Structural Design of Platform Supply Vessel Less than 90m

Desalegn Eltiro

Master Thesis

presented in partial fulfillment
of the requirements for the double degree:
"Advanced Master in Naval Architecture" conferred by University of Liege
"Master of Sciences in Applied Mechanics, specialization in Hydrodynamics, Energetics and Propulsion" conferred by Ecole Centrale de Nantes

Supervisor: Prof. Zbigniew Sekulski, West Pomeranian University of Technology, Szczecin
Reviewer: Prof. Le Sourne, ICAM

February 17, 2014

Introduction

What

Platform Supply Vessel

Why

- Demand for fuel => Offshore activities are moving to deeper waters
- **30%** World Oil and gas comes from offshore.
  (John Ferentinos, 2013. Global Offshore Oil and Gas Outlook– Infield Systems Gas/Electric Partnership)
- In **2013**, OSV valued at **$69.3 billion** will reach **$91. 23 billion** in **2018.**
  (http://www.researchandmarkets.com/reports/2588246/offshore support vessel market global trends)

Objective

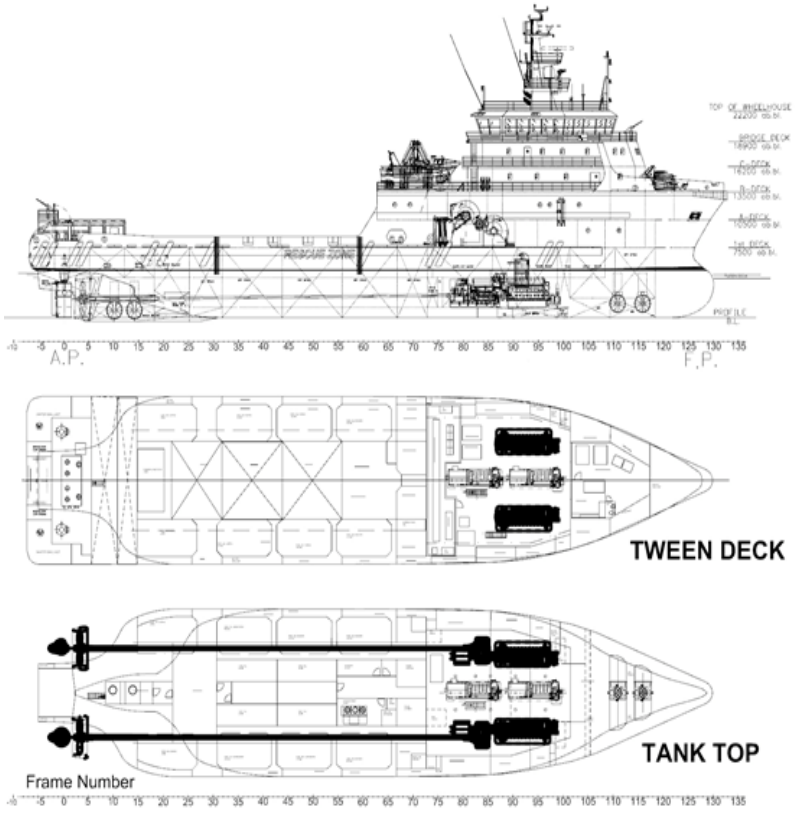
The objective is to do a structural design of platform supply vessel by identifying the responses of the hull under the given loading condition near the mid ship area.

A vessel that:

- withstands the loads it is subjected to over its life span,
- fulfills the classification society requirements, and
- is economically viable.

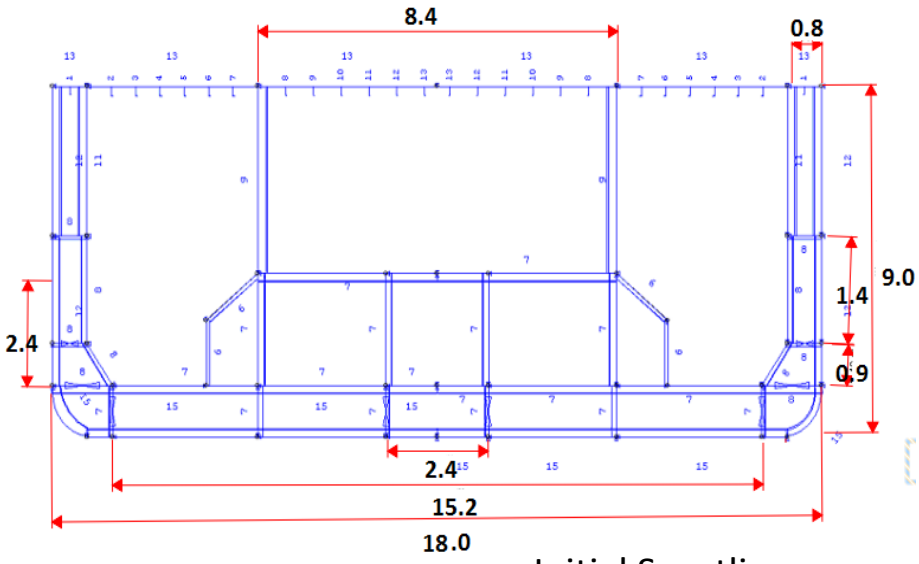
PARTICULARS:	Symbol	Value	Unit
Length Overall	L_{OA}	83.3	[m]
Length between Perpendiculars	Lpp	76.8	[m]
Draught	T	6.2	[m]
Depth to Main Deck	D	7.5	[m]
Moulded Breadth	B	18	[m]
Speed	V	14	[kn]
Block Coefficient	CB	0.721	-
Deck load	P	10	[t/m^2]

General Arrangement



Material and Initial Scantling

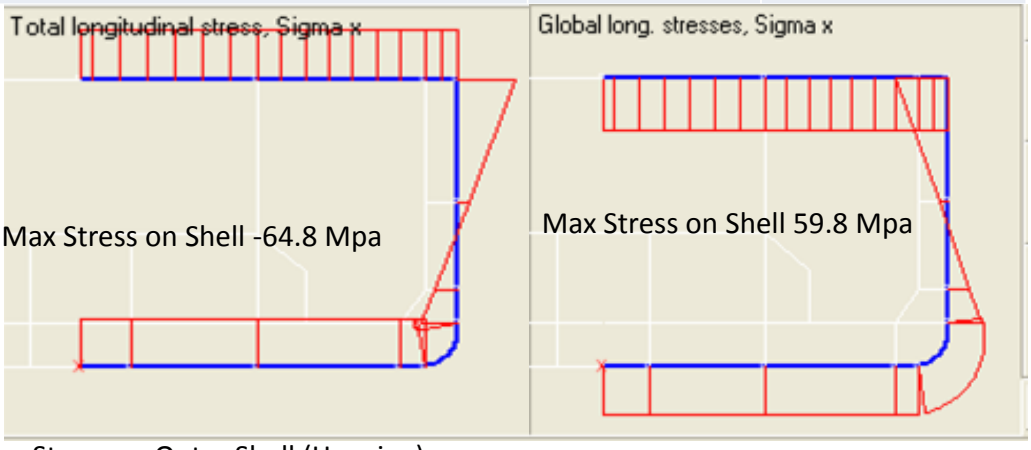
Grade	A	
Yield Point, R_{eH}	235	MPa
Density, ρ	7.85	t/m^3
Poisson ratio, v	0.3	-



Initial Scantling

Design Bending Moments

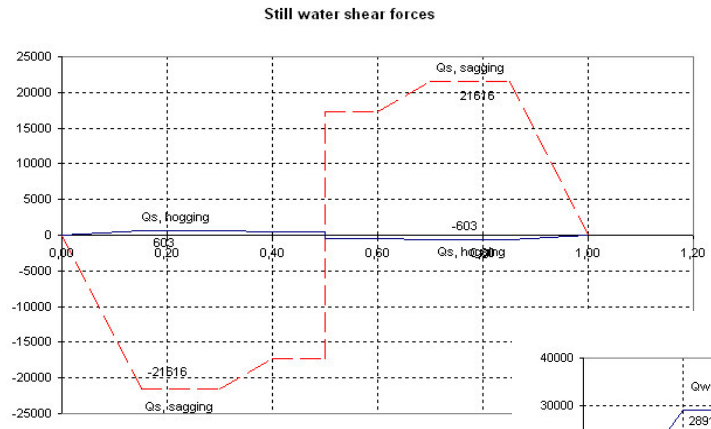
	Sagging(KNm)	Hogging (KNm)
Standard values according to Rules, Mso	60250	60250
Given as input (actual cargo/ballast conditions)	60250	60250
Design still water bending moments, Ms	60250	60250
Design wave bending moments, Mw	100941	88465
Design wave bending moments, Mw for buckling check	100941	88465



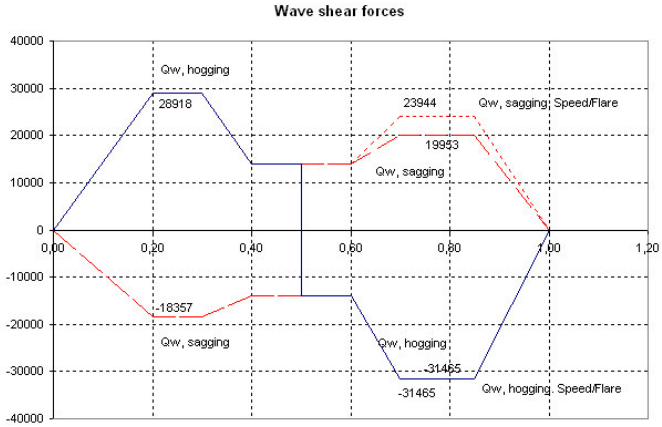
Stress on Outer Shell (Hogging)

Stress on Outer Shell (Sagging)

Shear Force

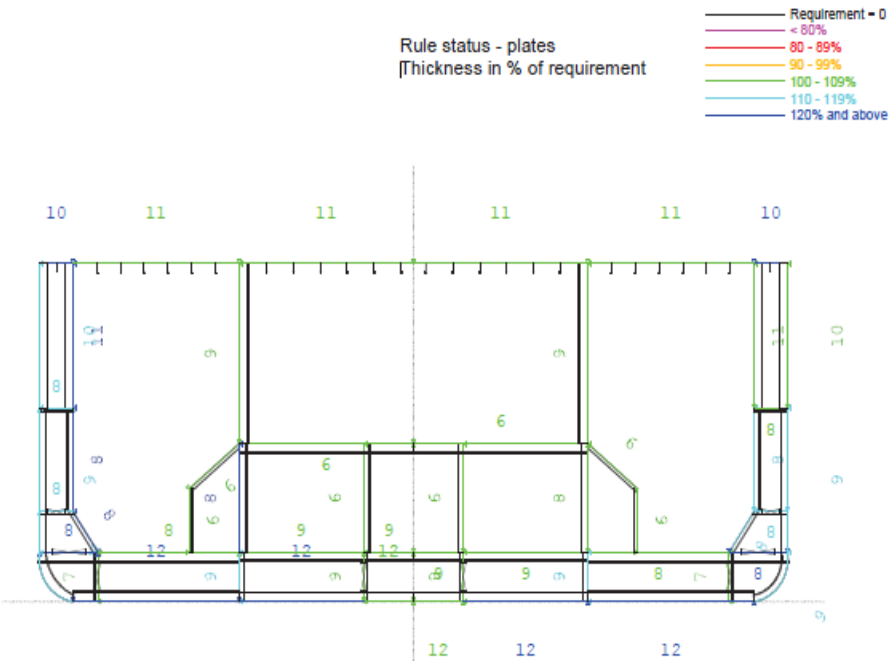


Still water Shear Force

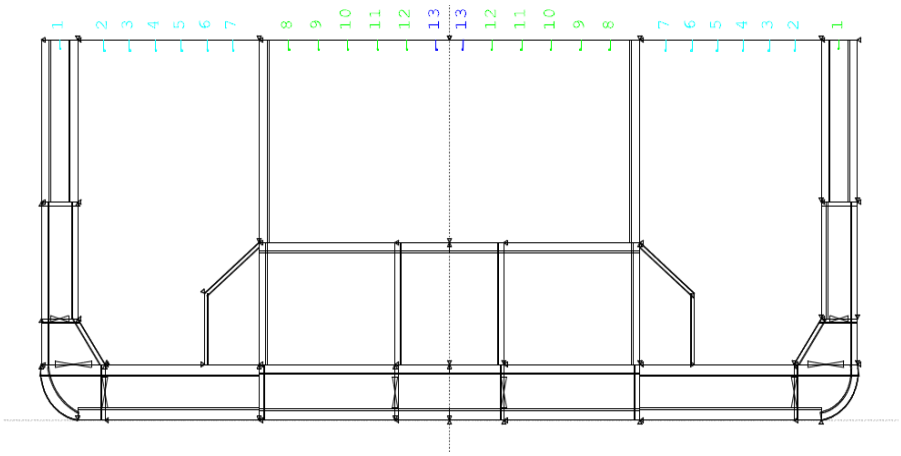


Wave Shear Force

Final Scantling



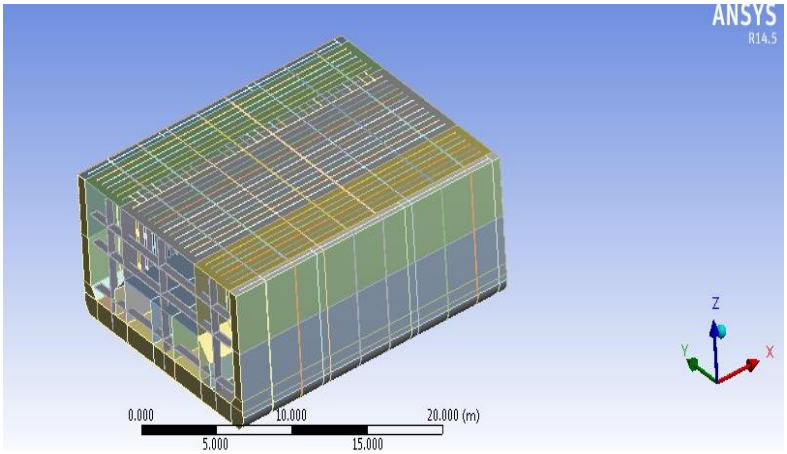
Final scantling of longitudinal stiffeners



Weight Estimation

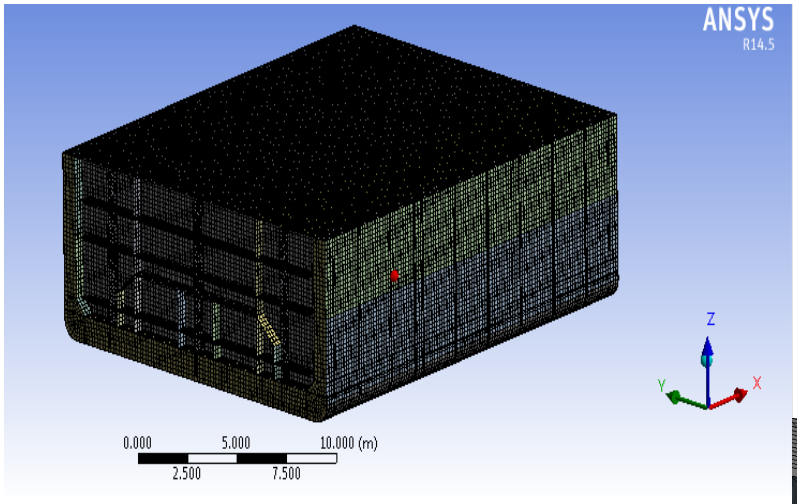
	M, t	M, % Mt
Longitudinal plates	637.89	62.91
Longitudinal Stiffeners	30.087	2.97
Transverse plates (floors and web frames)	38.2122	3.77
Bulkheads plates	6.387	0.63
Transversal stiffeners	214.5762	21.16
Bulkhead (frameworks and stringers)	86.816	8.56
Total mass in one cargo hold, Wt		1013.968

Strength Analysis by FEM

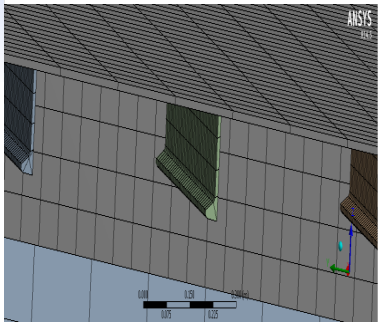


The length of each cargo hold is 6.6 m along the length of the vessel and 0.6 m empty space for separation of cargo are provided at the end of each cargo length.

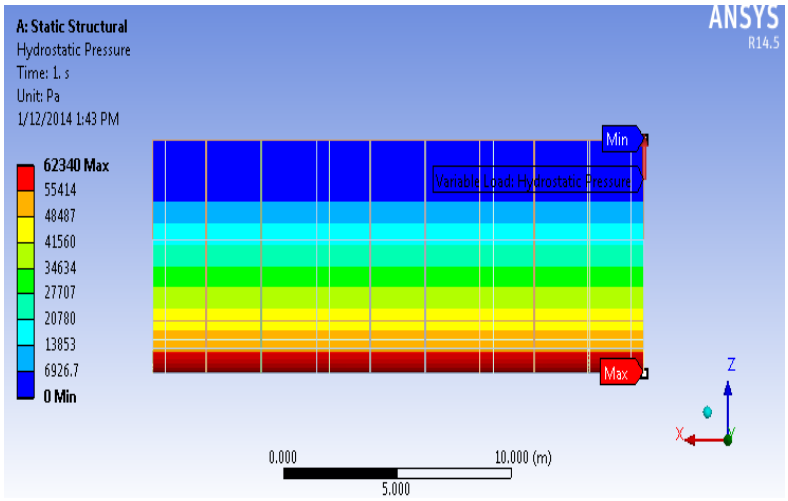
Mesh



- Element size: 233332
- No. of nodes: 883714



Hydrostatic Pressure



Maximum Hydrostatic Pressure = **62340 Pa**

Loading

pressure at the deck, P_d **= 78452 Pa.**

hydrostatic pressure , **P = 62342.58 Pa**

Pressure at the tween deck, P_{td} **= 11128 Pa.**

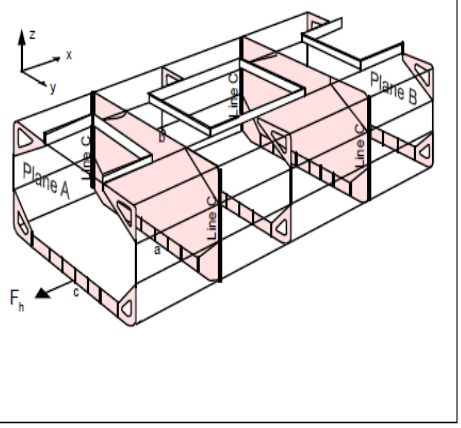
Pressure at the side hold, ***P*** **= 22072 Pa.**

pressure at tank top, ***P*** **= 8000 Pa.**

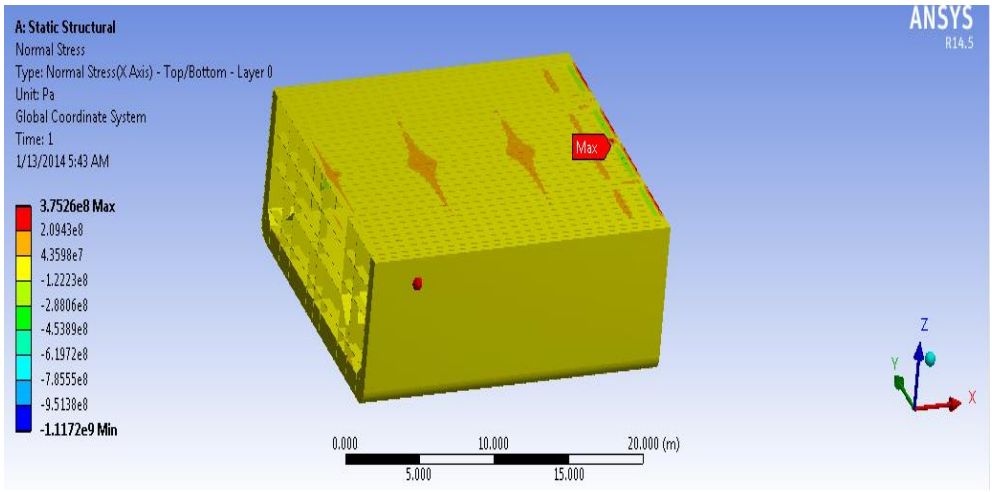
Boundary Conditions

Location	*Displacement*			*Rotation*		
	δx	δy	δz	θx	θy	θz
Plane A	L	-	-	-	X	X
Plane B	X	-	-	-	X	X
Line C			S			
Point a, b		X				
Point c	F_h					

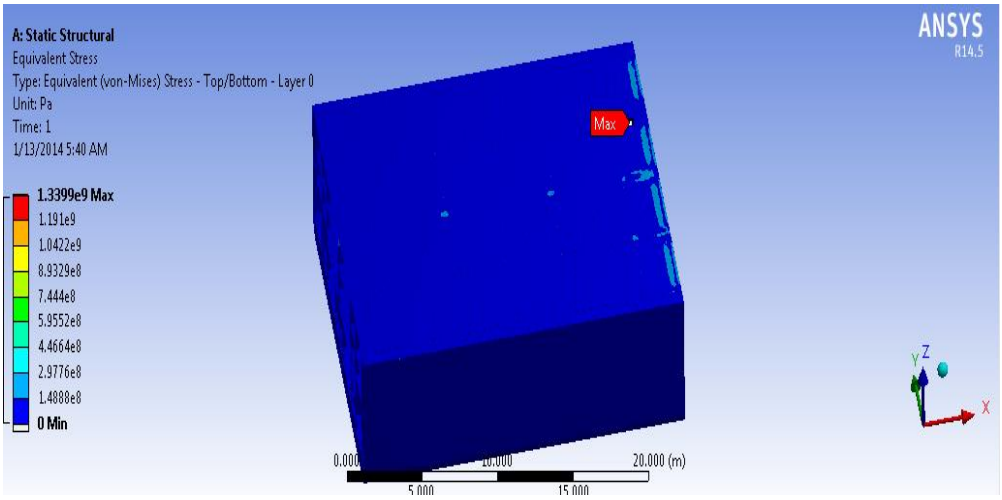
X	=	Restricted from displacement or rotation
L	=	Linearly dependant of point c
-	=	Free
S	=	Springs
F_V	=	Vertical forces. When vertical forces are applied the model must in addition be restricted from translation in the vertical direction by fixing it in one node.
F_h	=	Counteracting horizontal force



Normal Stress



Equivalent (Von Mises) Stress



Maximum Equivalent Stress at mid ship 148 MPa

Result and Discussion

The plating thickness

- **maximum 12 mm** at the bottom and
- **minimum 6mm** at the engine shaft vault.

The largest size of the longitudinal stiffener is found to be ***Hp* 200*12** and smaller is **180*10** with a minimum section modulus of ***Z* =57.27 cm^3** with a maximum design bending moment of **60250 KNm.**

The maximum shear force at seagoing condition according to the rules is **-31465 KN** in hogging and **41570 KNm** in sagging.

The mass the structure is

- **1048.54 t,**
- **62 %** longitudinal plates,
- **13 %** is dedicated to the longitudinal stiffeners,
- **25%** transverse members including the structure of the transverse bulkhead

The values obtained above are further substantiated by direct FEM assessment using Ansys.

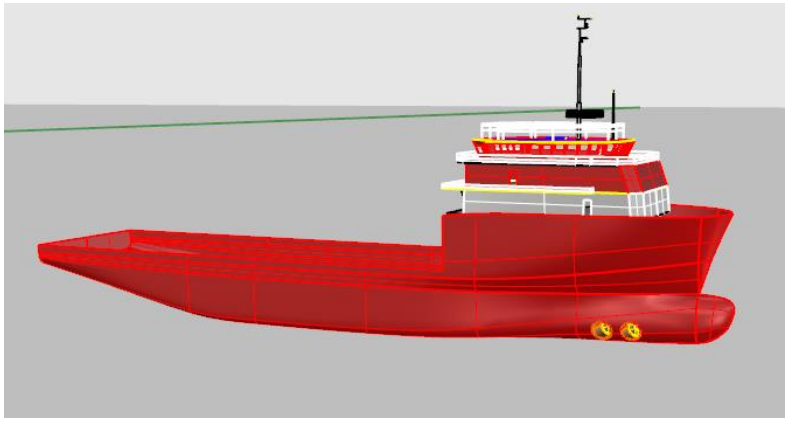
Conclusion

A hull structure that supports loads that the ship might encounters in its lifetime is conceived. In an attempt to attain the objective, a conceptual model of mid ship section is developed. The constituent parts of the mid ship are then checked individually against the minimum requirement.

Having all iterative process by modifying the thicknesses, a final scantling that satisfies all the criteria is achieved.

The result obtained by the rules are further examined and corroborated by direct strength assessment using Ansys software on one cargo hold on the mid ship area. Both systems verified that the structural model developed in fact sustains all the loads assumed.

The results obtained would be more accurate if the design is made for the full hull length.



Thank you!