Universität Rostock
Traditio et Innovatio

EMship Advanced Design

DEVELOPMENT OPTIONS FOR A&R SHIPYARD HARBOUR

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Master Thesis

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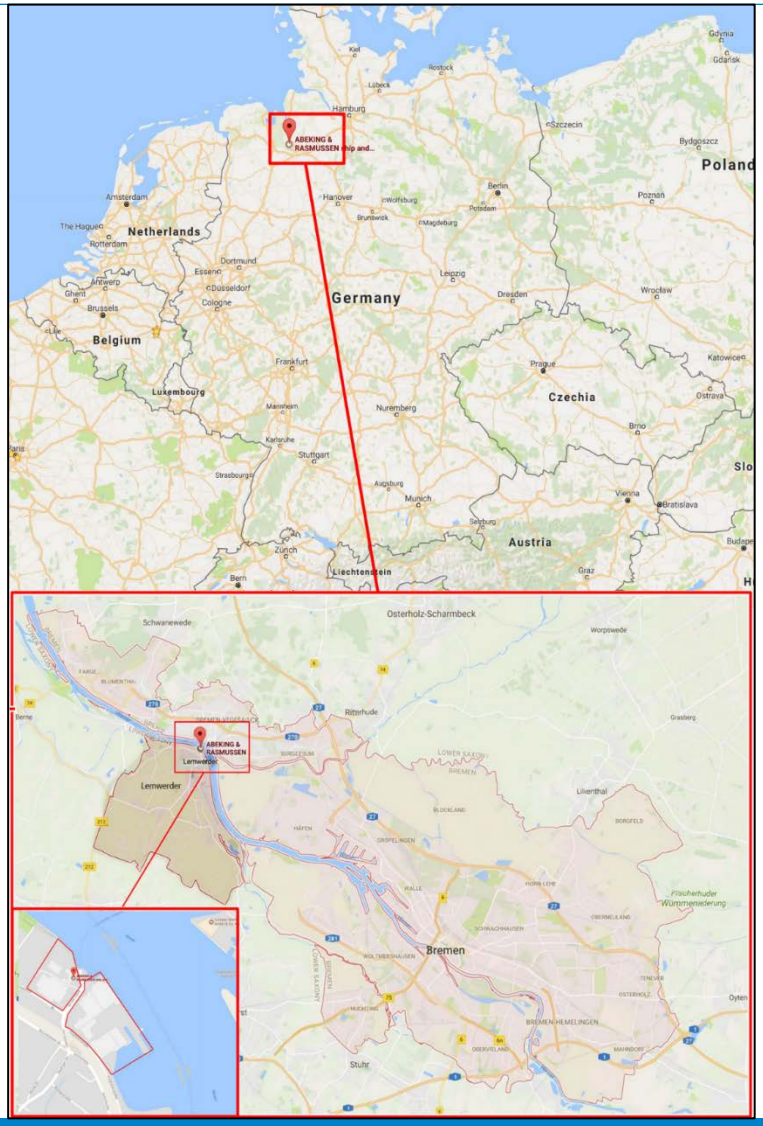
Key Topics

- Introduction
- Problem Description
- Sediments
- Multi-Criteria Analysis and Harbour Layout Selection
- Design Proposal of the Layout
- Cost Estimation
- Conclusion

Abeking & Rasmussen

- One of most well known shipyards;
- Over 100 years old;
- Located on the left coast of river Weser;
- 60km from the coast of the North Sea;
- 17km from Bremen.

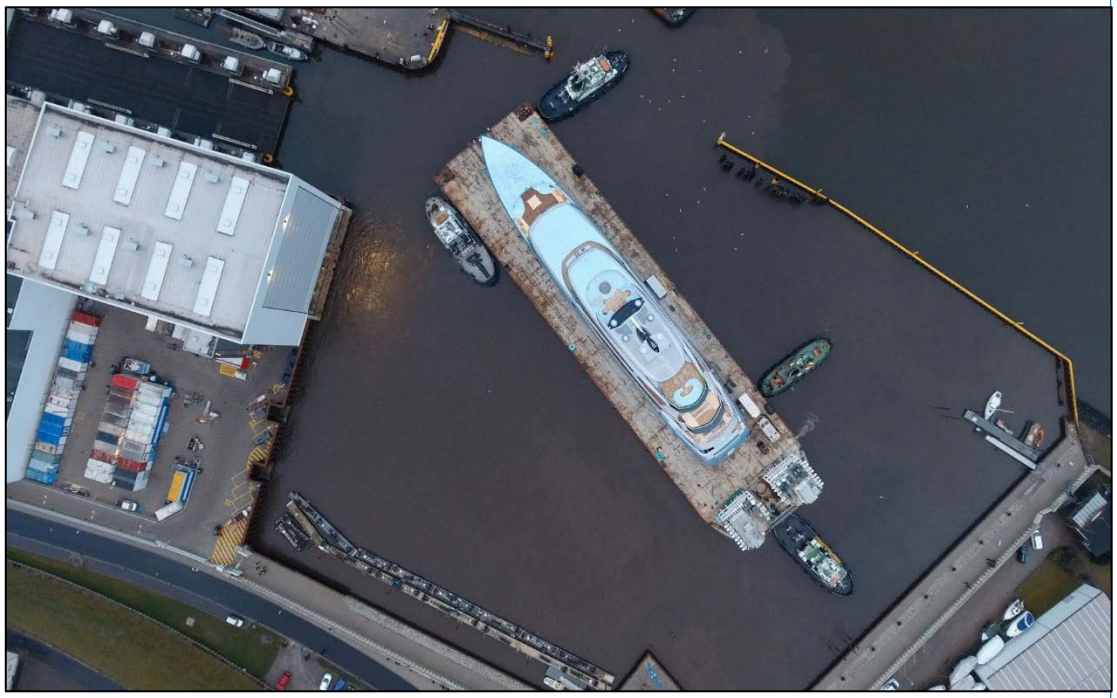


Focus of the work

- On the small craft Harbour;
- Used by A&R for launching/docking of vessels;
- Used by the local Lemwerder Yacht Club as marina;
- Shared between A&R and Yacht Club;
- Decision making process is complex;
- Main goal is to give new proposals for Harbour layout.

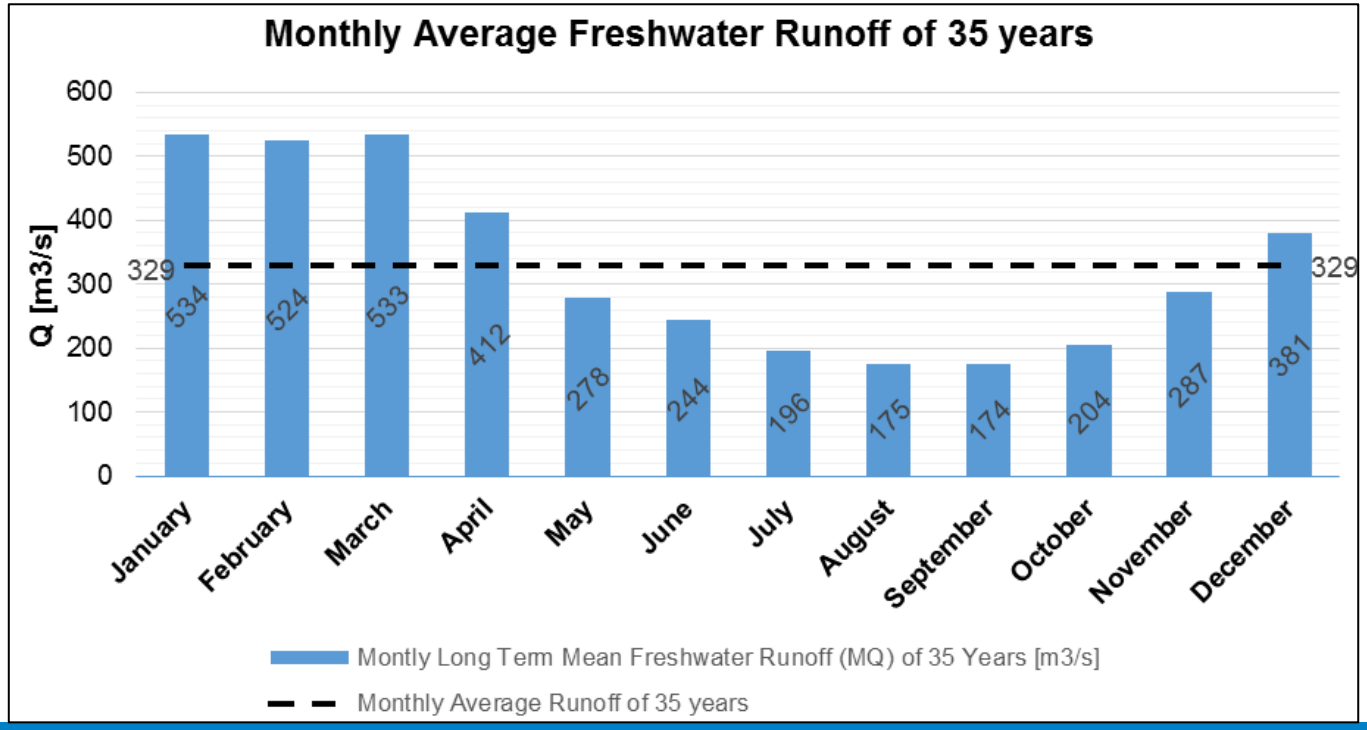
Why to remodel the Harbour?

1. Vessel size limitations 83m for syncrolift;
2. Current entrance requires 90 degree turning angles;
3. Great tidal influence;
4. Frequent dredging required.

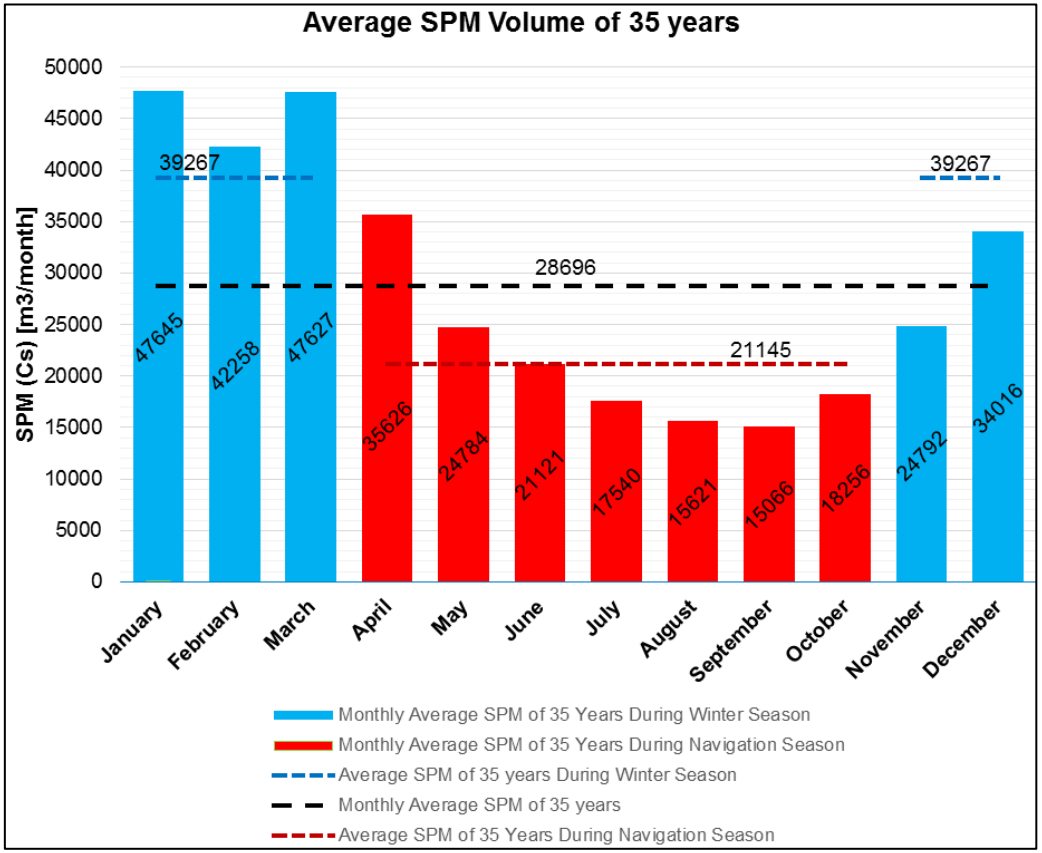


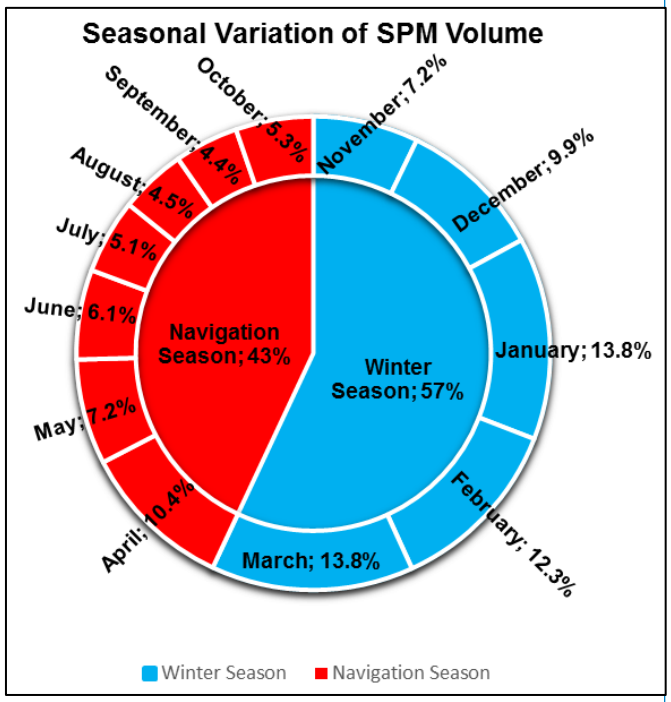
Sediments

- Average amount of sediments deposited 13cm/year;
- Literature analysis of the sediments for lower Weser region;
- 35-years of observation data used from Deutsches Gewässerkundliches Jahrbuch;
- During higher fresh water runoff values the sedimenation risk is higher.



Amount of sediments

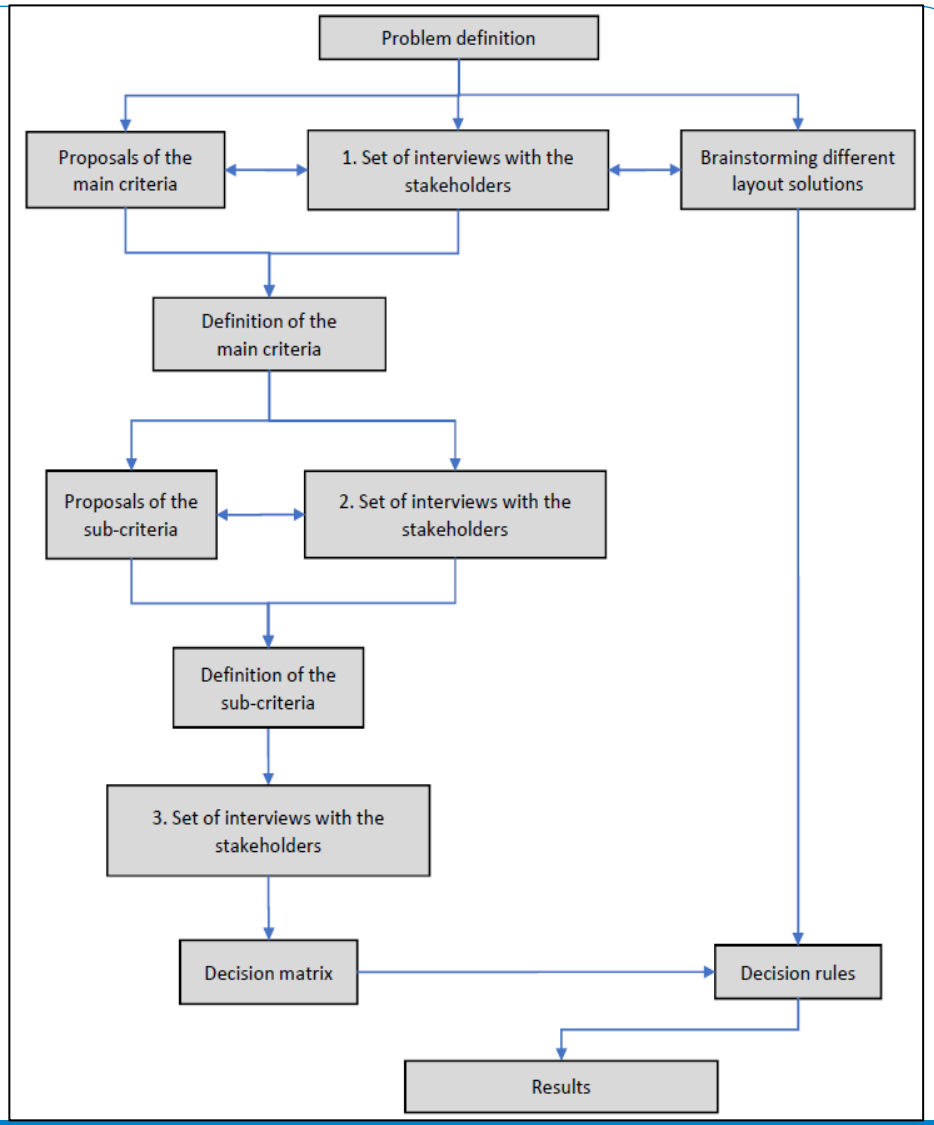




- Up to 57% of sediments from the yearly 13cm/year can be avoided

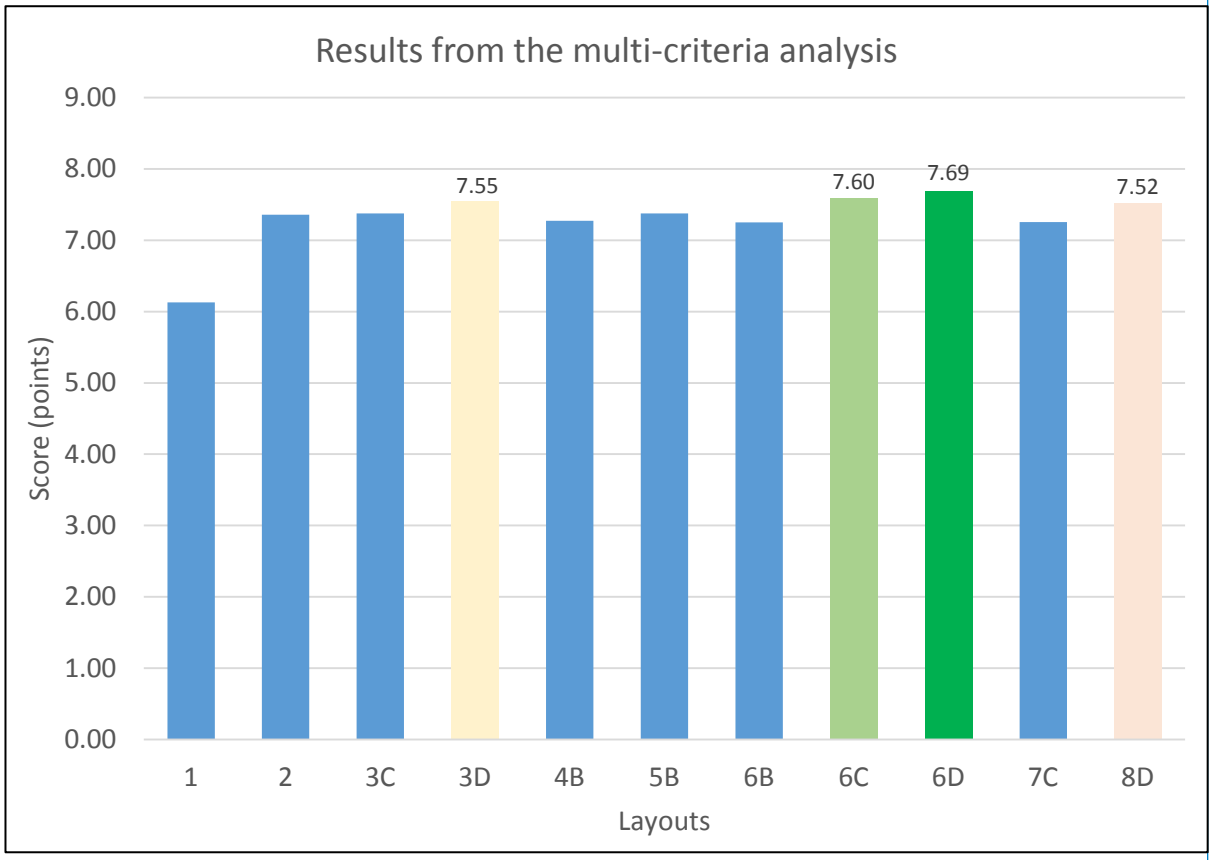
Multi-Criteria Analysis

1. Problems and goals defined;
2. 20 new layouts were brainstormed, each a bit different;
3. Multiple sessions of interviews with the stakeholders;
4. Defining the main Criteria and sub-criteria;
5. Finally resulting in a decision matix;
6. Descision rules;
7. Results.



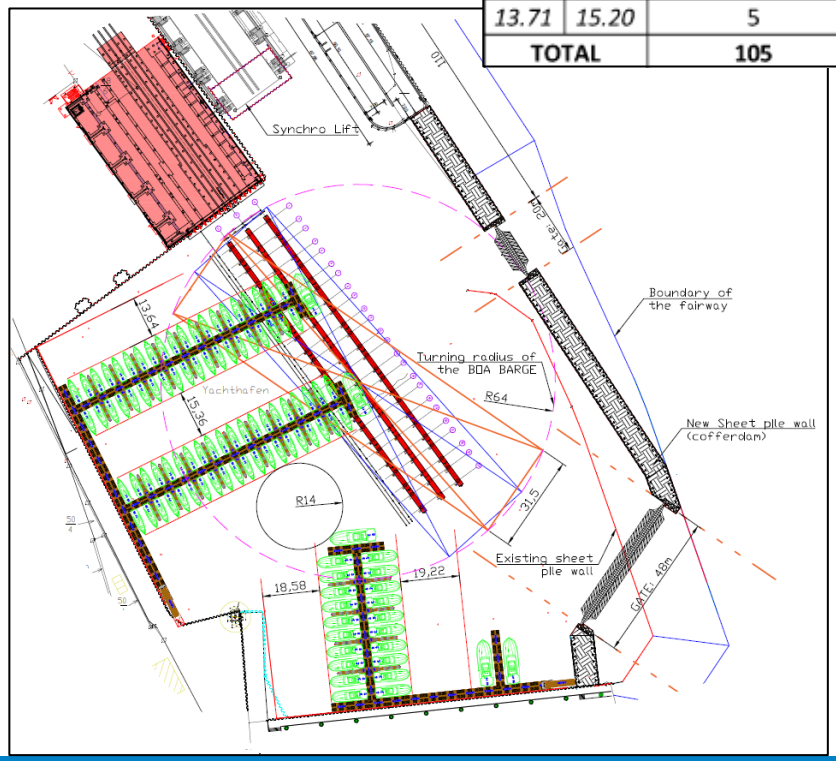
Decision criteria's and results

Nr	Criterion	Weighting factor
1	Entrance of the harbour	0.183
2	Maneuverability inside the harbour basin	0.208
3	Time to release a ship	0.120
4	Effect of tides/ currents/ sedimentation	0.175
5	Impact on the marina and its users	0.190
6	Complexity of the solution and need of public authorisation	0.125
	A.Skalicky	***15.0%***
	E. Pietschik	*5.0%*
	Weser Yacht Club	*5.0%*
	K.Tull	***25.0%***
	TOTAL	**1.00**

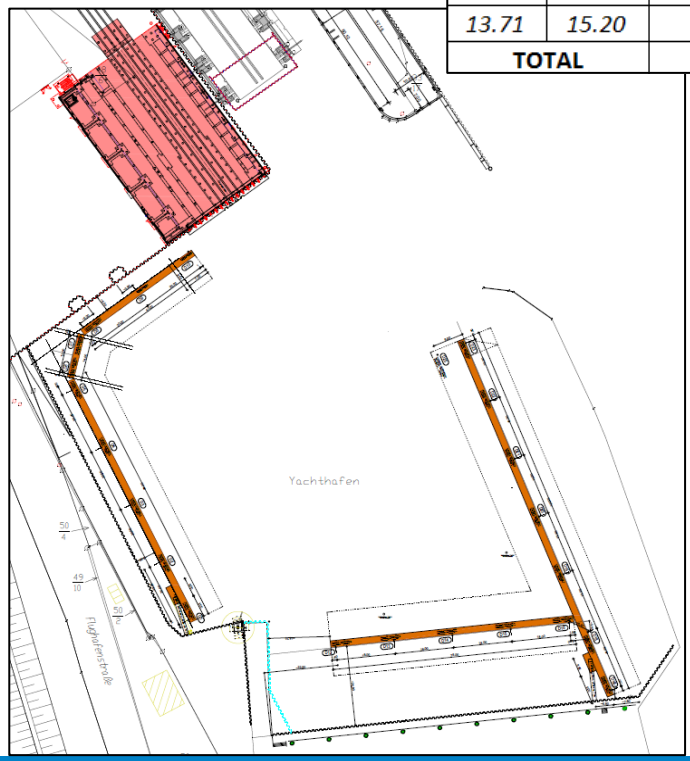


Top scored layout VS Current layout

Boat Length Range (m)		Layout 6D No of boat places
0.00	6.10	
6.11	7.60	
7.61	9.10	80
9.11	10.70	
10.71	12.20	20
12.21	13.70	
13.71	15.20	5
TOTAL		105



Boat Lengths Range (m)		Current Layout No of boat places
0.00	6.10	31
6.11	7.60	19
7.61	9.10	28
9.11	10.70	15
10.71	12.20	5
12.21	13.70	2
13.71	15.20	1
TOTAL		101

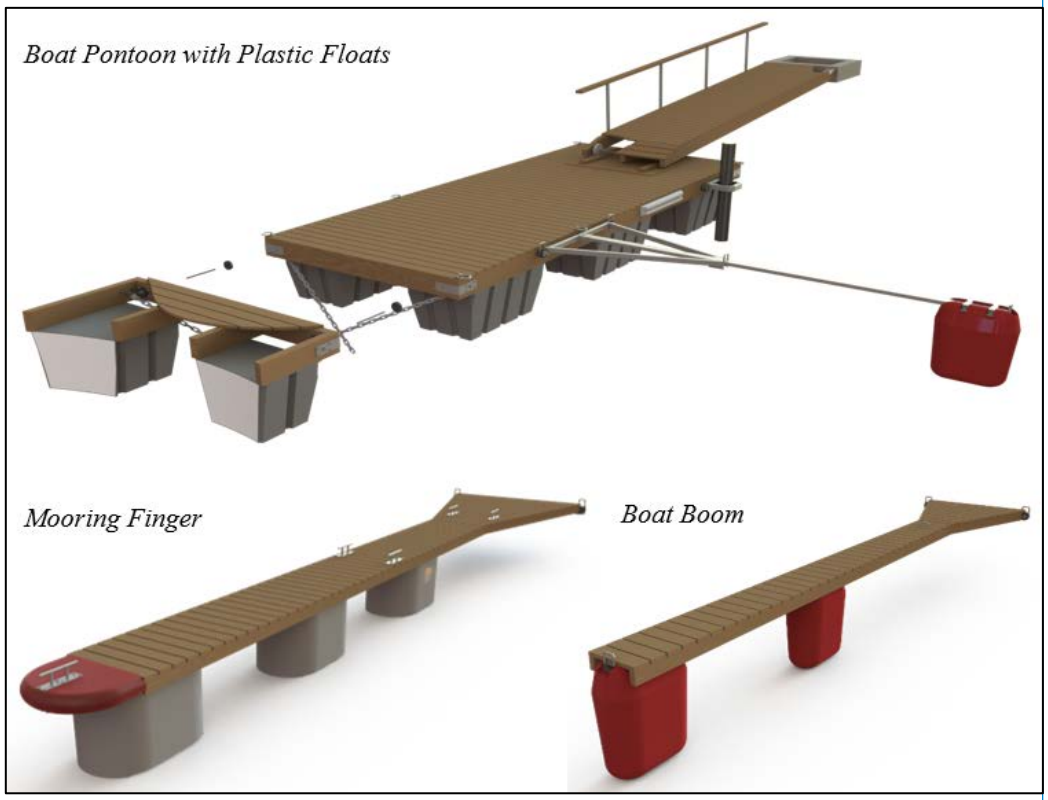


Floating marina

- Design of the marina according to:

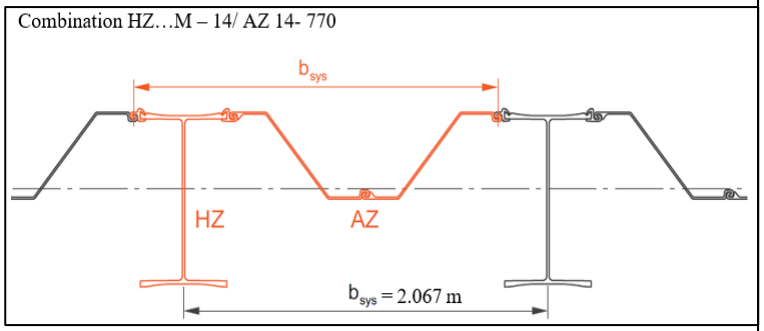
  A Code of Practice for the Design and Construction of Marinas and Yacht Harbours (The Yacht Harbour Association LTD);

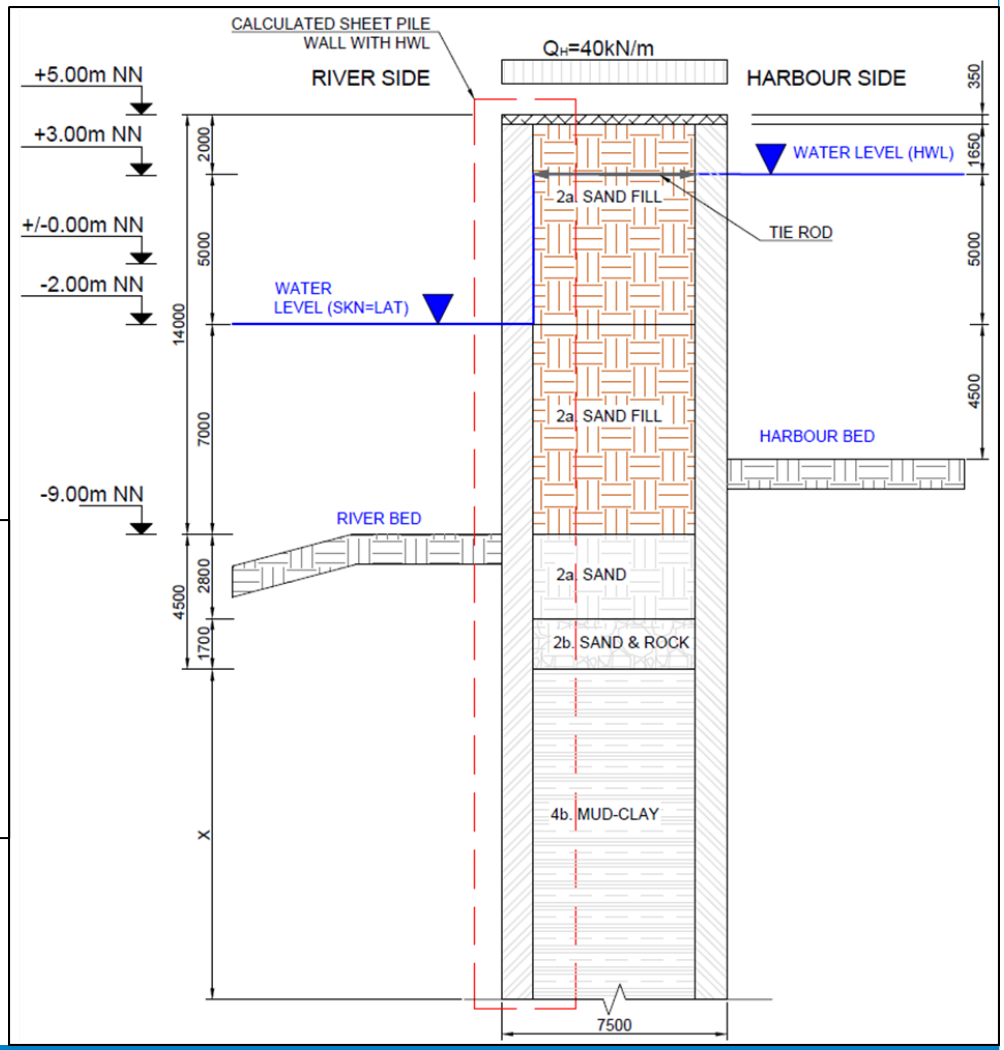
- Technical experience of marina supplier company Top Marine OÜ;
- More and bigger boat places;
- Better distribution and use of space;



Sheet pile cofferdam

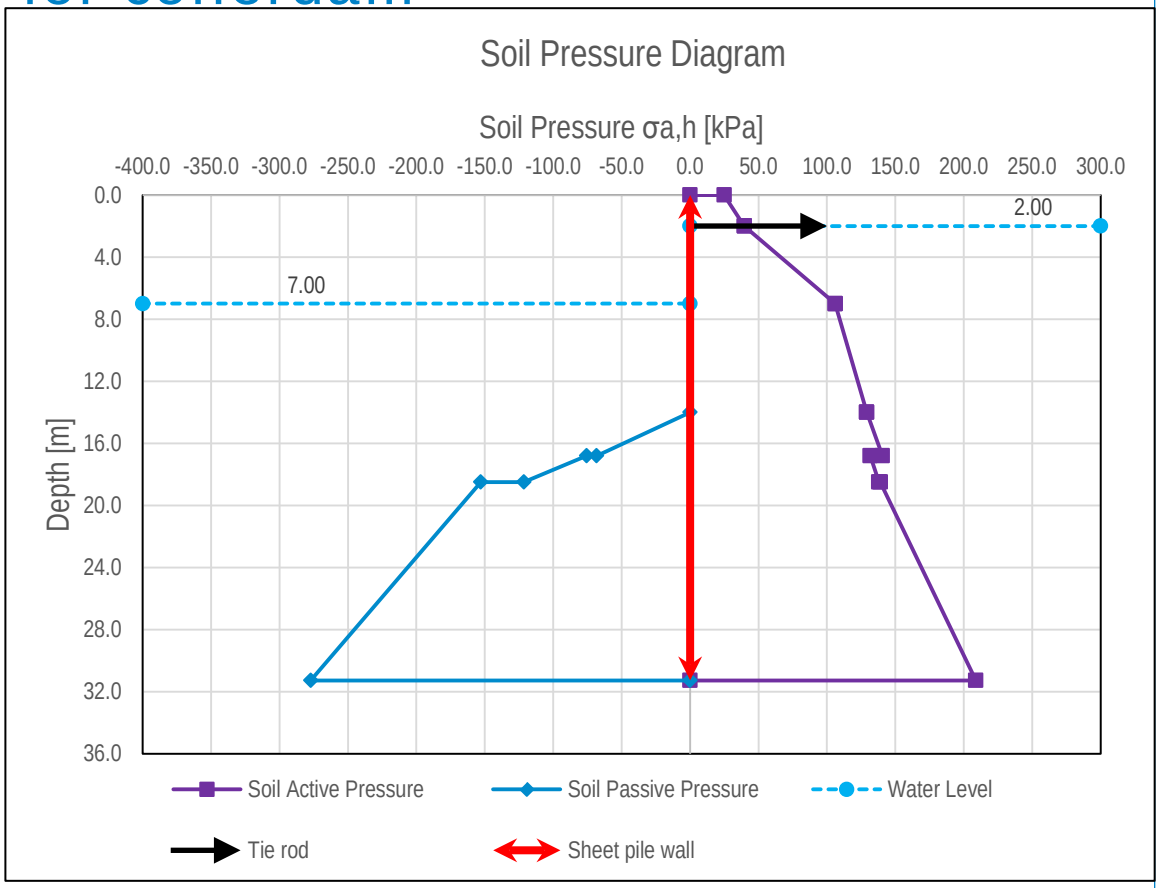
- Width 7.5m, Total length of piles 31m;
- Height from the ground 14m;
- Water level differences of 5m;
- Anchored at 2m from the top.





Design assumptions for cofferdam

1. Design according to Eurocode 7.
2. There is no loading from waves;
3. Active pressure from the soil inside the cofferdam;
4. Hydrostatic pressure from the water level differences;
5. Designed for movable crane load 40kN/m2 (Port Designers Handbook)
6. Calculated as an anchored sheet pile wall.



Preliminary design of floating door

- Width 6m, height 11.5m
- Smaller gate Length 20m;
  Bigger gate length 48m;
- Maximum draft at 9.5m;
- Maximum capacity of fresh water 1475t;
- Lightship weight 380t;
- Loaded weight 1855t.

Design assumptions for floating door

1. Designed according to Bureau Veritas rule:

   NR612 – Rules for the Classification of Harbour Equipment – November 2015 edition

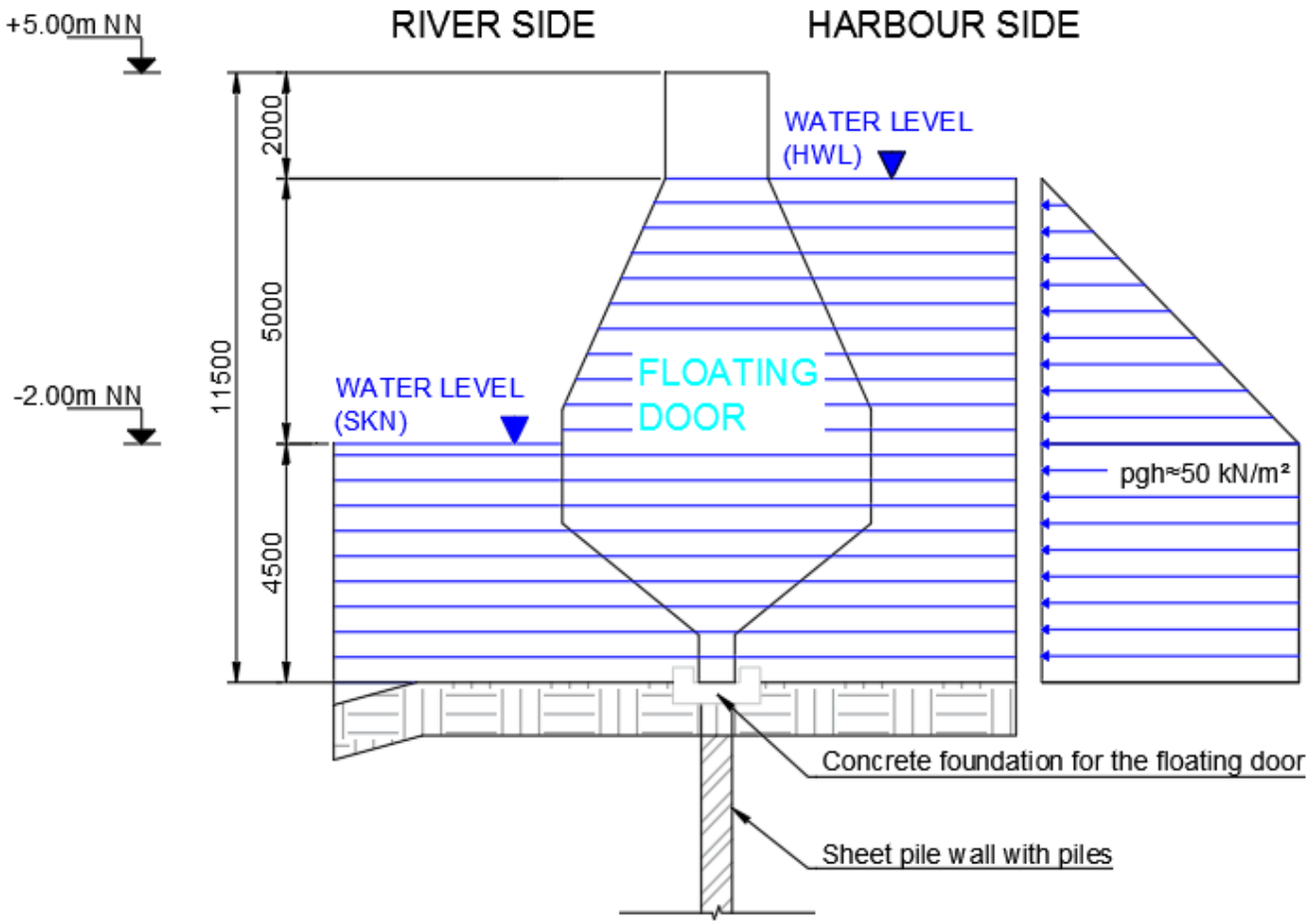
2. There is no loading loading from waves;

3. There is no hogging or sagging effect as we assume no waves;

4. Main load is the hydrostatic pressure from the water level differences of 5m;

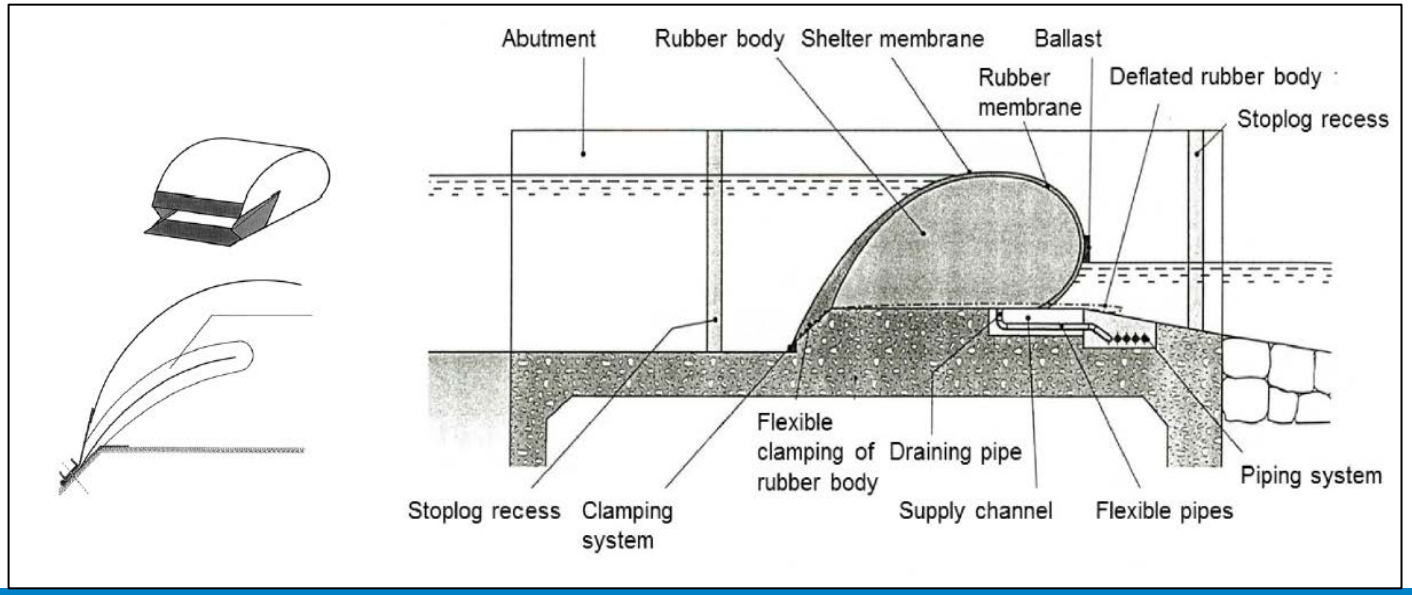
5. The structure is considered as simply supported.

Floating door on its place



Alternative solution for floating door

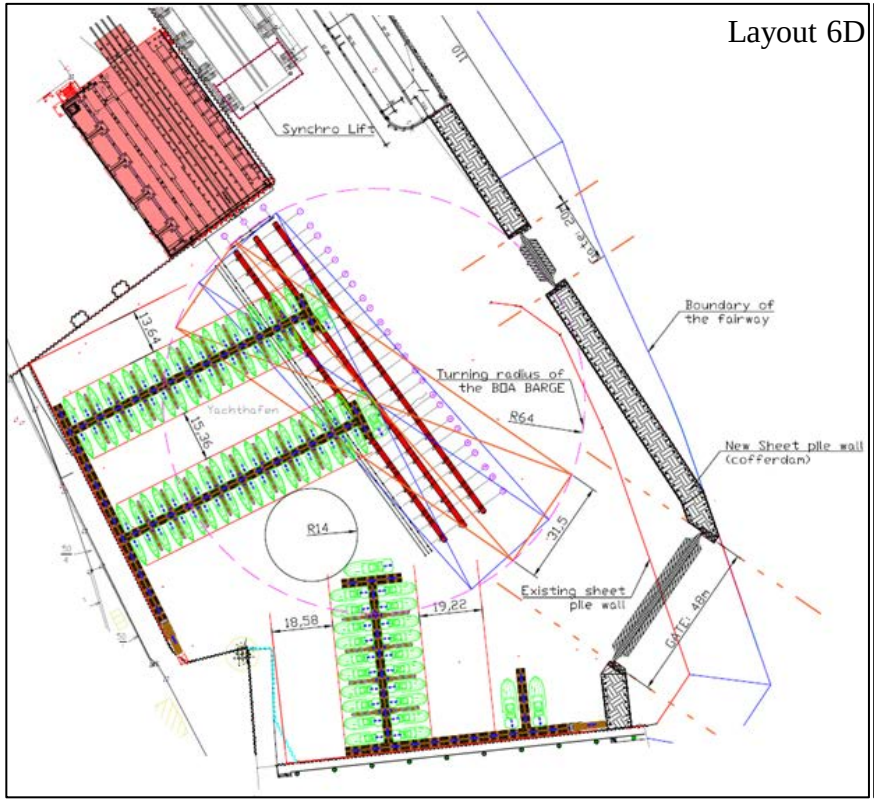
- Inflatable rubber gate;
- Good alternative for the smaller entrance;
- Initial cost cheaper than floating door;
- Entrance can be closed fast in case of storms/floods;
- Does not need considerable manpower compared to floating door;
- Quite new technology; less experienced suppliers and manufactures of this kind of structure.



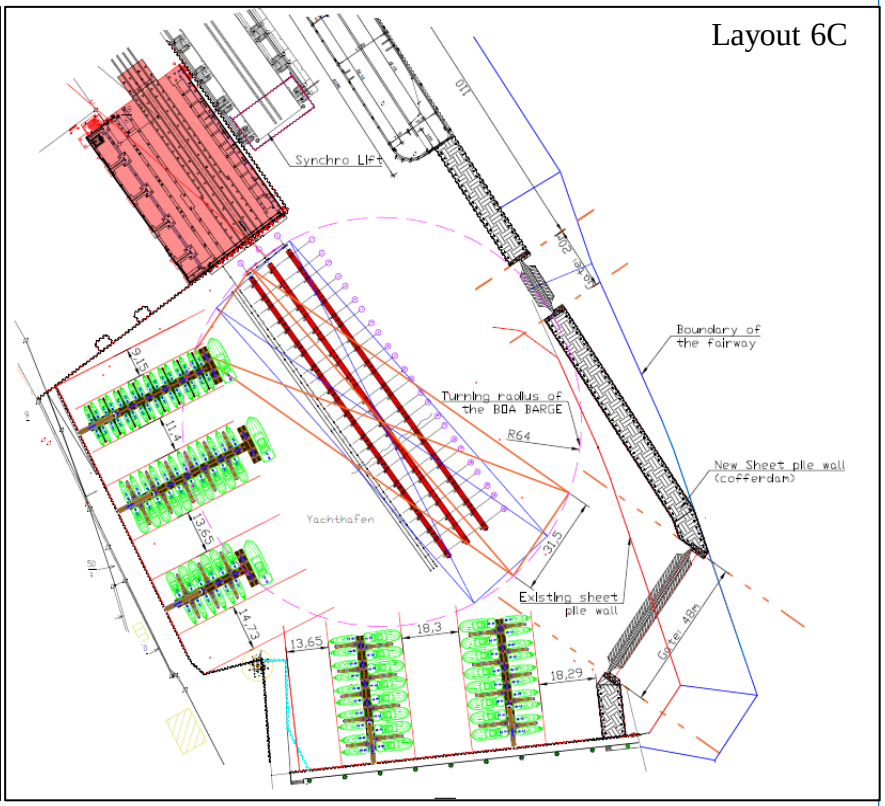
Cost estimation and comparison

Rank	Multi-criteria analysis results	Cost estimation analysis results
1	Layout (6D) - 7.69p	Layout (6C) - 9,396,400.00 €
2	Layout (6C) - 7.60p	Layout (6D) - 9,485,400.00 €

Layout 6D



Layout 6C



Visualization of the best layout

Goals achieved

- ✓ Less sedimentation problem → Less dredging;
- ✓ More and bigger boat places;
- ✓ Better accessibility of the harbour;
- ✓ Independence from the tides if harbour is closed;

Thank You!