Group
TYPSA

Artificial islands for connecting offshore wind farms

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Bilbao
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1.TYPSA

Wind EUROPE | Group TYPSA

53 years of experience

Revenue in 2017 **200 M EUR**

2,400 professionals
(Yearly average number of employees)

Completely **independent**

100% employee-owned

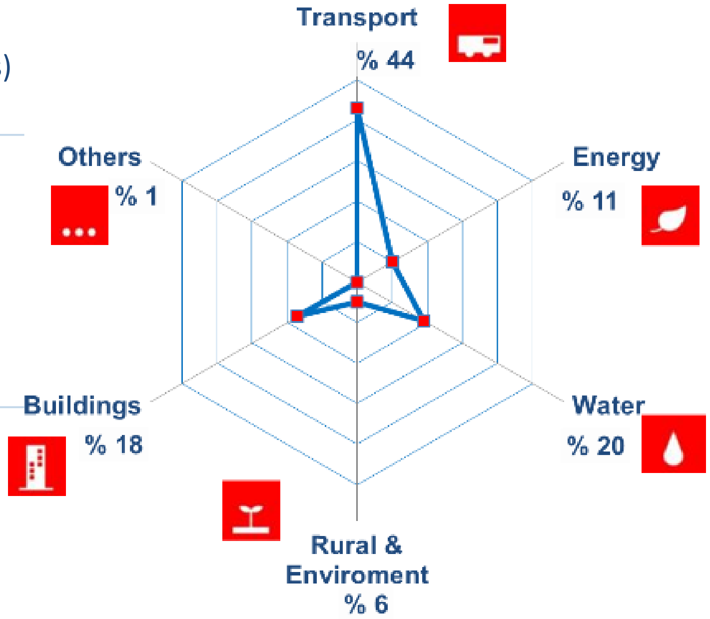
Equity: **100 M EUR**

Consultancy services for large infrastructure

Multidisciplinary approach

Commitment to **quality** and **sustainability**

KEY BUSINESS AREAS



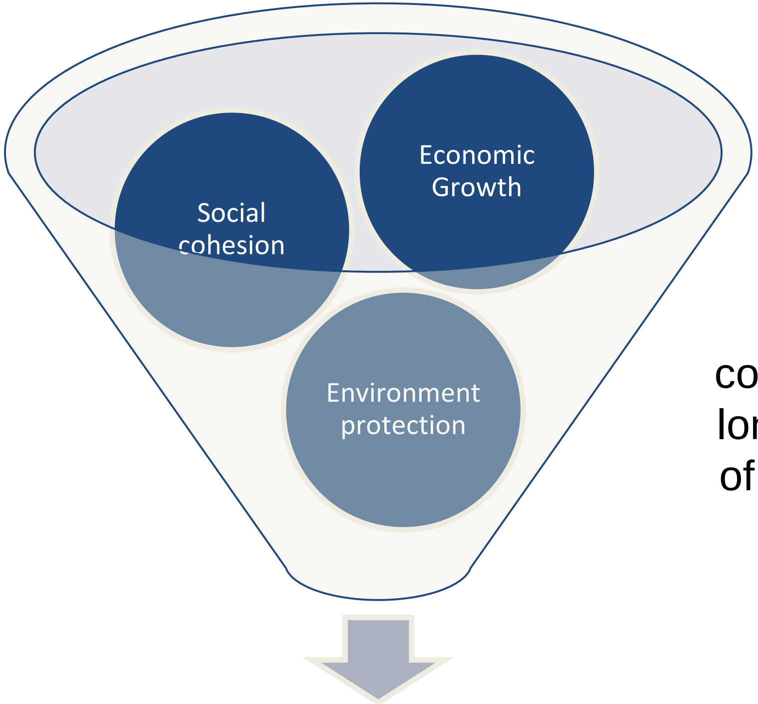
2017 ENR TOP 150 — ENR Engineering News-Record

Marine and Ports: #11

Wind Energy: #6

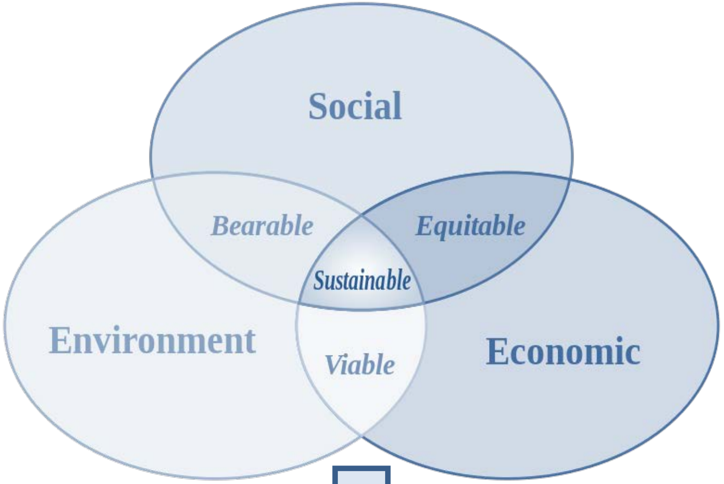
This work is the consequence of the combination of skills and capacities of both divisions

2. Substations: Blue energy



Sustainable Development Strategy

Should the three concepts converge, the long-term sustainability of a project is reached.



2. Substations: conventional solutions

Greater size of wind turbines

Greater wind farms

Need of bigger substations

Need of new solutions to optimise CAPEX

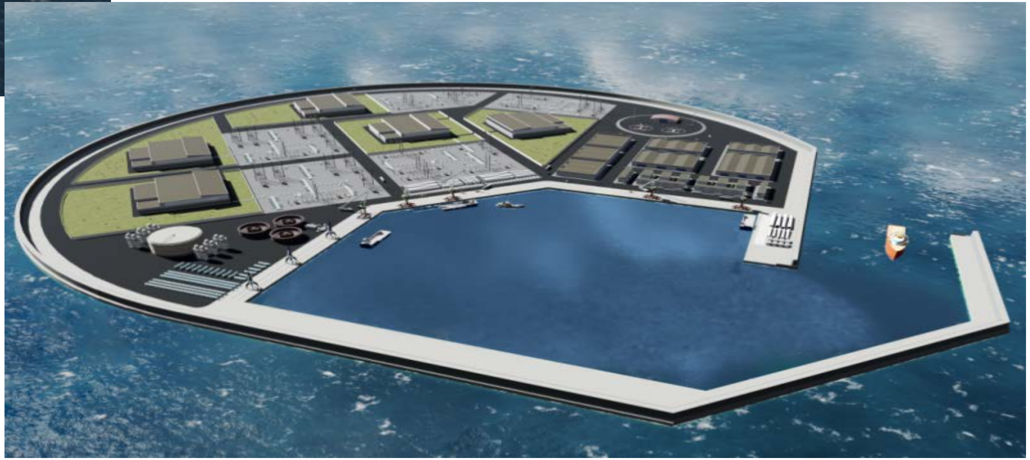
2. Substations with artificial islands

Key advantages of artificial islands

Power link islands
Improve connection between countries
Create logistic hubs
Facilitate O&M activities
Large capacity of power conversion
Adapt to demands of new gen of WTGs

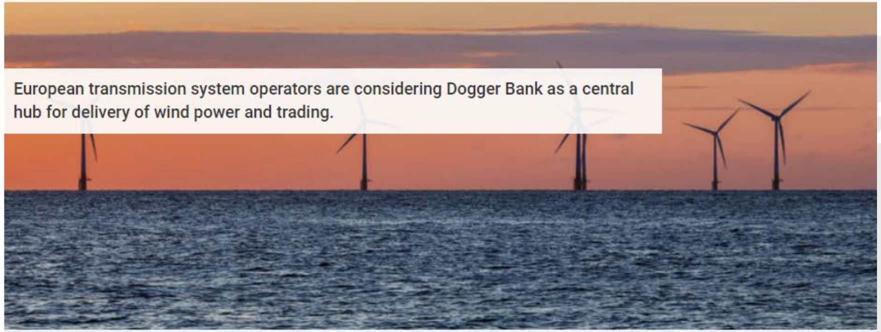
Main challenges

Distance to the coast
AC / DC
Design
CAPEX reduction



3. Artificial islands

North Sea Wind Power Hub to be built on artificial island



Published: Mon 05 Mar 2018

The North Sea's Dogger Bank zone has long attracted special interest as a site for offshore wind power generation.

Key figures:

- 80 Nautical Miles from the coast
- 600 Ha
- Capacity for 30 GW
- UK, Netherlands, Germany, Denmark, Norway

3. Artificial islands

TenneT is holding market consultation for grid connection concepts for the IJmuiden Ver wind energy area, which is farther from the coast than currently developed areas. The company is consulting on HVDC platforms and an artificial island as potential solutions.

Key figures:

- 50 Nautical Miles from the coast (Netherlands)
- + 60 Ha
- Capacity for 10 GW
- UK & Netherlands
- Water depth: 23 m

ENGINEERING CHALLENGES?

Differences between land reclamation and artificial islands

Land reclamation projects:

- Purpose of gaining space
- Near to the population
- Low water depths
- Mild wave climate
- Hydraulic filling and rubble mound breakwater

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ENGINEERING CHALLENGES?

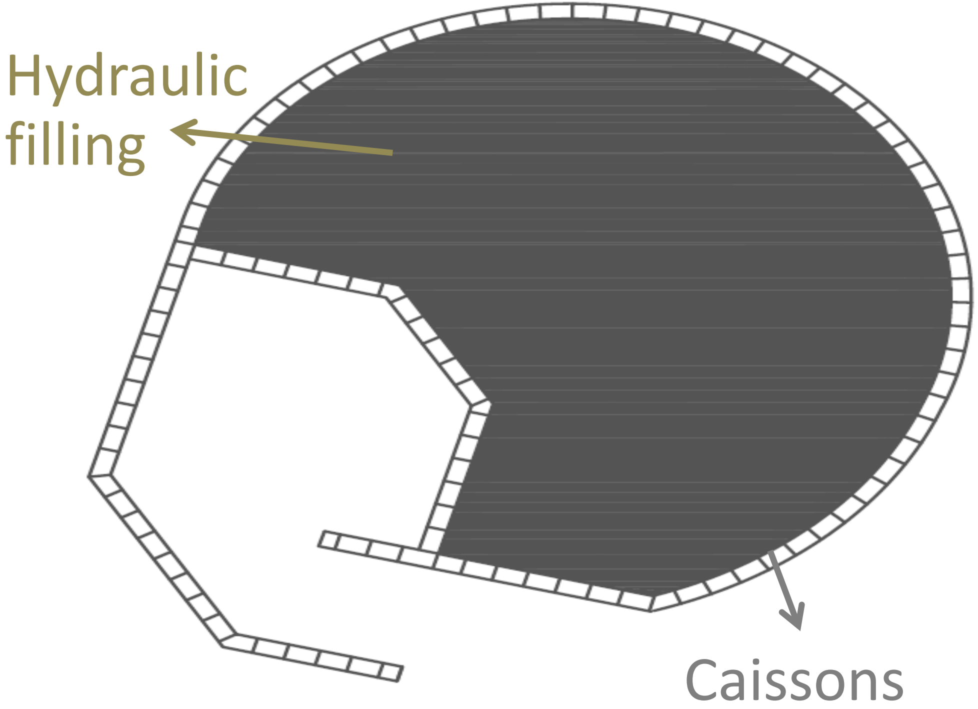
Differences between land reclamation and artificial islands

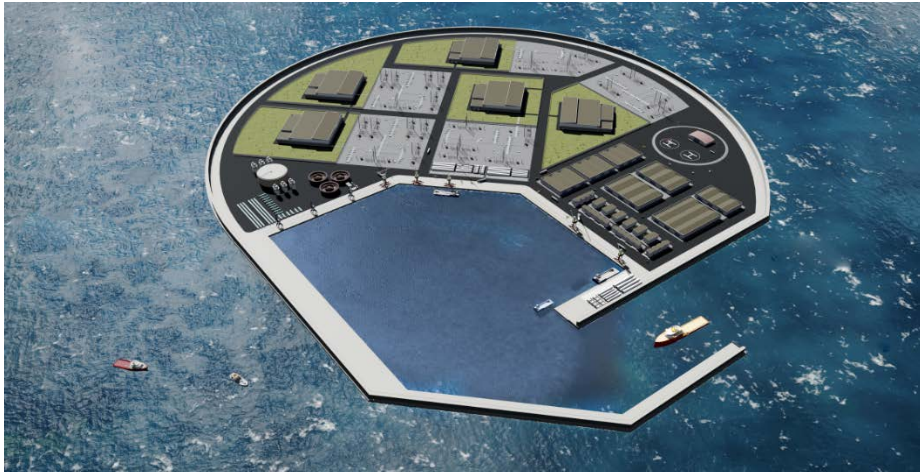
Artificial Islands

- Improving grid connection
- Creating a hub area for logistics
- Far from the population
- Water depths +25 m
- More severe wave climate
- Need of large volumes of filling

4. The case study: Ijmuiden Ver

CONCEPTUAL DESIGN CONDUCTED BY TYPSA for TENNET in Ijmuiden Ver

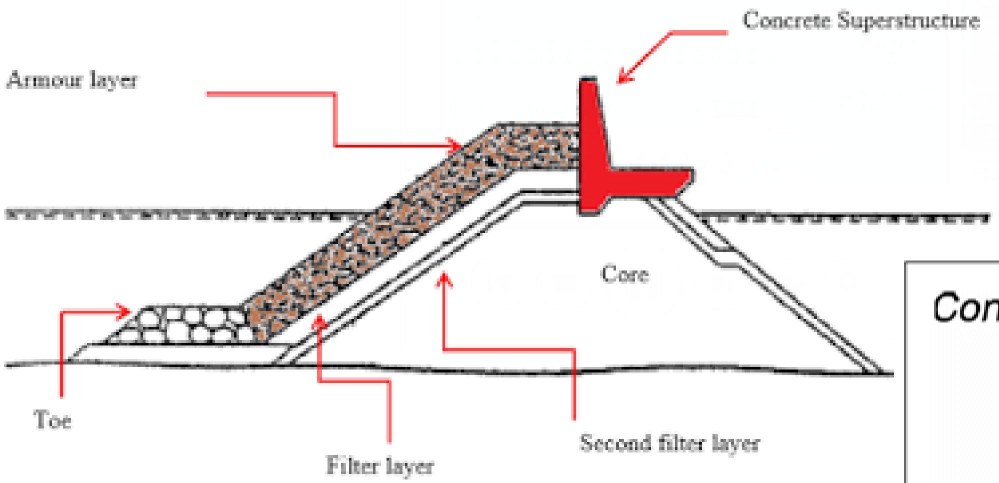




KEY advantadge: Employ of vertical caissons for reducing costs and environmental impact

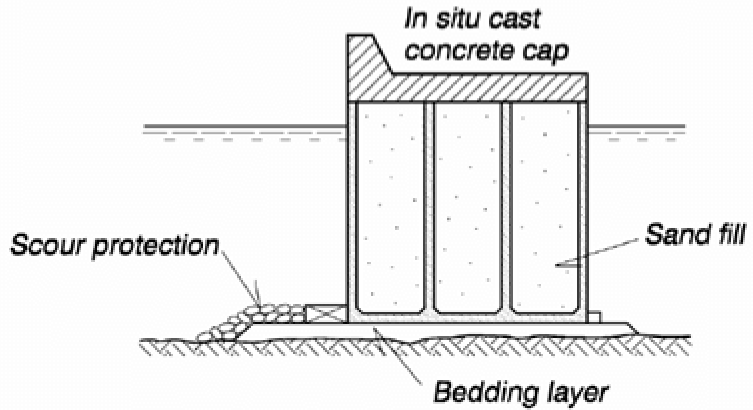
4. The case study: Ijmuiden Ver

Rubblemound breakwaters



Two main type of solutions for breakwaters and docks

Conventional caisson breakwater with vertical front



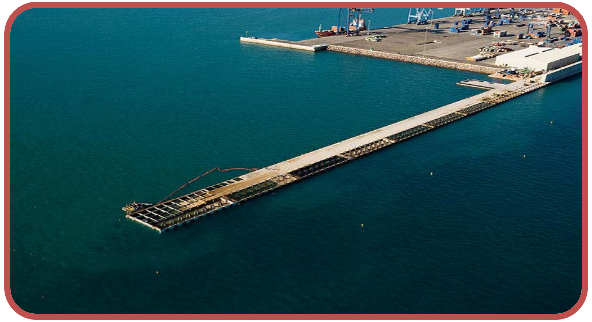
Advantages of caisson-type solutions

- ✓ More competitive for water depths larger than 20 m
- ✓ Less volume of hydraulic filling needed
- ✓ High density of wind farms in the area of North Sea (not many borrow areas)
- ✓ Speed up construction method
  - ✓ Limit the damage during winter periods → material washed

Advantages of caisson-type solutions

- ✓ Reduced environmental impact
- ✓ Rubble mound breakwater can induce wave breaking
- ✓ New caisson solutions (anti-reflection) can avoid high reflection coefficients
- ✓ Optimize the port space the employ of caissons
- ✓ Cable landing

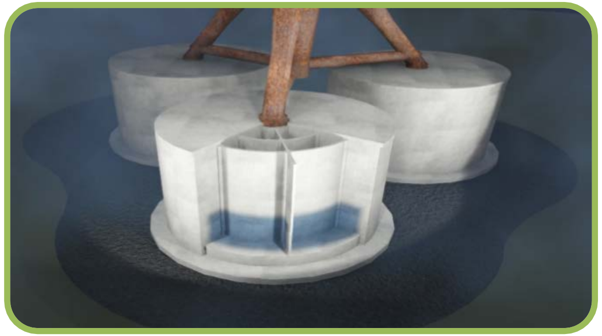
4. The case study: Ijmuiden Ver



Employ of well developed technology in port engineering

Cellular structures – so they are self-buoyant

Easy to transport by means of tugs



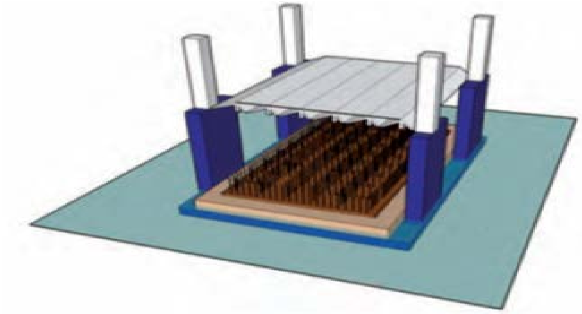
Easy to install by means of water/sand

Provide sufficient weight to withstand wave forces

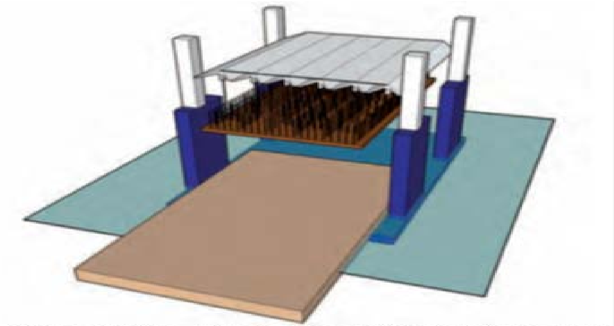
Reduced construction time using floating docks

4. The case study: Ijmuiden Ver

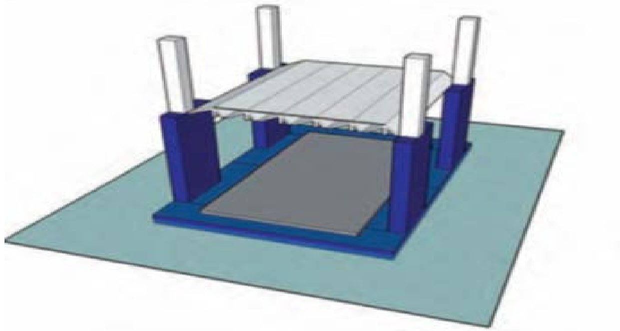
CONSTRUCTION TECHNOLOGY



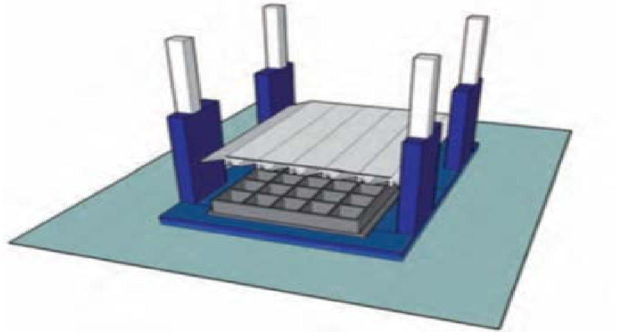
Step 1: The steel cage of the bottom slab of the caisson is provided by means of a pontoon. The floating dock is submerged to allow the entrance of the pontoon.



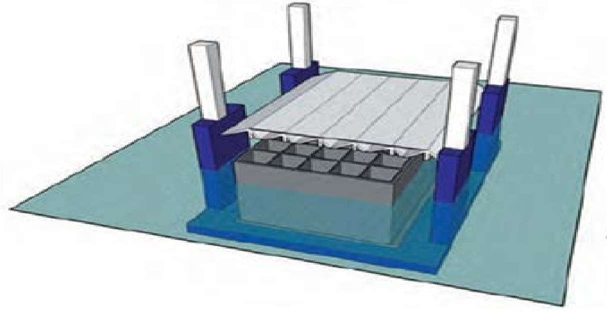
Step 2: The steel cage of the bottom slab is hanged by the floating dock, while the pontoon is removed



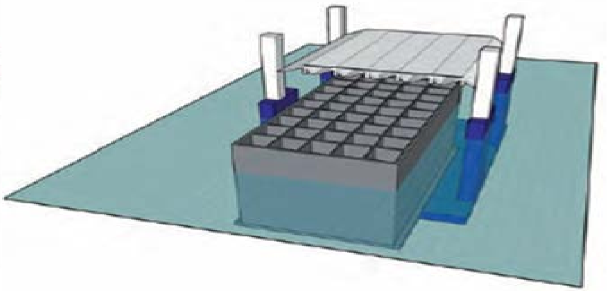
Step 3: The bottom slab of the pontoon is emerged and the steel cage is placed over it



Step 4: The concrete is poured using a formwork and the bottom slab of the floating dock starts to submerge as the caissons starts to rise

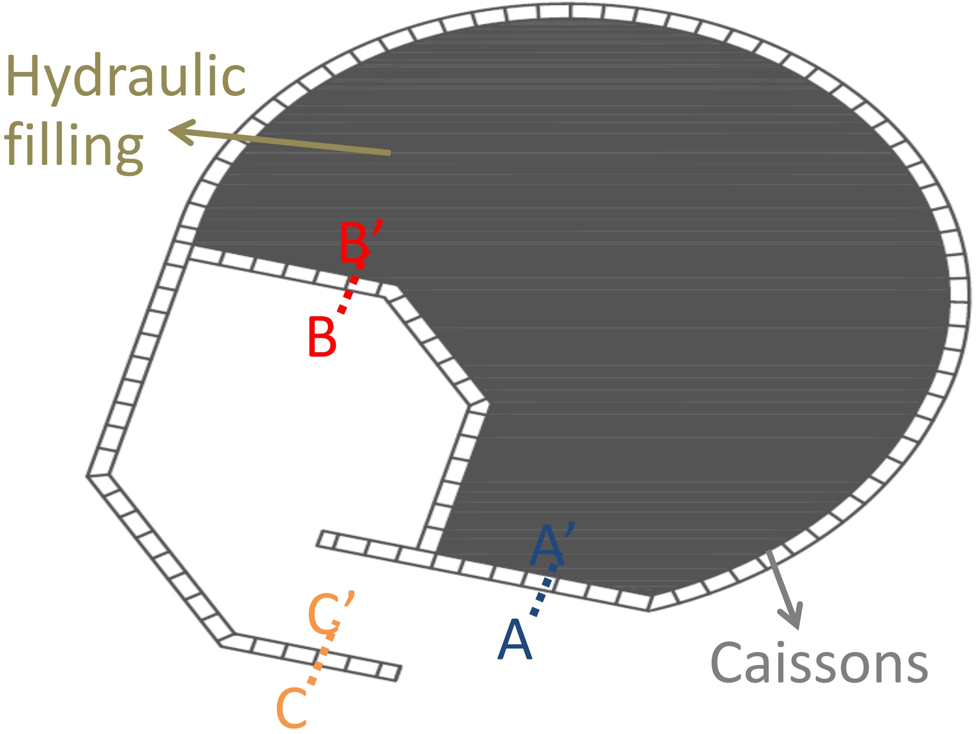


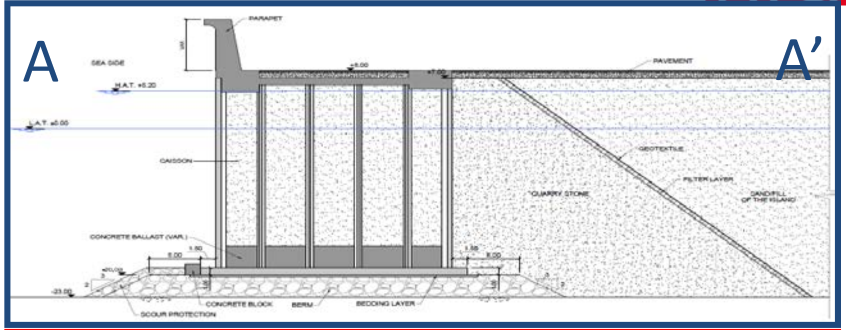
Step 5: The pouring process until the total height of the caisson is reached. The top slab of the caisson is installed once finished

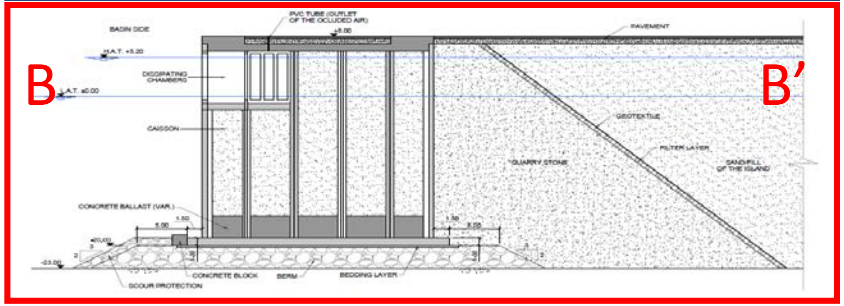


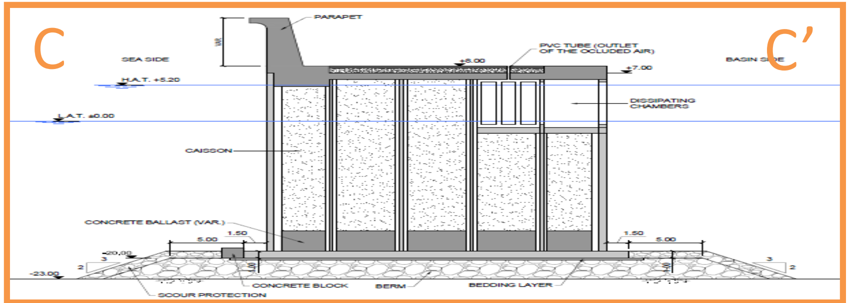
Step 6: The caisson is launched by means of auxiliary maritime resources

4. The case study: Ijmuiden Ver

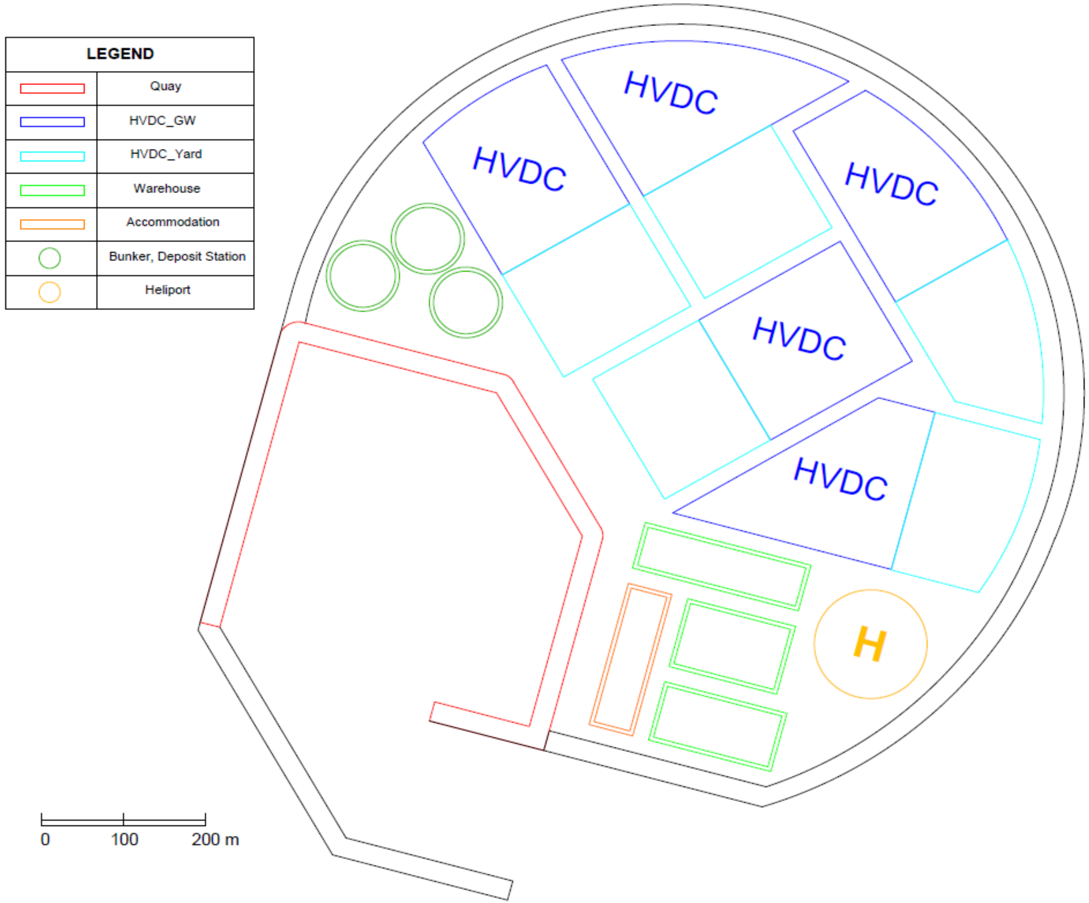


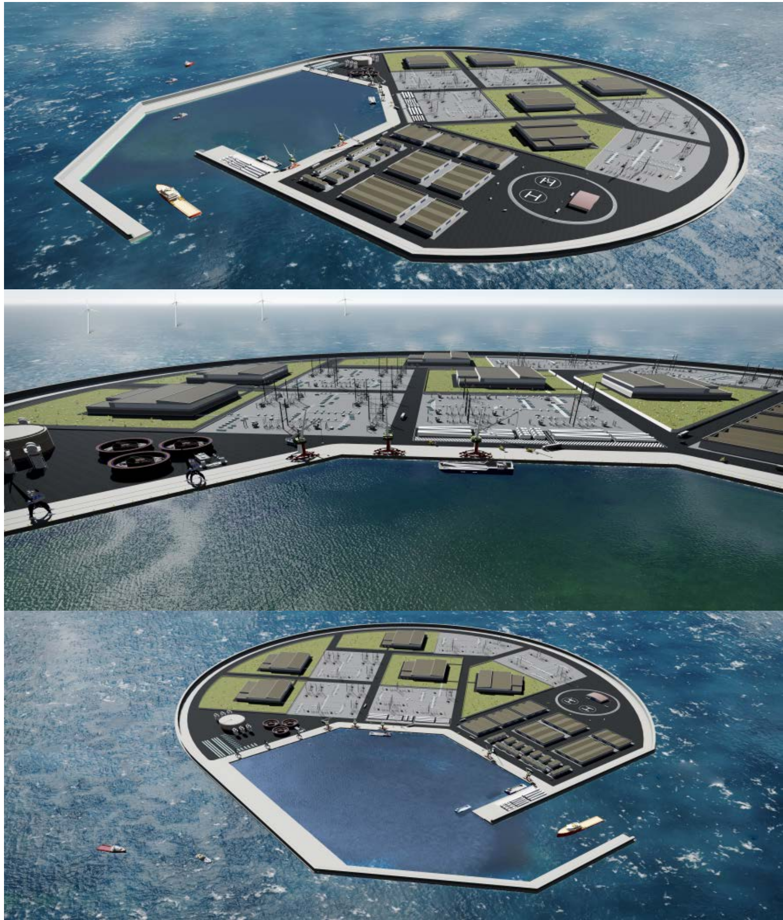






4. The case study: Ijmuiden Ver

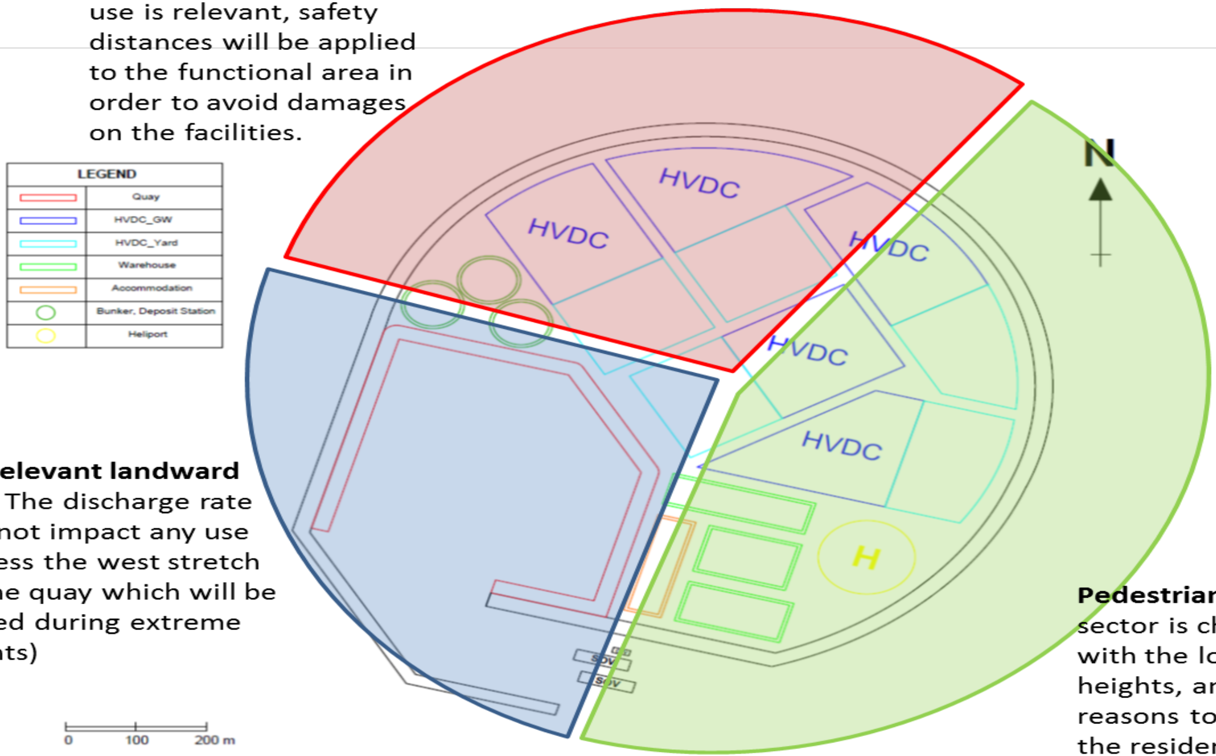




4. The case study: Ijmuiden Ver

Distribution of spaces according to the wave conditions in order to mitigate

Highest wave conditions. Although the landward use is relevant, safety distances will be applied to the functional area in order to avoid damages on the facilities.



No relevant landward use. The discharge rate will not impact any use (unless the west stretch of the quay which will be closed during extreme events)

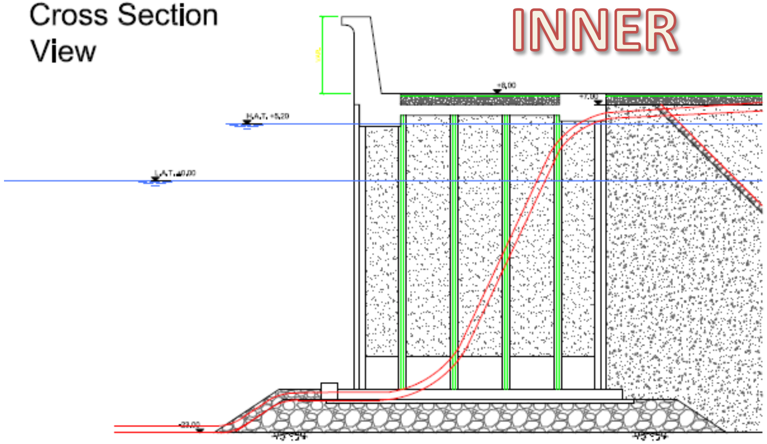
Pedestrian area. This sector is characterized with the lowest wave heights, and that is the reasons to allocate on it the residential area. Therefore, this area will have the more limiting discharges.

4. The case study: Ijmuiden Ver

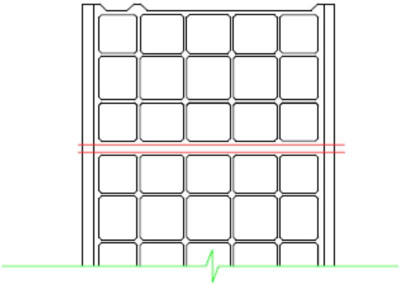
CABLE LANDING

INNER vs EXTERIOR

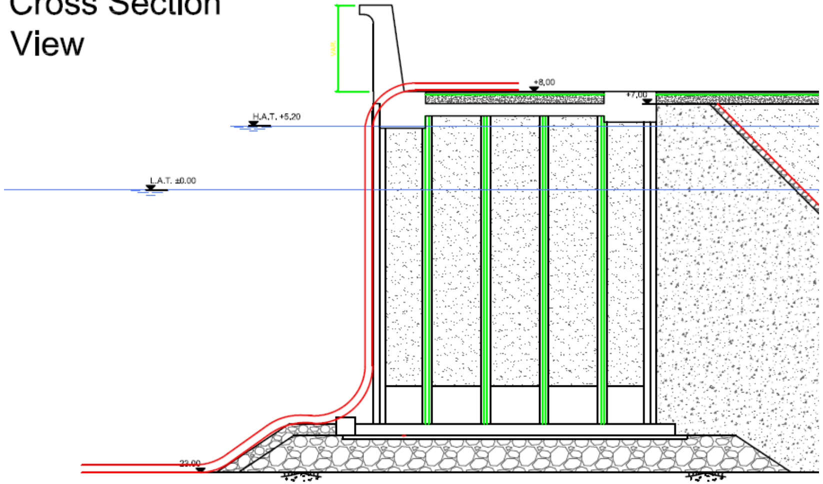
Cross Section View



Plant View



Cross Section View



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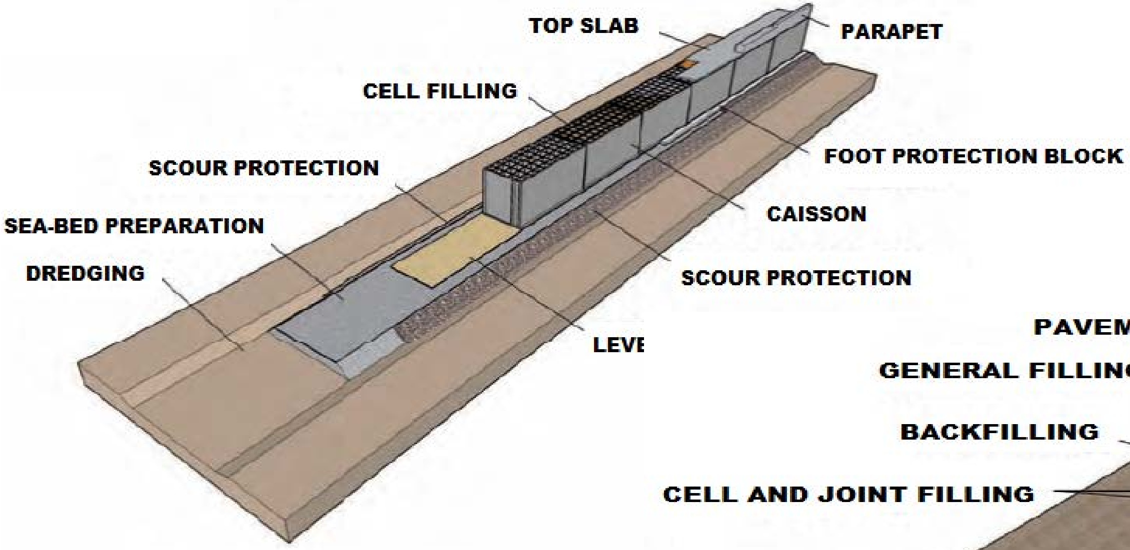
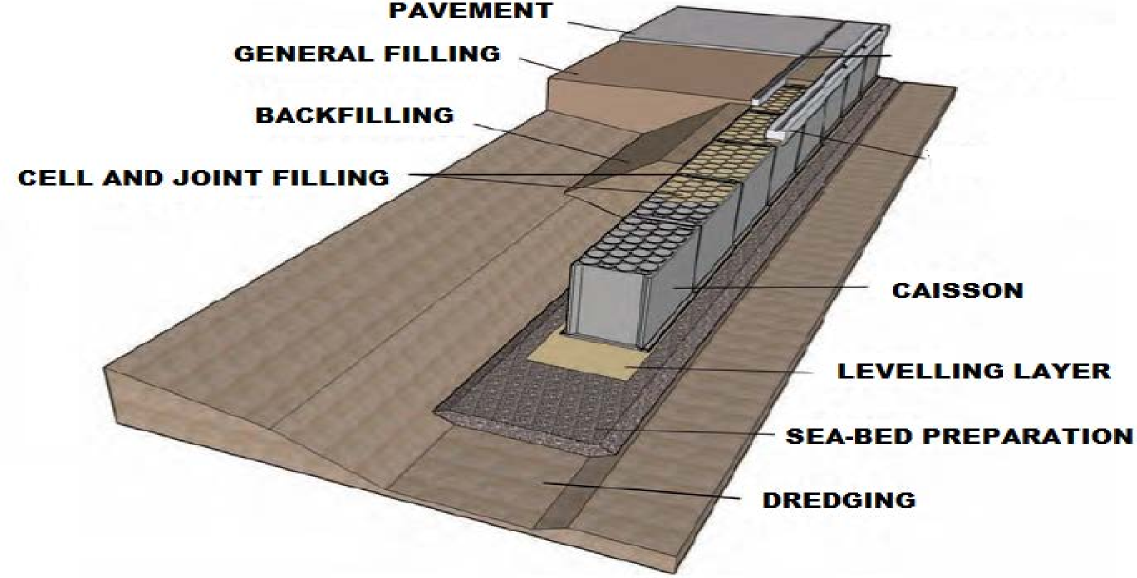
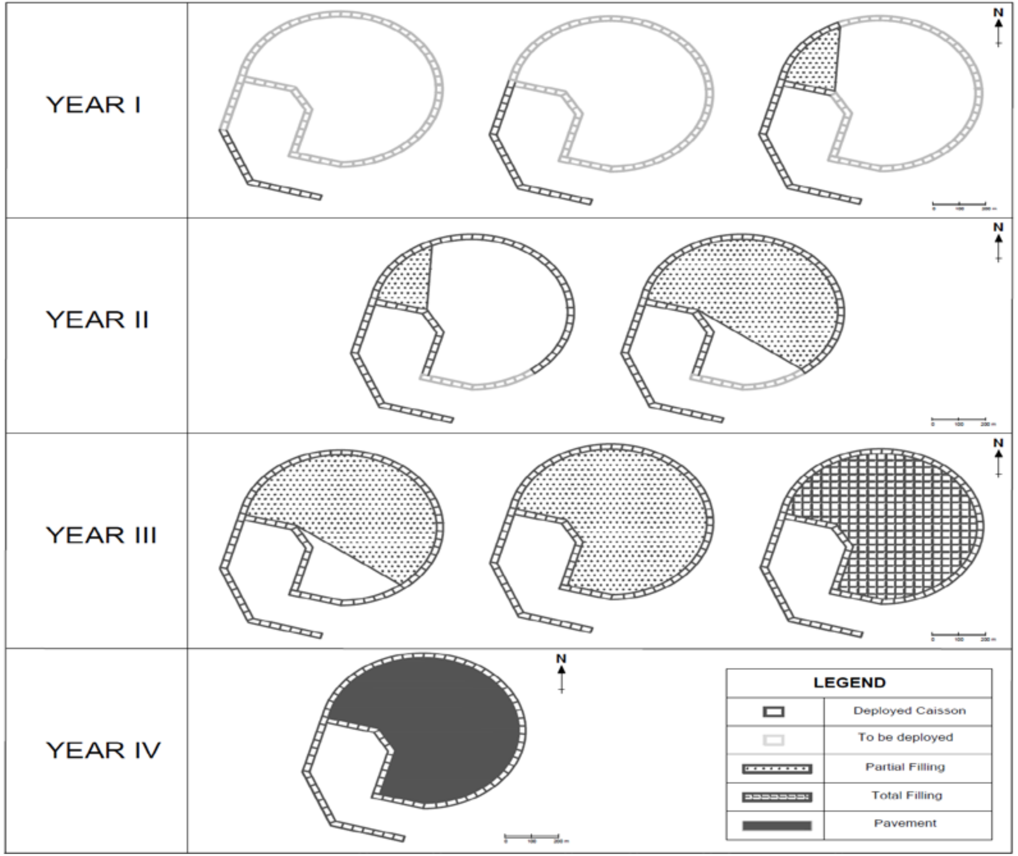


Construction approach for docks and breakwaters using caisson-type solutions



Artificial islands for connecting offshore wind farms

4. The case study: Ijmuiden Ver



5. Conclusions

- Need to overcome the arising shortcomings of the market in order to continue with the current growth ratio
- Artificial islands is a need to overcome these issues
- Improvement of electrical grid with a transnational network
- Employ of caissons to optimize costs, time and reduce environmental impacts