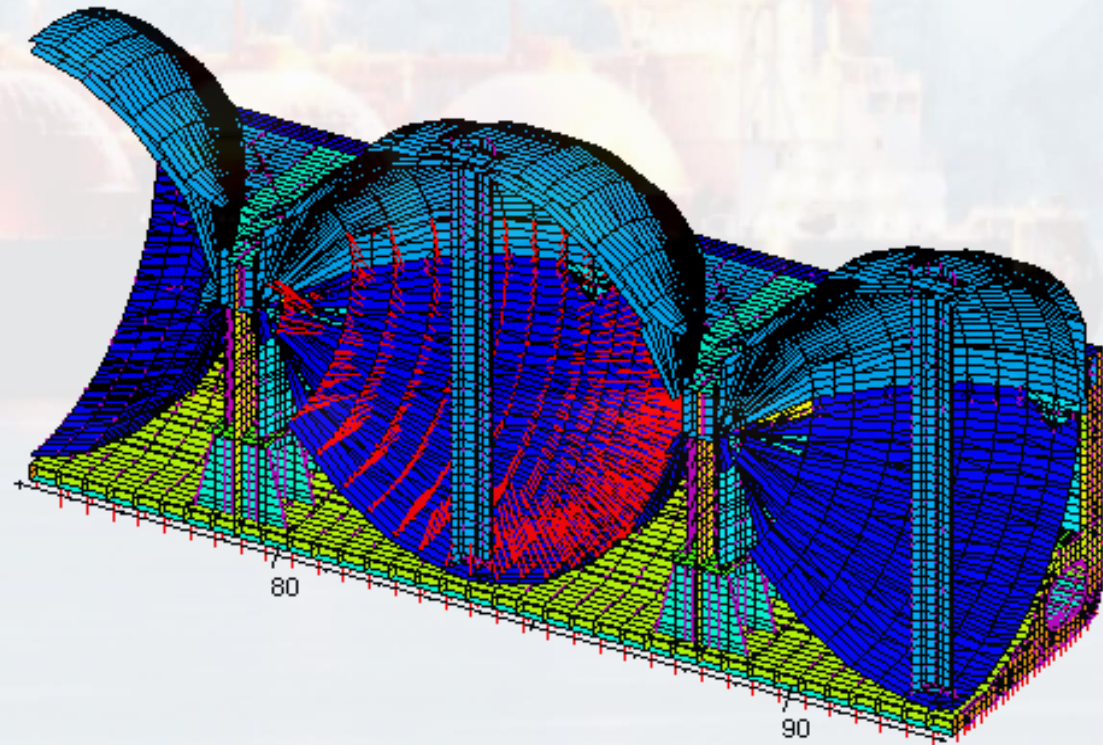
Generate FE model

Adjustment of global bending moment

- Results

1- Distribution of the Von Mises stress stresses

 1-1 load case 1
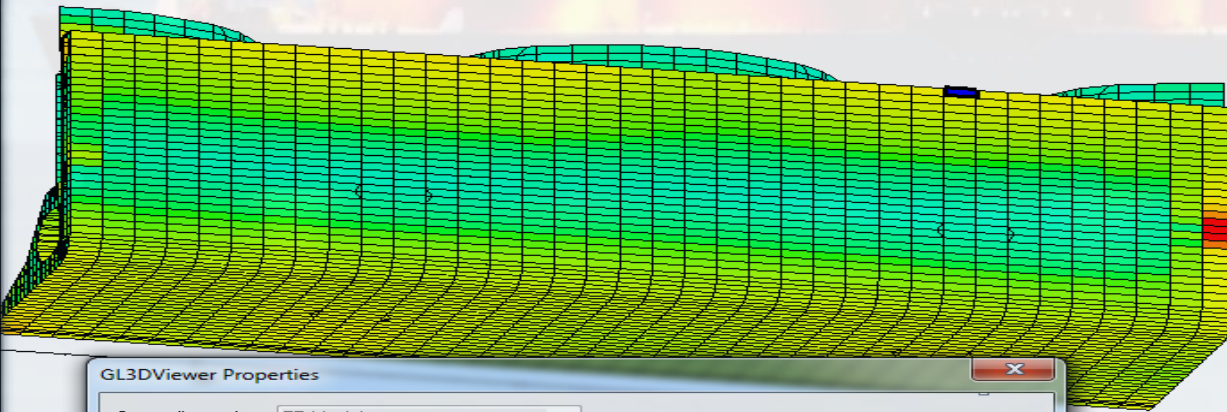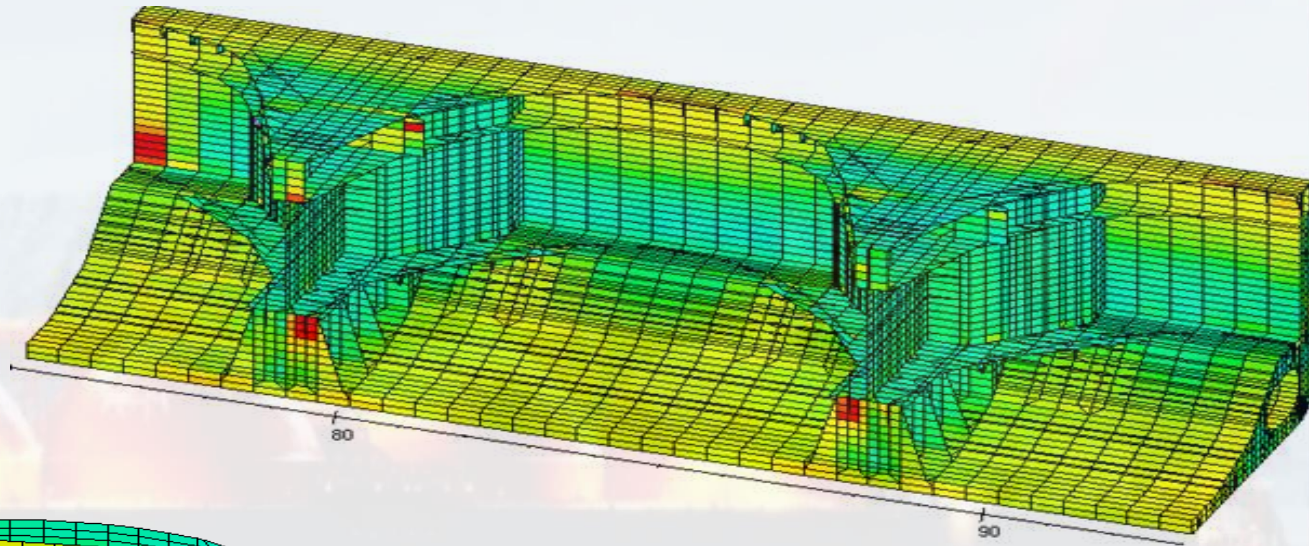
LNG Carriers
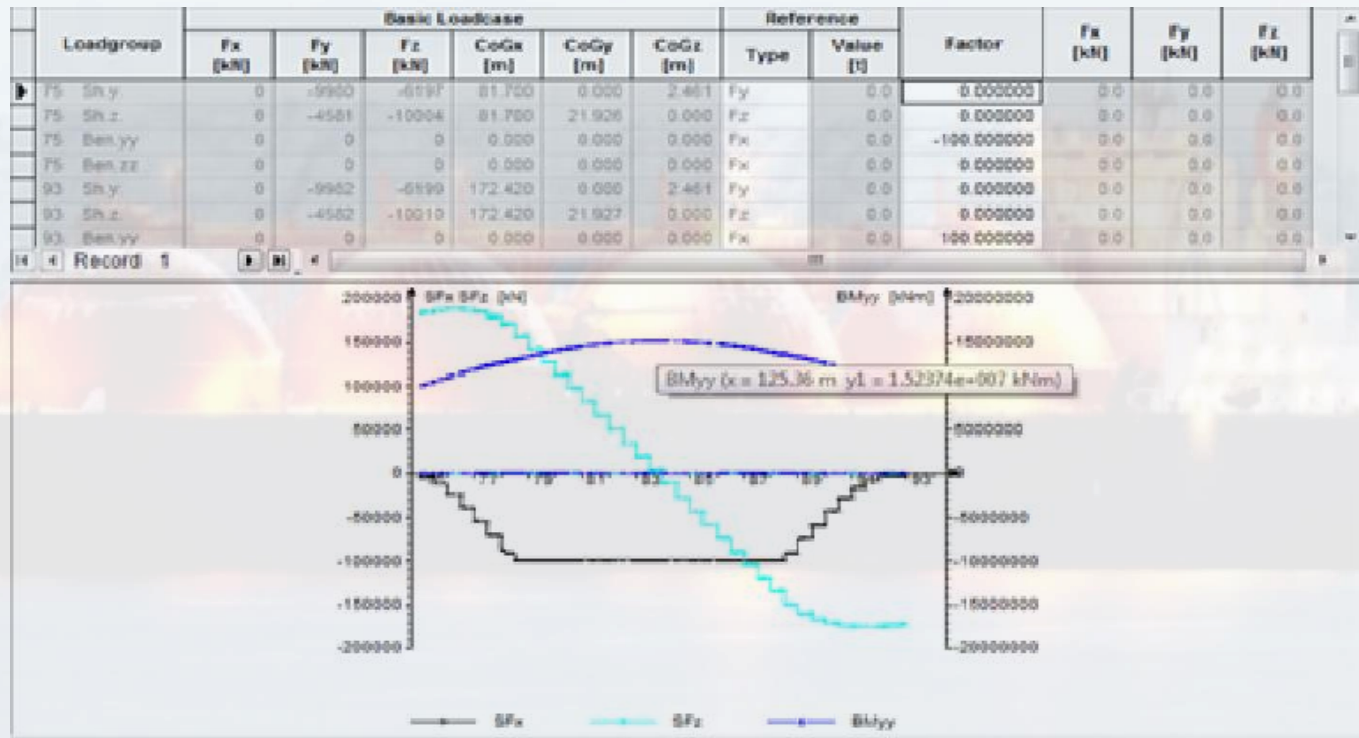
- Results

1- Distribution of the Von Mises stress stresses

 1-1 load case 2

GL3DViewer Properties

Set attributes for: FE Model

Selection | Visual Settings | Loads | Deformation | Results | Layout | Clipping | Settings | OpenGL

Options

LC 2:SAG

Type	Lin	Val	Col
von Mises at Centre			☑
Max. von Mises (GL)			

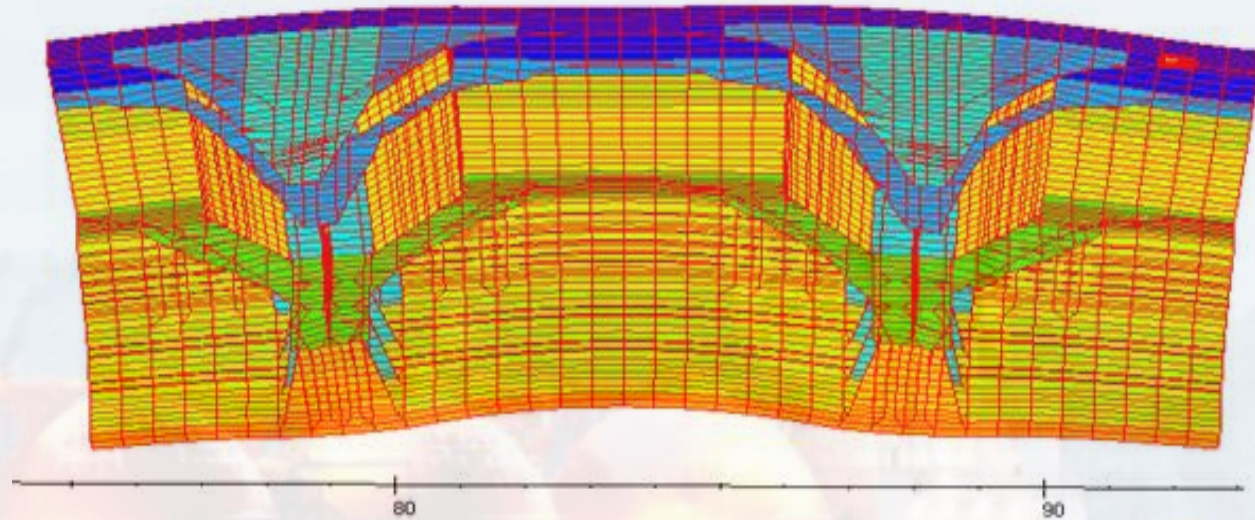☑ Auto Scale Stresses

Scalefactor: 0.189

☐ Use Fixed Scale

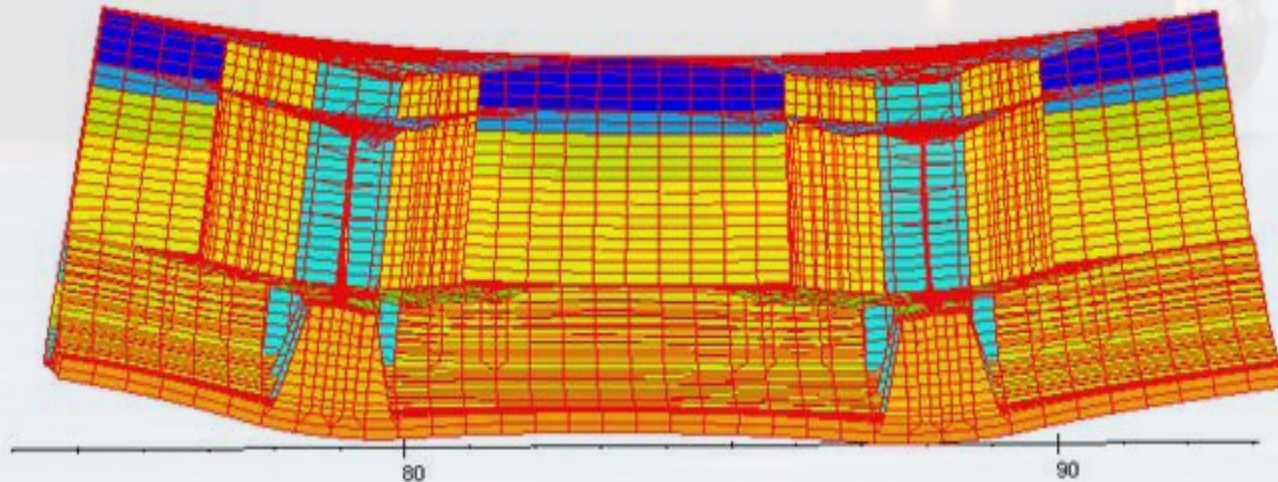- Model deformations under selected load cases

1- LC1

Maximum deflection

In Z = 0.14613

2- LC2

Maximum deflection

In Z = -0.14082

- The resulted structural scantling from the first approach was verified using the second approach which is based on the direct calculation and carried out by performing the finite element analysis of one cargo hold located at the middle of the ship.

- The objective of the ship hull structural design is achieving such hull structure capable of sustaining the different kind of loads which the ship may encounters during her life, and to serve its intended purpose.

Thanks you

dziękuje

شكرا

Let's all hope peace for Syria and all the world

Questions ?