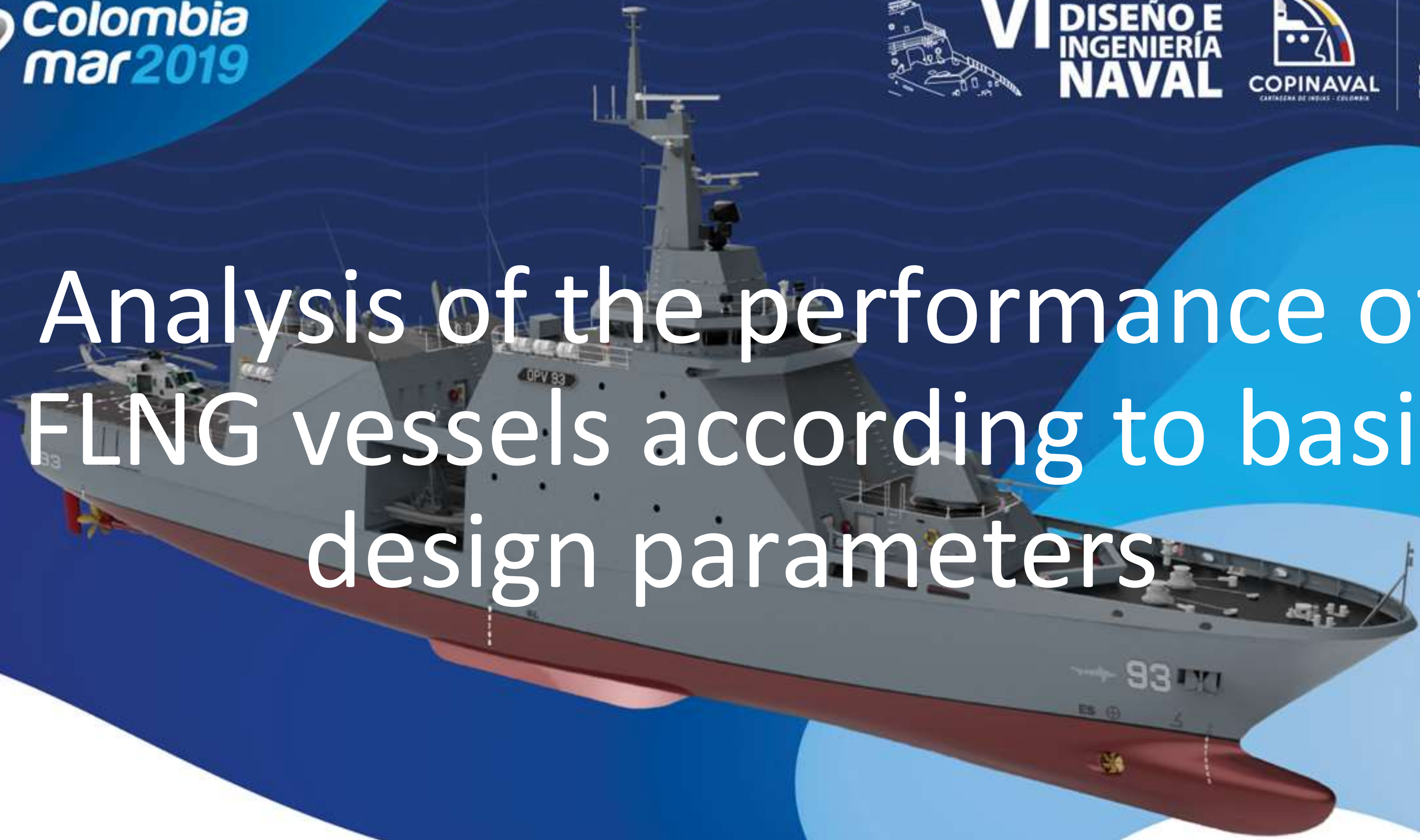
Colombia mar2019

VI CONGRESO INTERNACIONAL DE DISEÑO E INGENIERÍA NAVAL

COPINAVAL

XXVI CONGRESO PANAMERICANO DE INGENIERÍA NAVAL, TRANSPORTE MARÍTIMO E INGENIERÍA PORTUARIA



Analysis of the performance of FLNG vessels according to basic design parameters

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Summary

- Introduction
- Offshore Exploration
- Challenges
- Syntheis Model
- Numerical Model
- Analysis
- Results
- Conclusion

Introduction

LNG Production

- Power Generation

- Domestic uses

- Fertilizers

- Manufacture

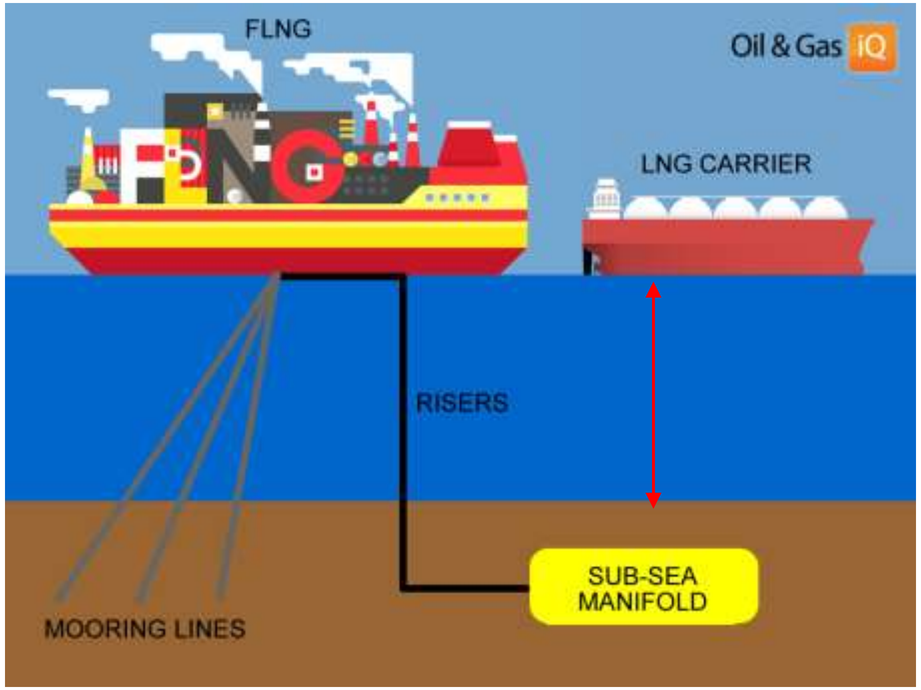
Profit

Source: https://www.clickittefaq.com/wp-content/uploads/2017/07/LNG-Combined-Cycle-Power-Plant.jpg
https://www.igu.org/natural-gas-fuels-innovation-home
http://www.oilandgas360.com/wp-content/uploads/2016/09/nat-gas-fertilizer.jpg?x38408
https://www.carbonbrief.org/whats-the-difference-between-natural-gas-liquid-natural-gas-shale-gas-shale-oil-and-methane-an-oil-and-gas-glossary
http://worldartsme.com/natural-gas-industry-clipart.html#gal_post_95924_natural-gas-industry-clipart-1.jpg

Offshore Exploration

- Use of a specialized floating unit for deep water exploration : FLNG

Goals:
- Production
- Processing
- Storage



Conditions

- High demand for Natural Gas
- Deep Water Exploration

Source:https://www.oilandgasiq.com/fpso-flng/articles/guide-to-flng

Challenges

Vessel Requirement

High Load Capacity

Structural Analysis

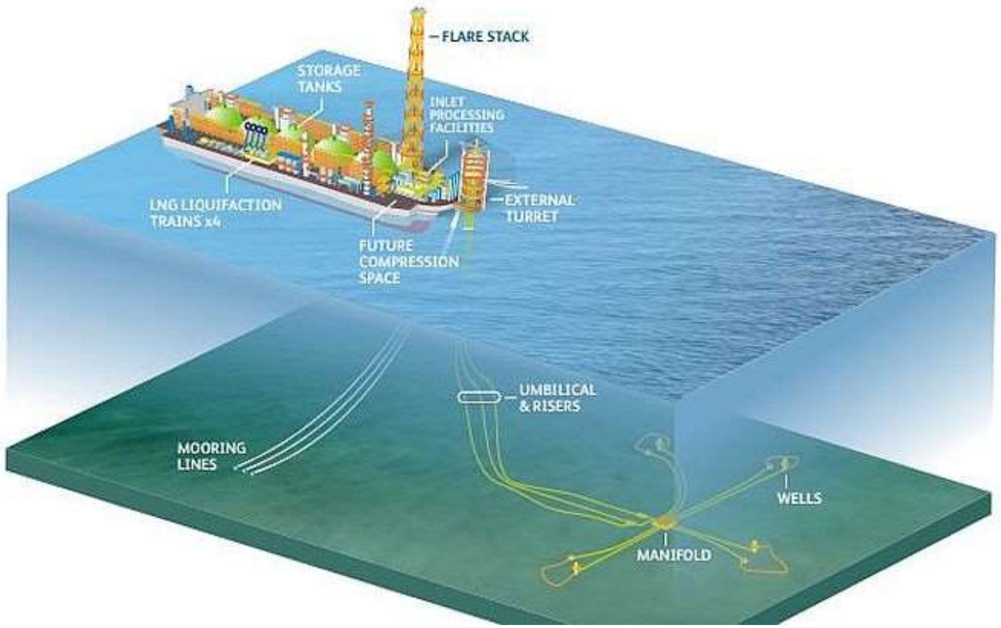
- Platform arrangement
- Structural mass
- Costs

Operational Downtime

- The influence of mooring lines, connections lines and fenders;
- Hydrodynamic of the free surface in the gap (resonance) between the vessels
- Sloshing

Vessel Characterization

- Dimensions
- Storage Capacity
- Installation area
- Ballast



Source: http://www.energyglobalnews.com/schlumberger-drops-fortuna-flng-project/

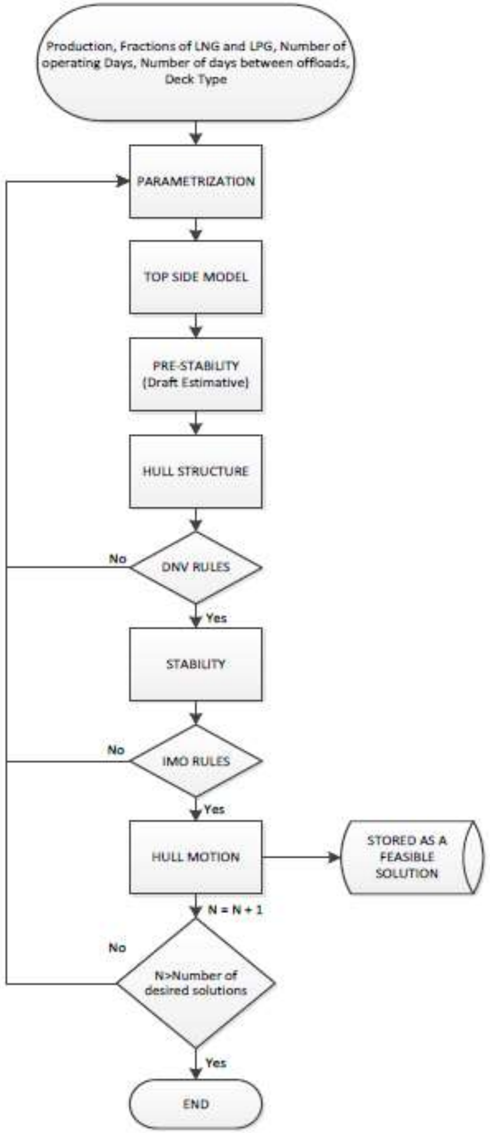
Synthesis Model

Definition:

- Gas Capacity
- Installation Area
- Water Depth
- Environmental Conditions
- Equipment operation conditions

Results:

- Midship section
- Lightweight hull hull center of gravity
- Inertia
- Definiton of maximum loads and accelerations



Synthesis Model

Production Requirements

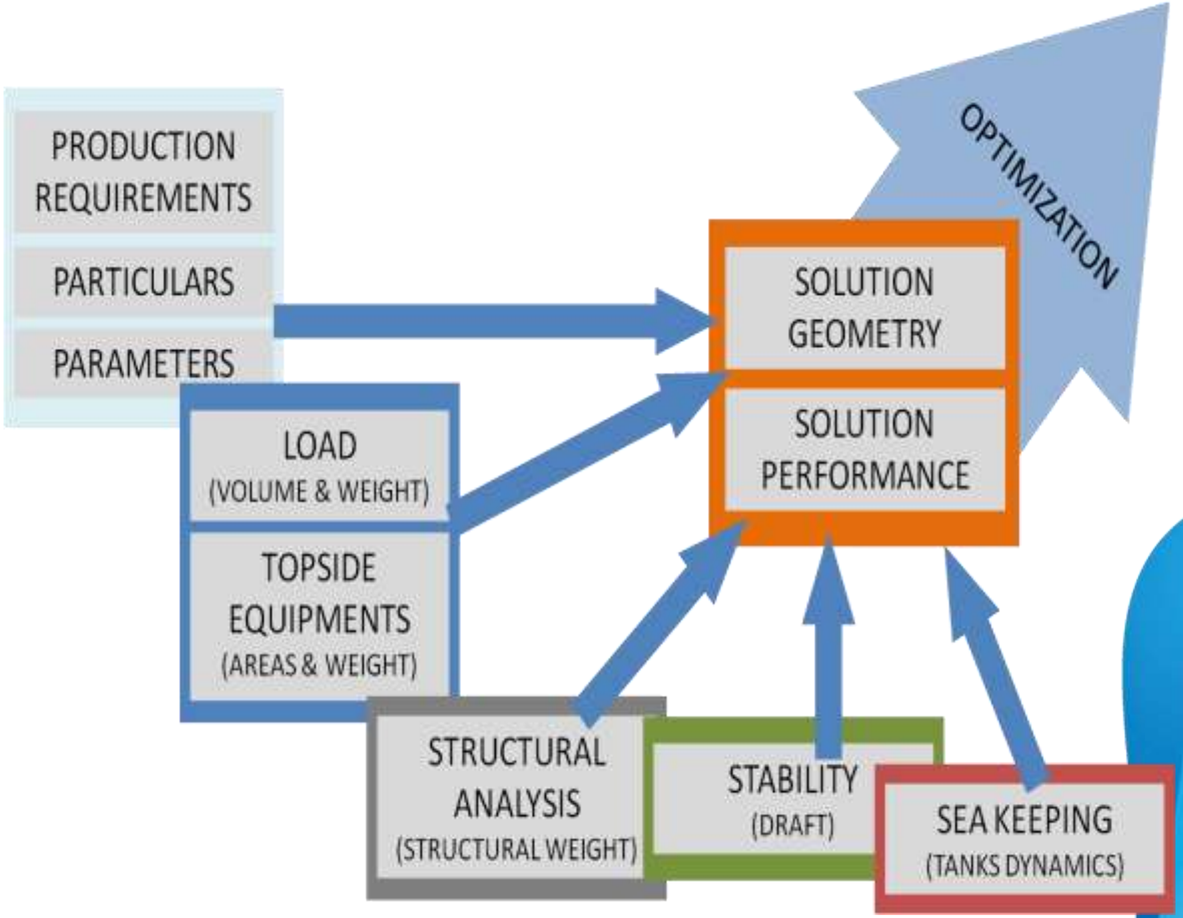
- Storage Volume
- Load Mass considering LNG and LPG volumes and densities
- Available Deck
- Structural Routine
- Stability Routine

Particulars

- FLNG’s dimensions

Parameters of Study

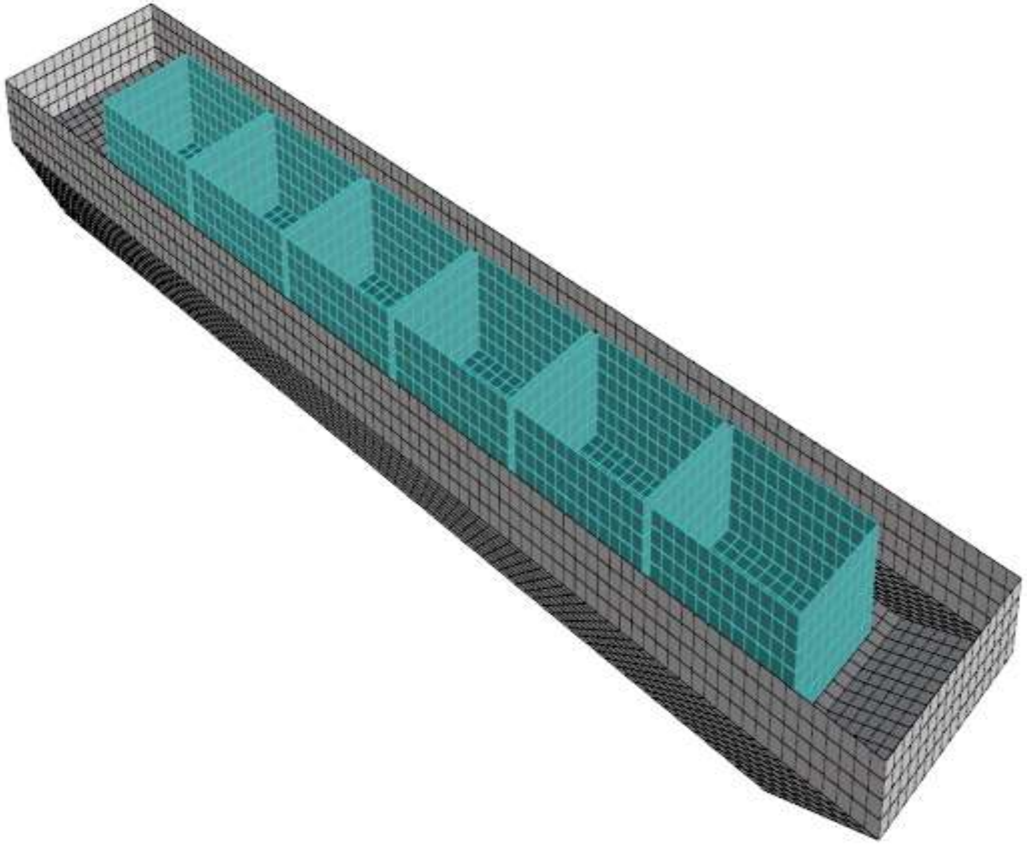
- Double Side
- Double Bottom
- Double Deck



Numerical Model

- WAMIT (Newman,1995)

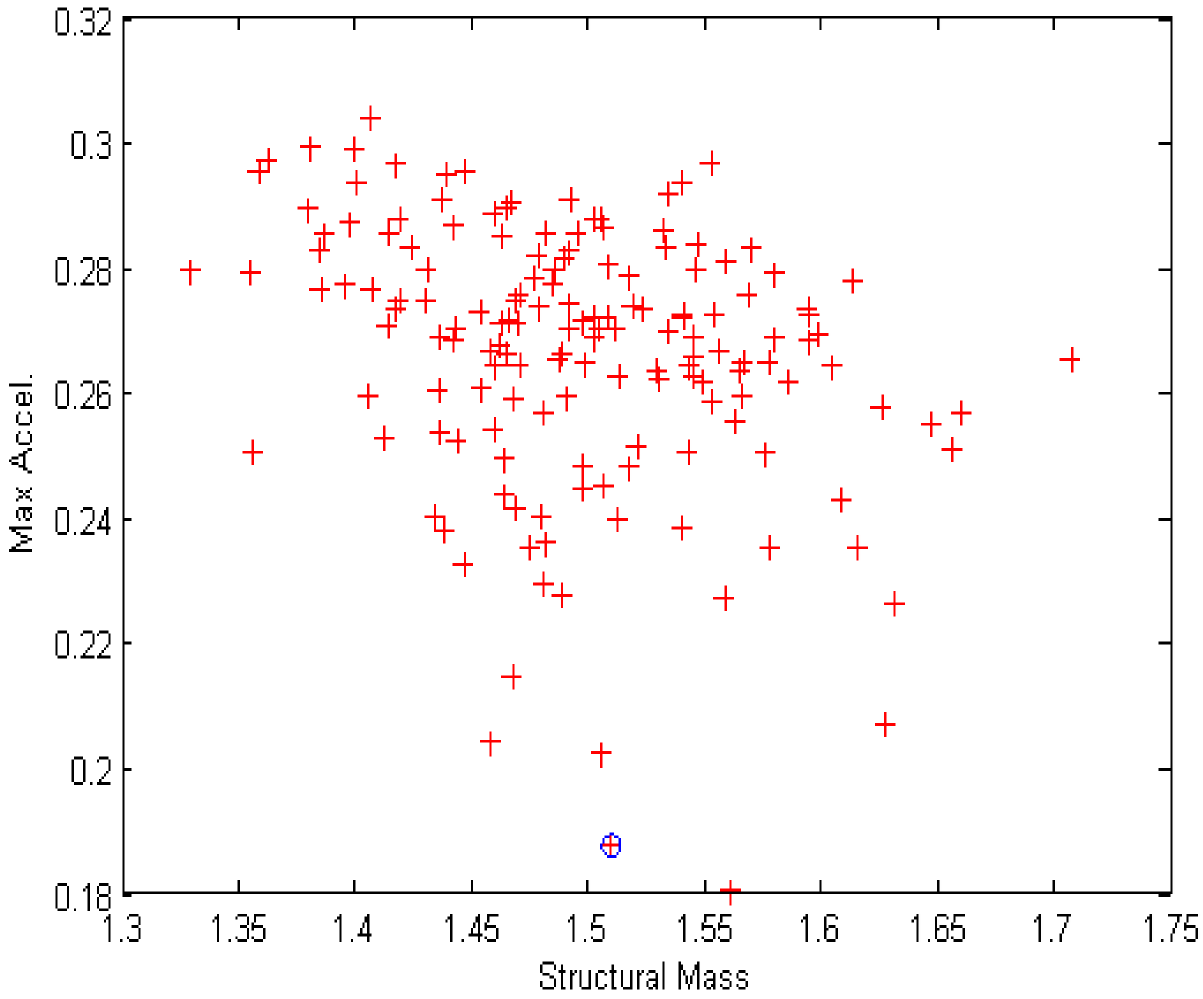
- Mesh of the wet surface of the vessel,
- Information about mass and inertia,
- A vector of periods (or frequencies) of the waves, and
- A vector of wave incidences.



Numerical Model

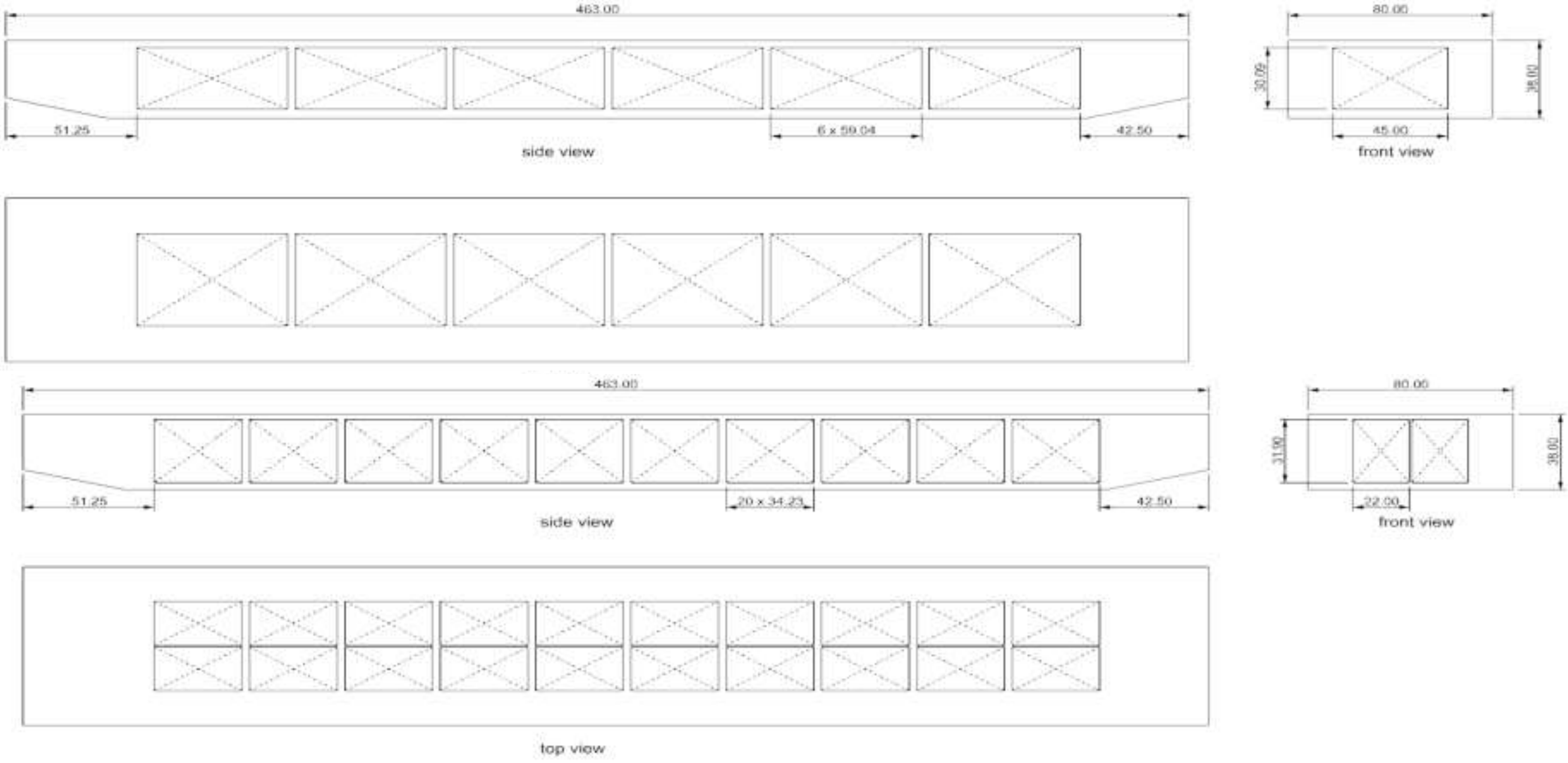
- FLNG's Particulars

- LOA – Length Overall
- B – Beam
- D – Depth
- Hpo – Height of stern chamfer
- Hpr – Height of bow chamfer
- Lpo – Length of the stern chamfer
- Lpr – Length of bow chamfer
- Ntanks – Number of storage tanks
- NtanksT – Number of storage tanks rows
- hDD – Height of double deck
- hDB – Height of double bottom
- wDS – Width of double side



Analysis

- The object of the study FLNG designed in CH- TPN in Brazil in association with Frade Japão Petróleo Ltda.



Analysis

Table 1 – FLNG main dimensions (Config. A)

Property	Value	units
Length	463.0	m
Breadth	80.0	m
Depth	38.0	m
Load. Cap.	240,000	ton
N° Tanks	6	units
Double Deck	2.0	m
Double Bottom	3.0	m
Double Side	2.5	m

	Case 1	Case 2	Case 3	Case 4	Case 5	units
Tank Length	59	59	59	59	59	m
Tank Width	45,0	52	59	66	73	m
Tank Height	30,1	26.1	23	20.5	18.6	m
Double Deck	2.9	5	6.5	7.7	8.7	m
Double Bottom	3.9	6	7.5	8.7	9.7	m
Double Side	17	13.5	10	6.5	3	m

Table 3 – FLNG main dimensions (Config. B)

Property	Value	units
Length	450.0	m
Breadth	81.0	m
Depth	38.0	m
Load. Cap.	240,000	ton
N° Tanks	20	units
Double Deck	8.0	m
Double Bottom	5.0	m
Double Side	3.0	m

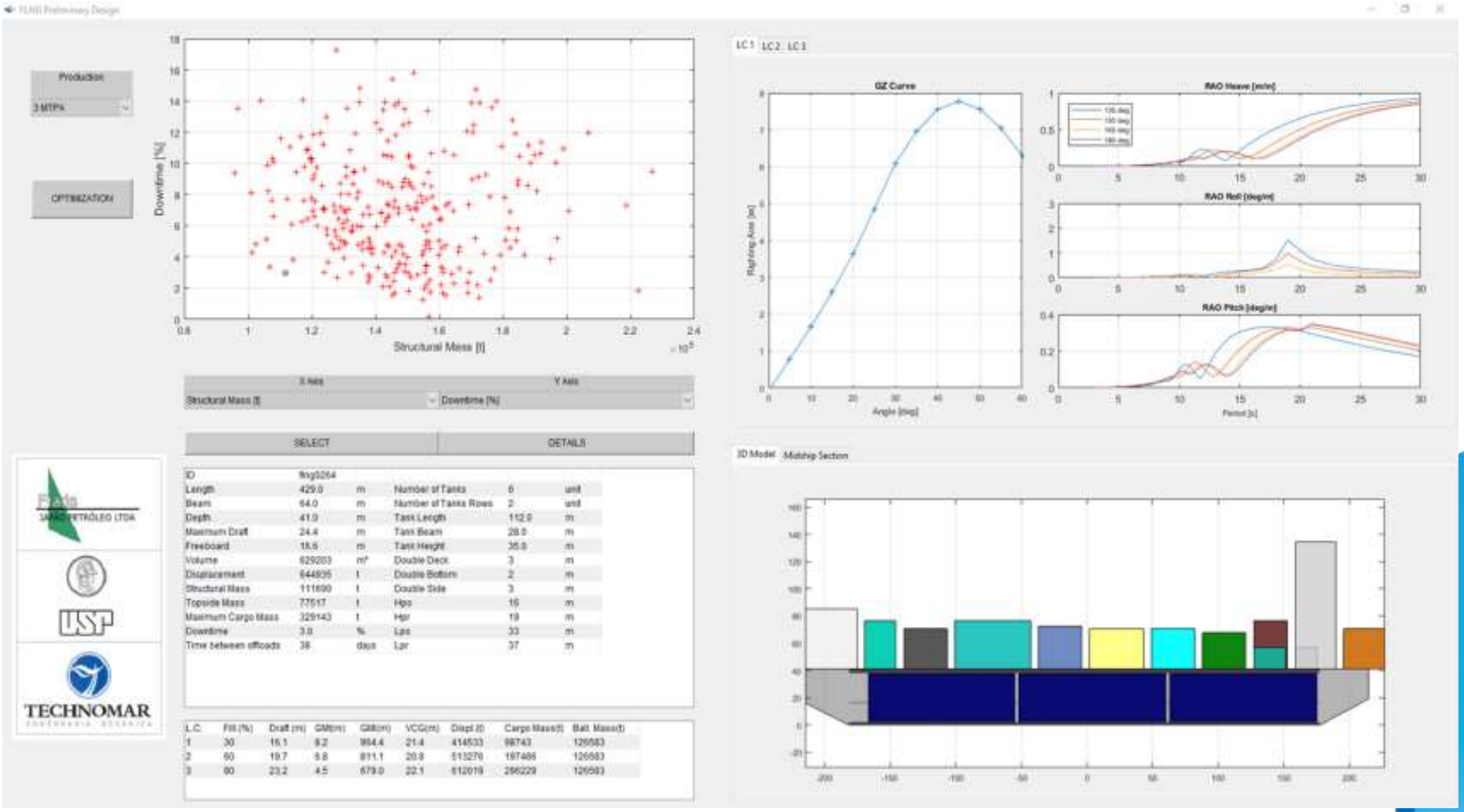
Table 4 – FLNG secondary dimensions (Config. B)

	Case 6	Case 7	Case 8	Case 9	Case 10	units
Tank Length	34.2	34.2	34.2	34.2	34.2	m
Tank Width	22	25.5	29	32.5	36	m
Tank Height	31.9	27.5	24.2	21.6	19.5	m
Double Deck	2.1	4.2	5.9	7.2	8.3	m
Double Bottom	3.1	5.2	6.9	8.2	9.3	m
Double Side	17	13.5	10	6.5	3	m

Interface

Objectives:

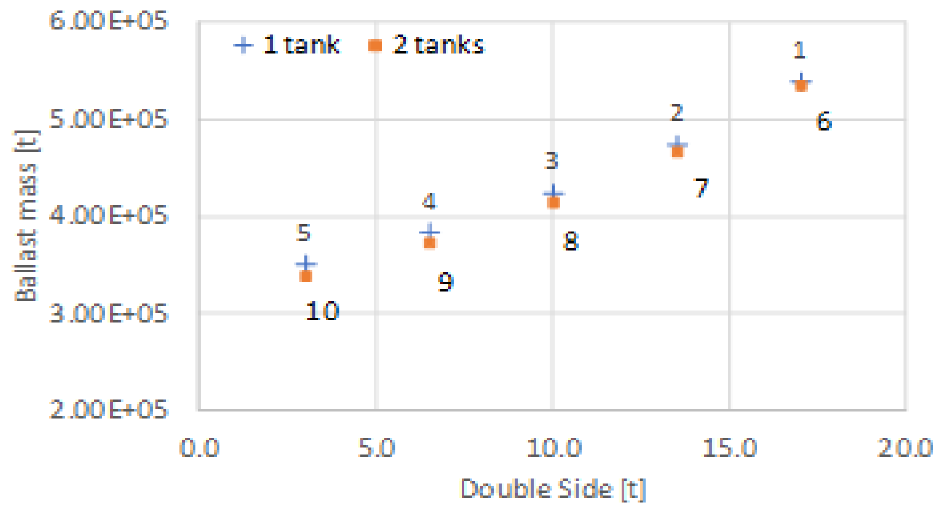
1. Summarize the main characteristics of each vessel generated
2. Compare the cases to each other and classify them rationally

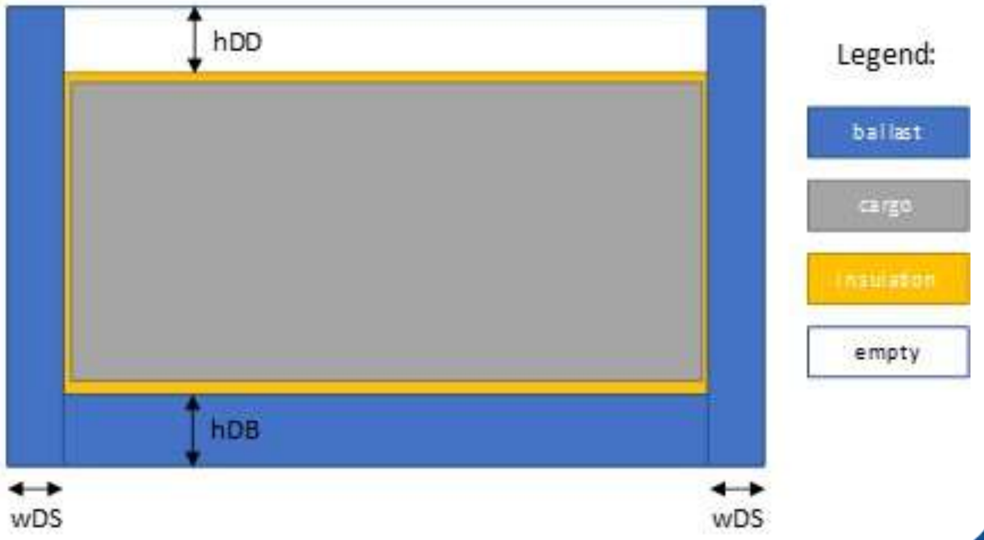


Results

- The evaluation was done comparing each case proposed using the implemented interface analysis.

- The solution was analyzed according to structural mass, freeboard and seakeeping/downtime performance.

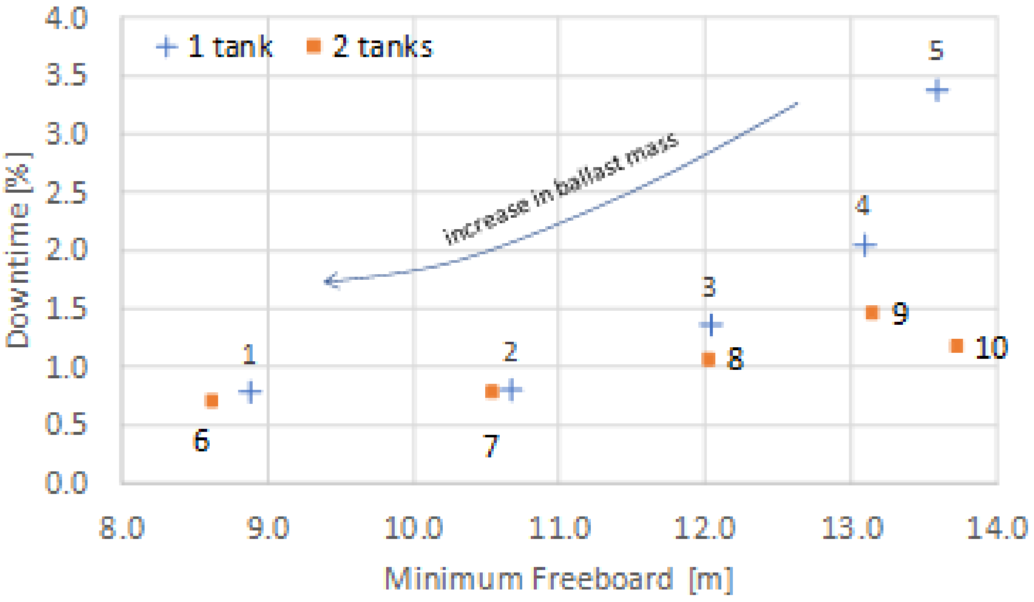




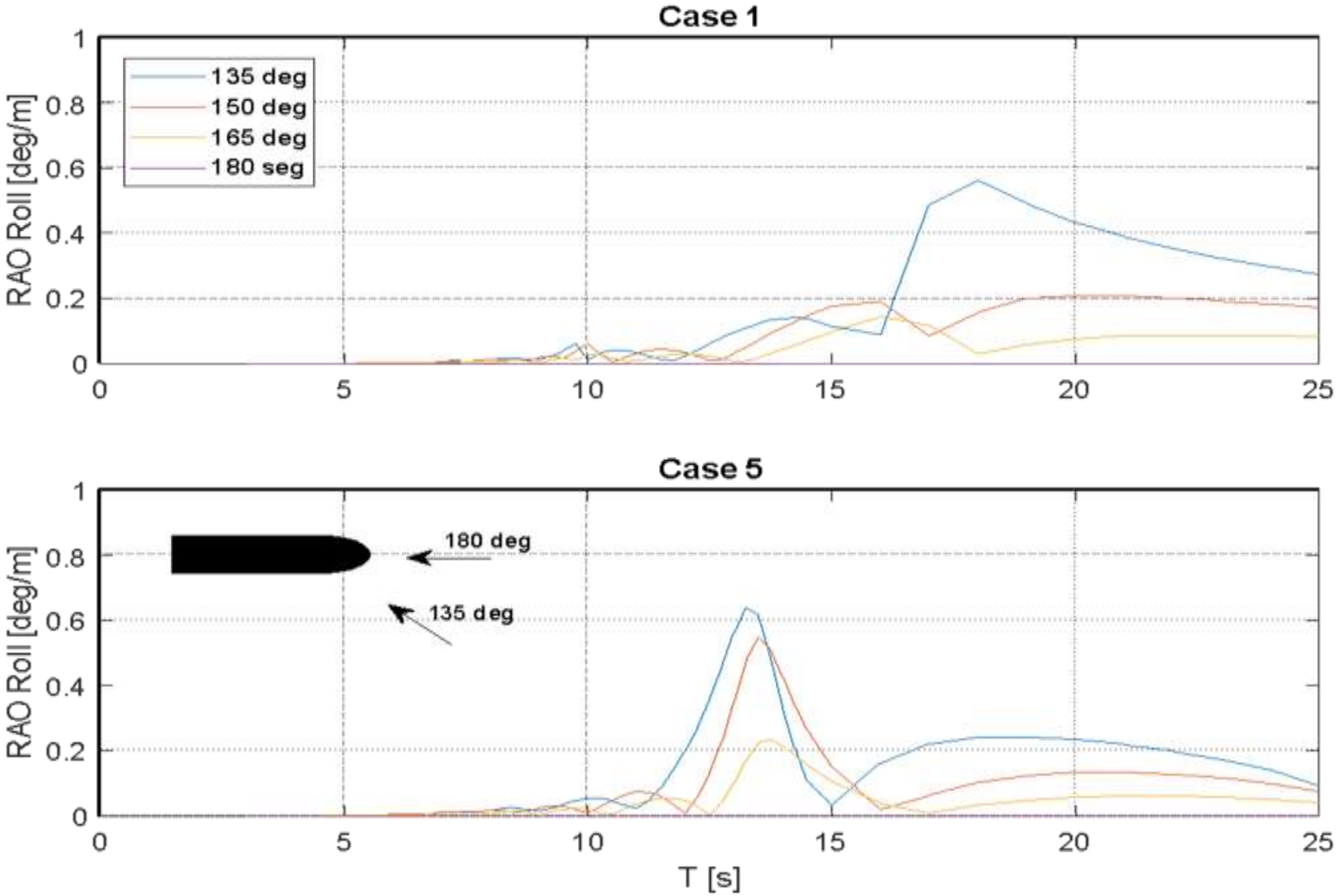
Results

FLNG Total Ballast

Case id	Ballast Mass [t]	Case id	Ballast Mass [t]
1	539,115	6	534,970
2	474,317	7	466,946
3	424,138	8	414,679
4	384,103	9	373,075
5	351,243	10	339,030

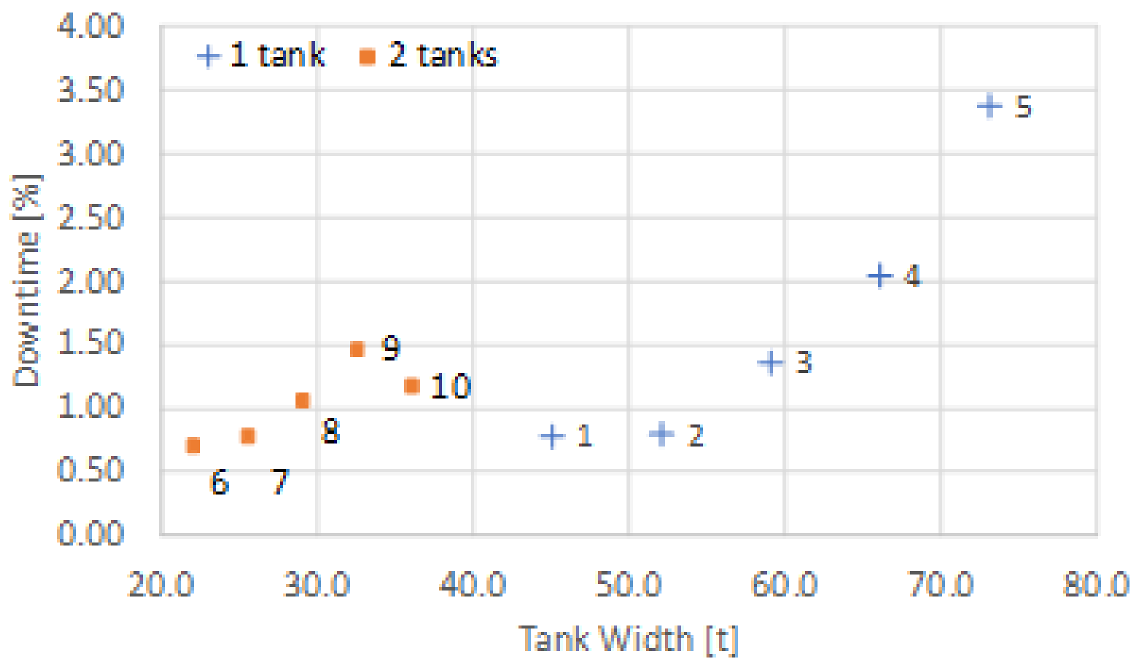


Results

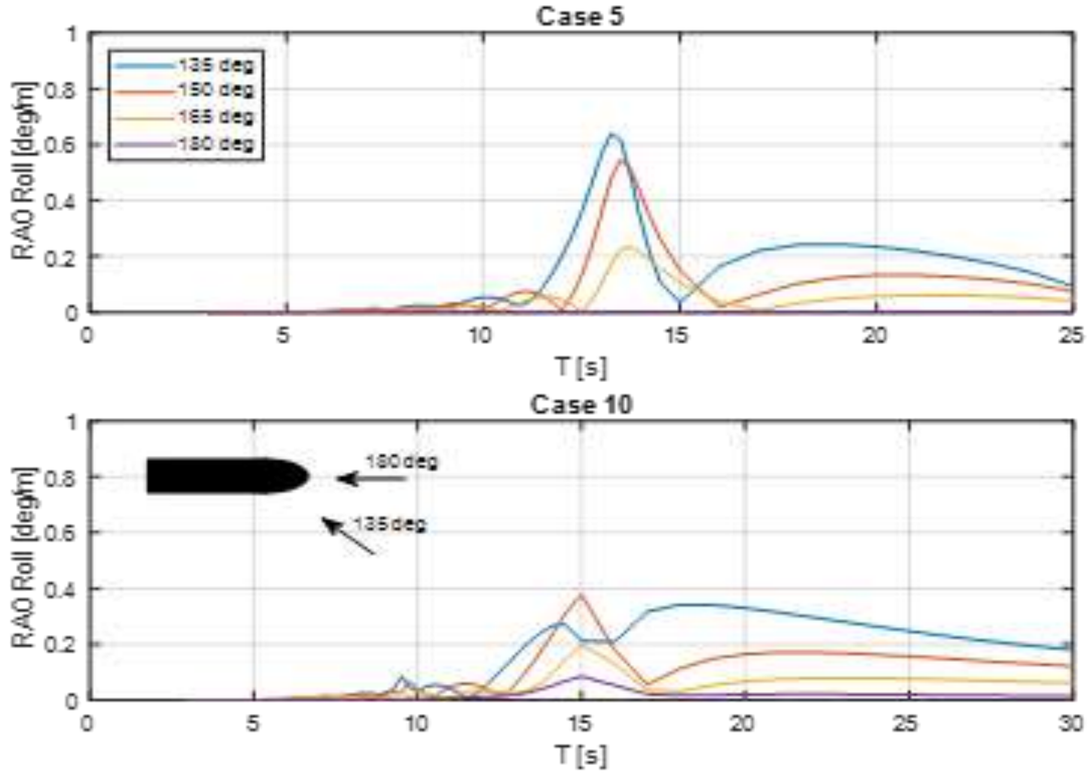


Case 1
RAO Roll [deg/m]
135 deg
150 deg
165 deg
180 seg
Case 5
RAO Roll [deg/m]
180 deg
135 deg
T [s]

Results



1 tank
2 tanks
Downtime [%]
Tank Width [t]
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
20.0
30.0
40.0
50.0
60.0
70.0
80.0
1
2
3
4
5
6
7
8
9
10



Case 5
135 deg
150 deg
165 deg
180 deg
RAO Roll [deg/m]
T [s]
Case 10
180 deg
135 deg
RAO Roll [deg/m]
T [s]

Conclusions

- Both proposed tank arrangement cases showed a possibility to reduce freeboard and optimize its behavior in waves and reduce downtime.

- The synthesis model allowed not only to create the desired case condition but also provided a powerful tool to evaluate each case and verify the best solution.

- Finally, the proposed model allows the designer to evaluate and, according to the given environmental conditions, design and study the pertinent features for a vessel in each metocean condition.

Thank You!

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