Westermost Rough Offshore Wind Farm

Foundations

13 November 2014

Prepared: ANDGA
Version: 12.11.14 @ 13.30

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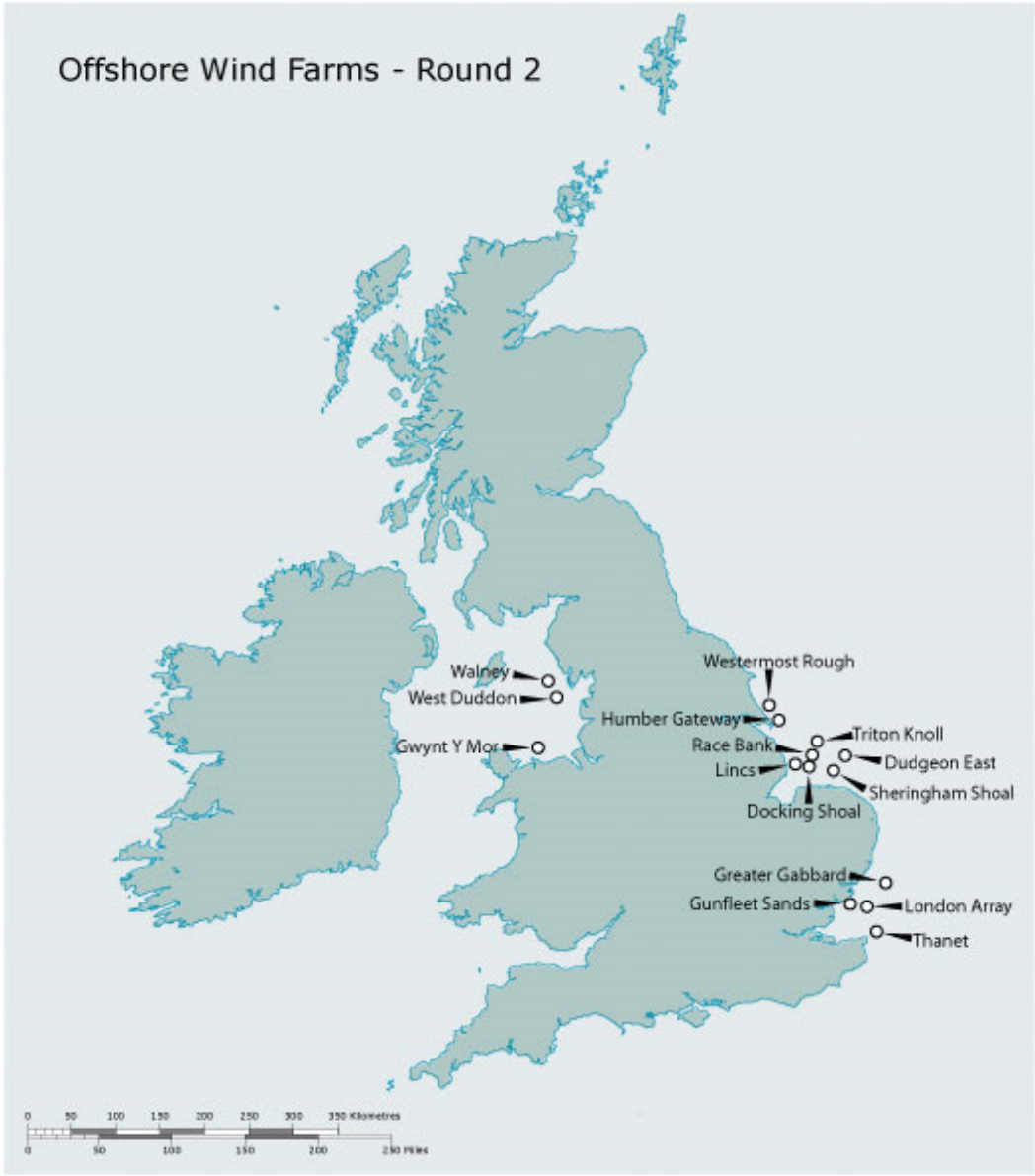
Overview – Westermost Rough



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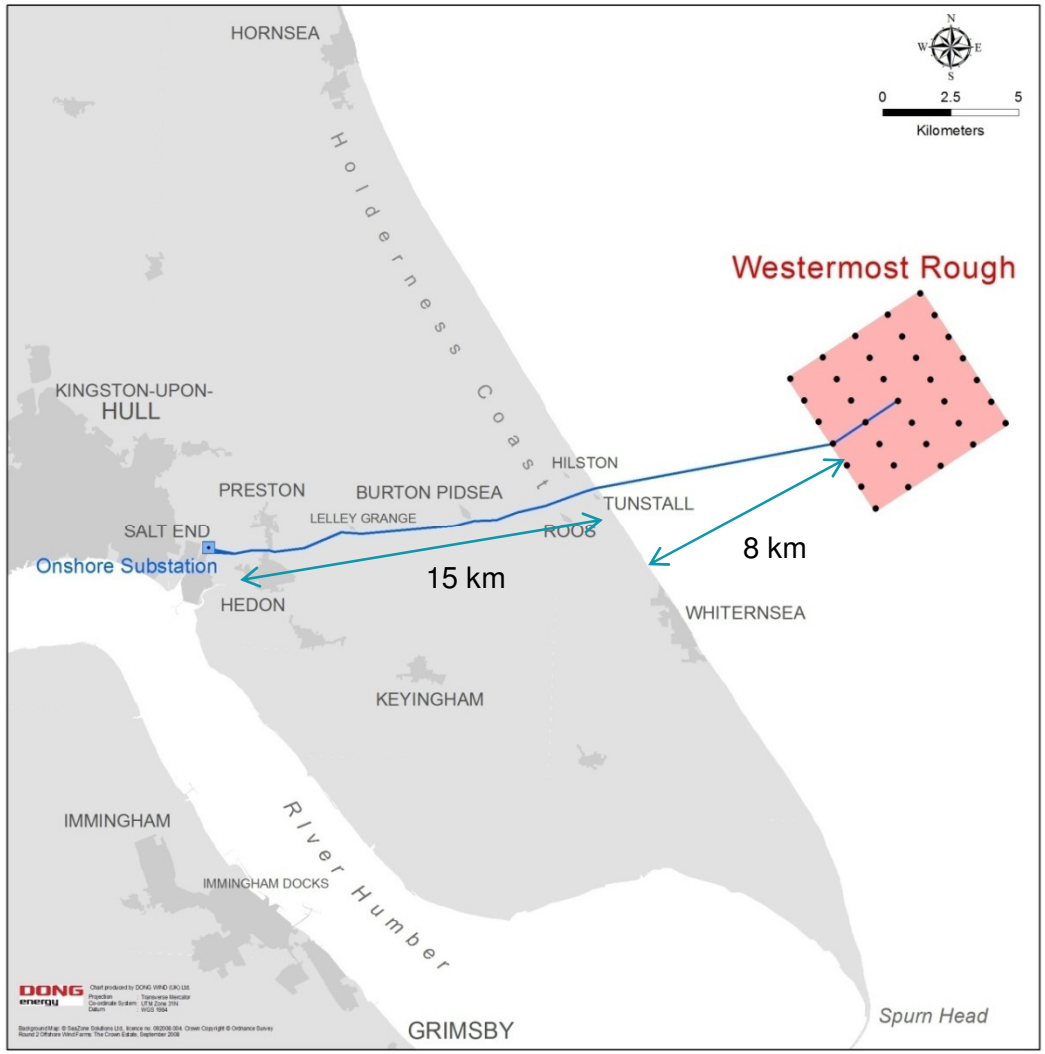
Westermost Rough Offshore Wind Farm – Key Data



Area: 35 km2

Capacity: 210 MW

Turbine Rating: 6 MW

Cable Landing: Tunstall

Onshore Substation: Hedon

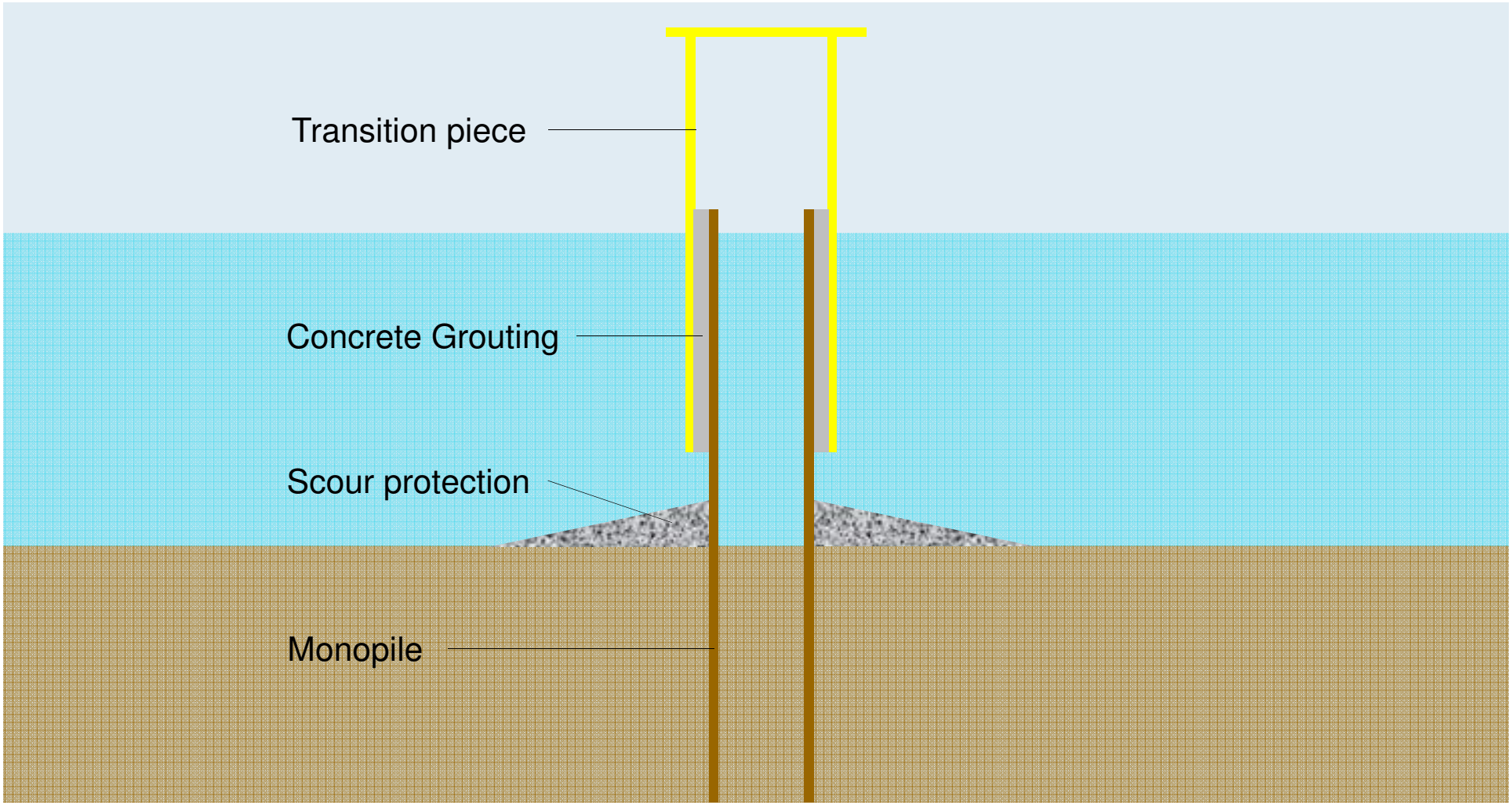
Water Depths: 16 – 26 m LAT

Construction: 2014

Indicative turbine lay-out

First commercial 6 MW wind turbine

Foundations
Structure



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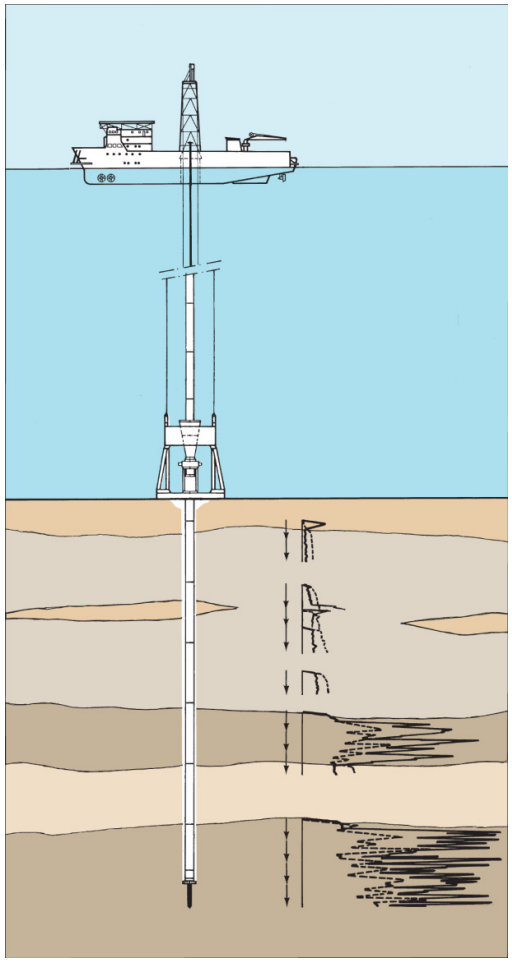
Site Assessment
Meassurement Campaigns

Wind

Waves

Geotechnics



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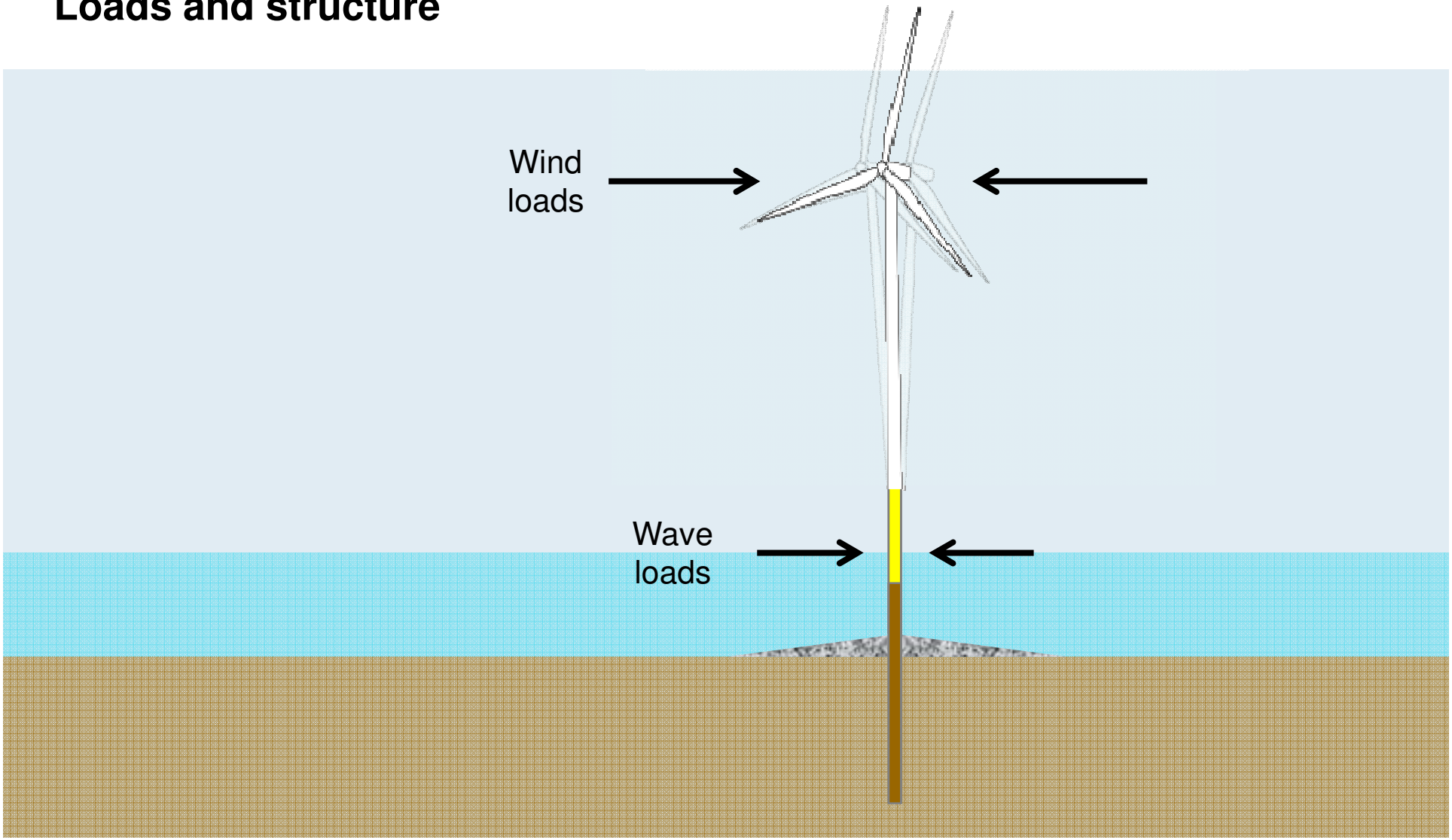
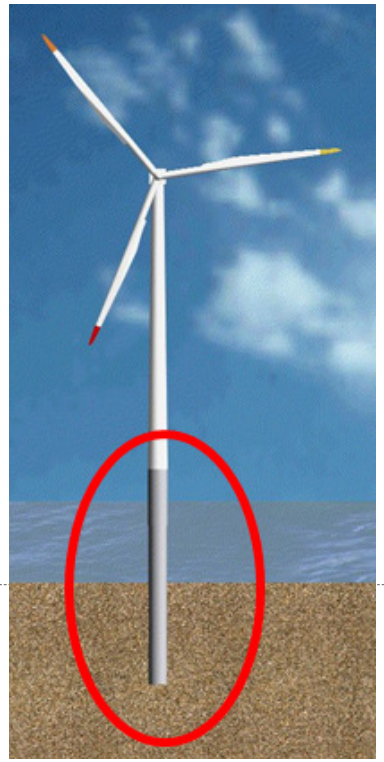
Foundations
Loads and structure



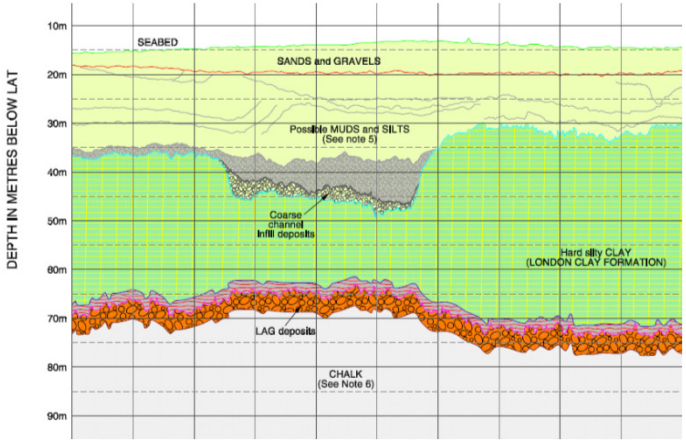
Site Assessment

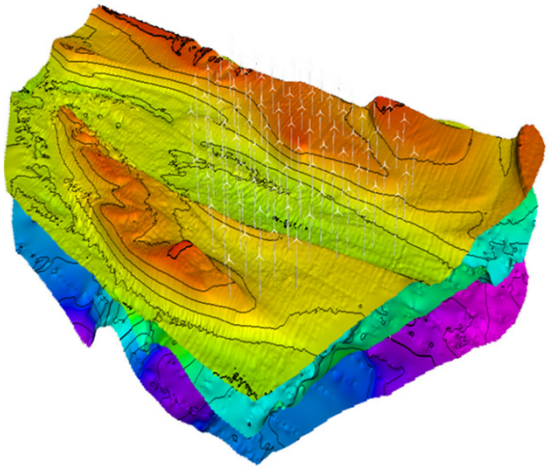
Loads vs ressistance

Loads
(wind and waves)



Resistance
(Soil)





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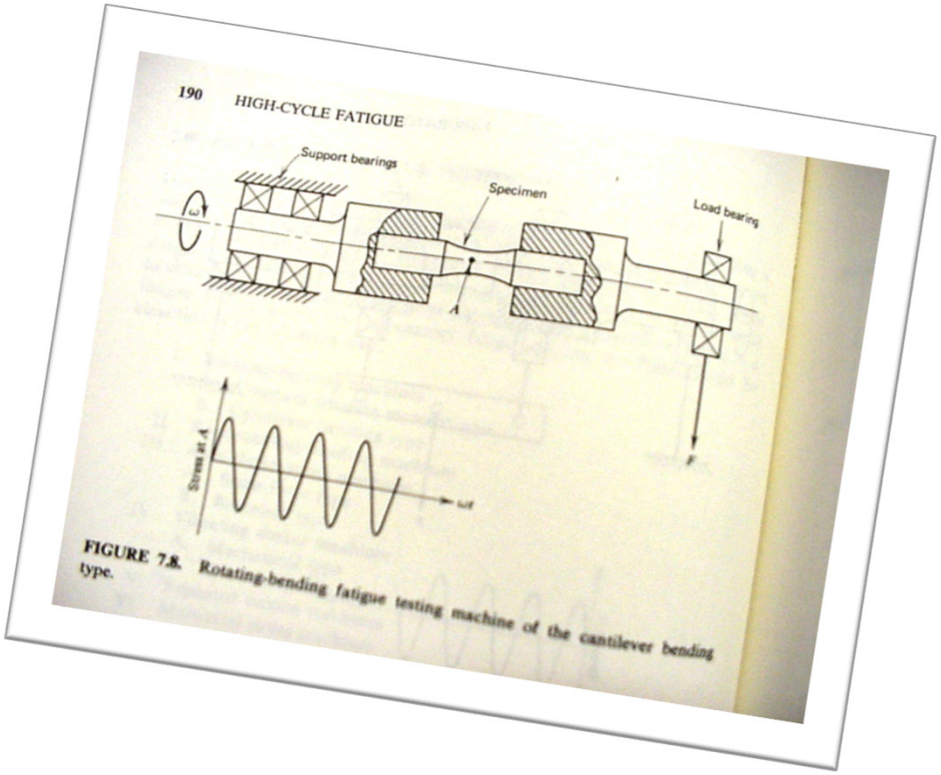
Site Assessment
Loads vs ressistance

Loads
What drives the Design

Extreme

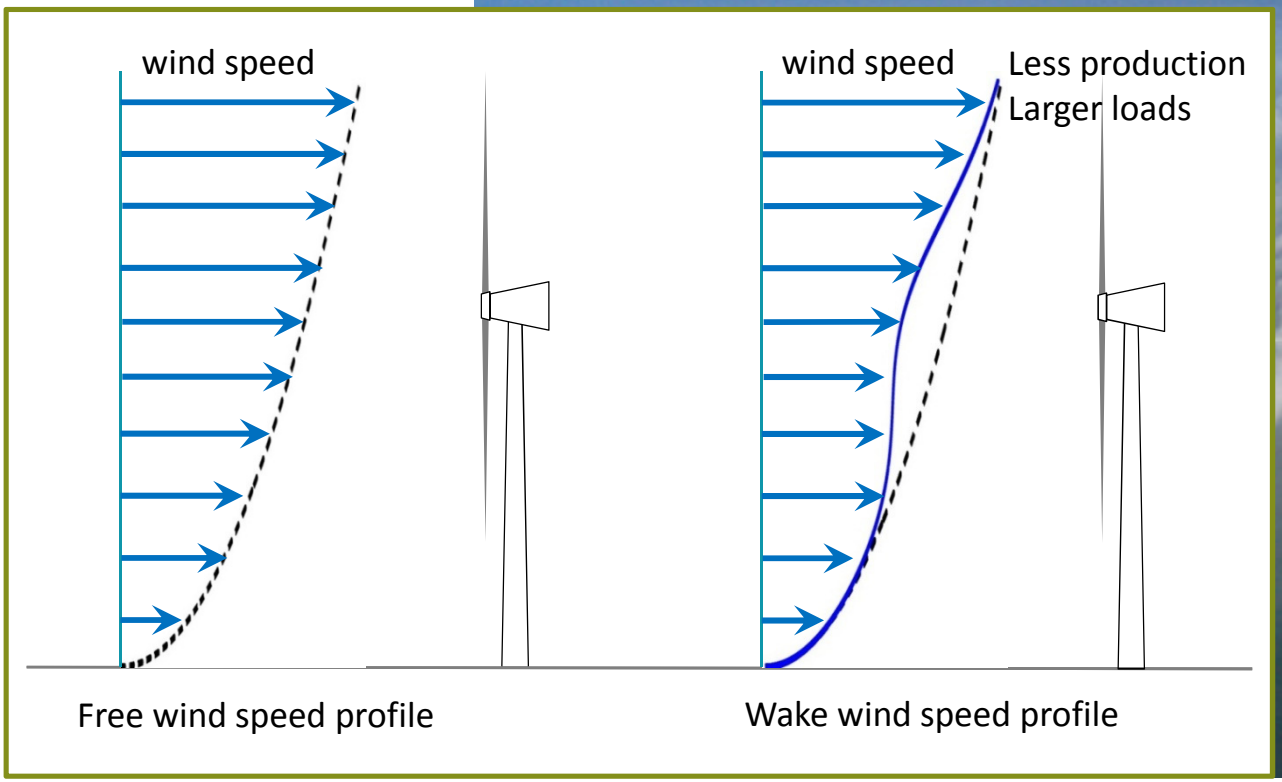
Fatigue limit state, small strains



Site assessment

Optimize and analyze wind farm data

Wake causes production loss up to 10-25%



Wind Loads
Average conditions

Swept area:

$A_{rotor} = \pi r^2$

$A_{rotor} = 18\,625\ m^2$

= 2 football fields

Mass of air:

$V_{wind} = 12\ m/s$

$\rho_{air,\ 20^\circ} = 1.2\ kg/m^3$

$m_{air} = A\ V\ \rho = 268\,200\ kg/s$

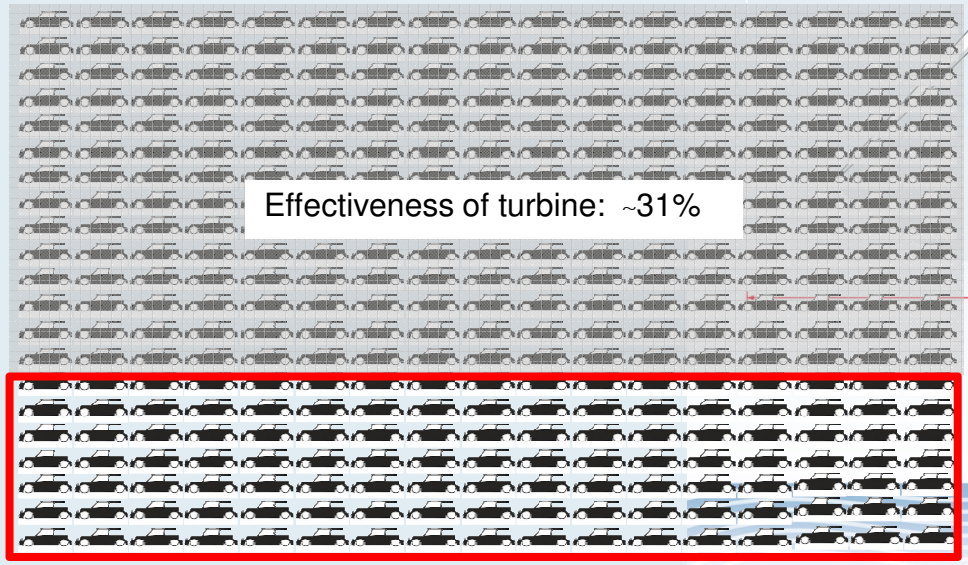
= 36 Elephants per second

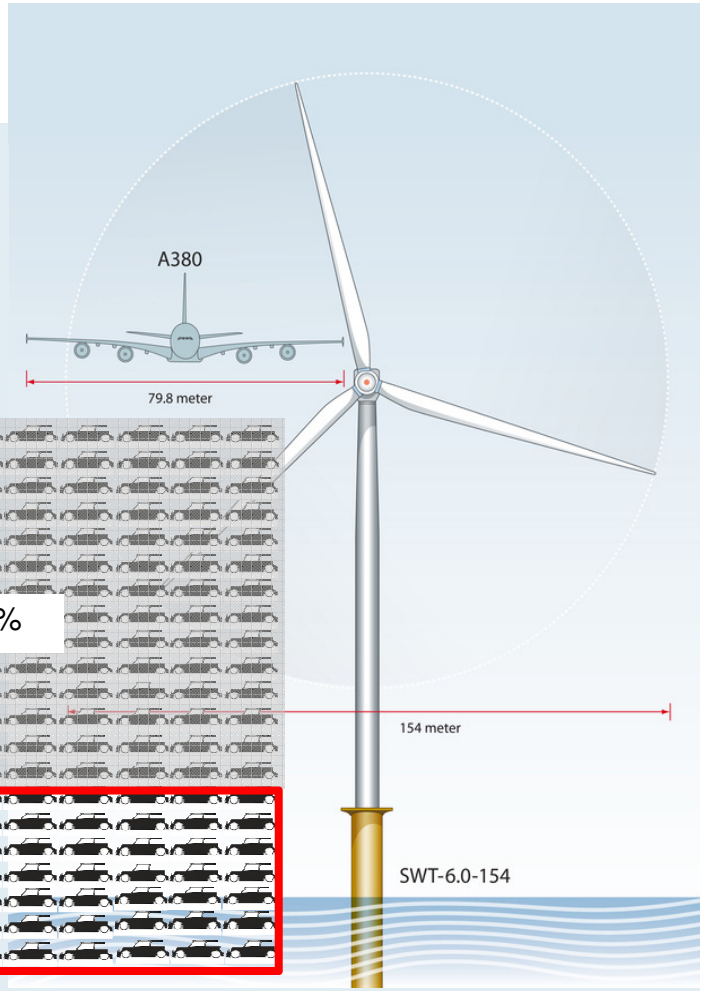
Power of air:

$P_{air} = ½\ 36$  $(12m/s)^2$

= 19MW

= 390 mini coopers





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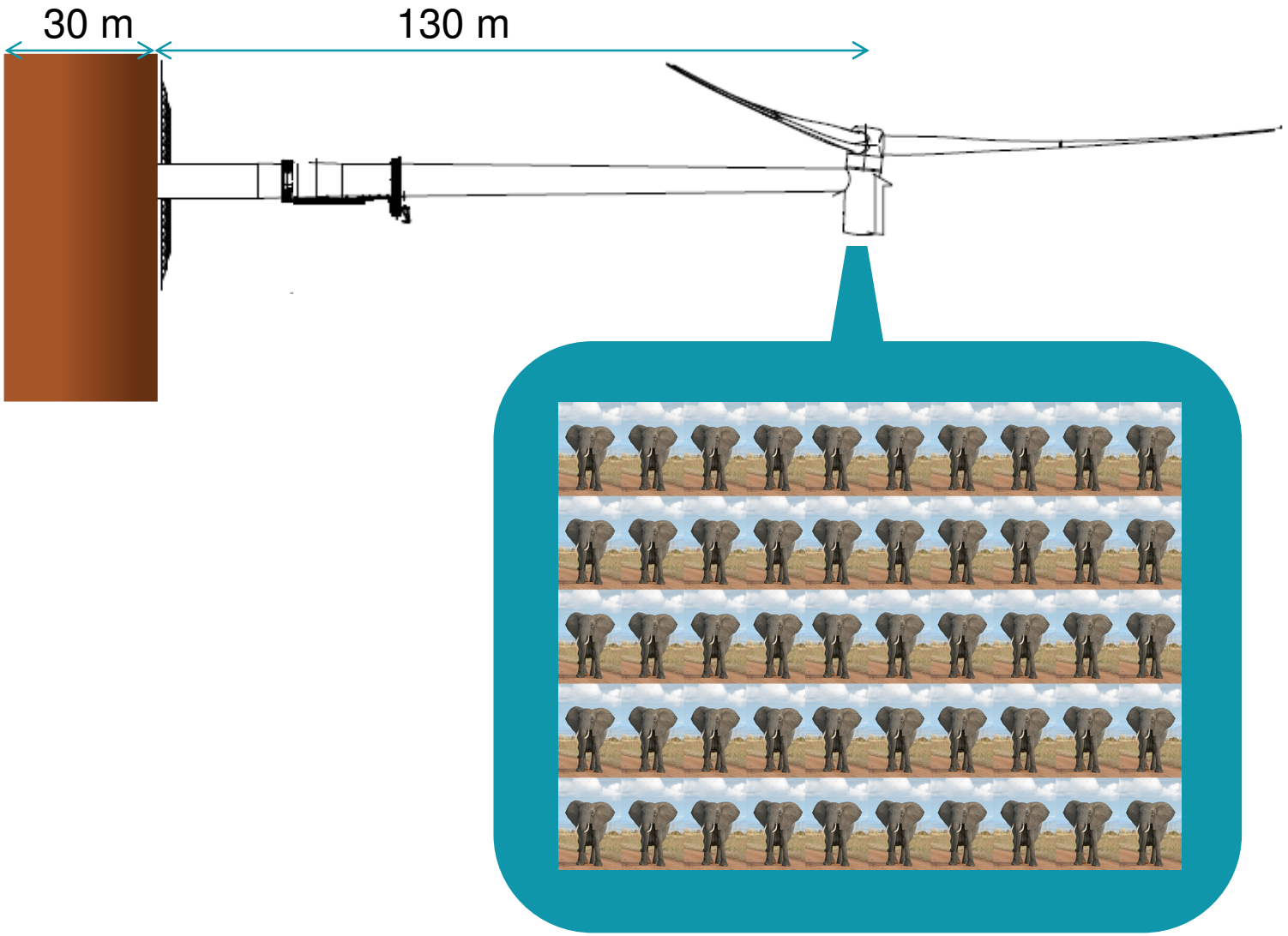
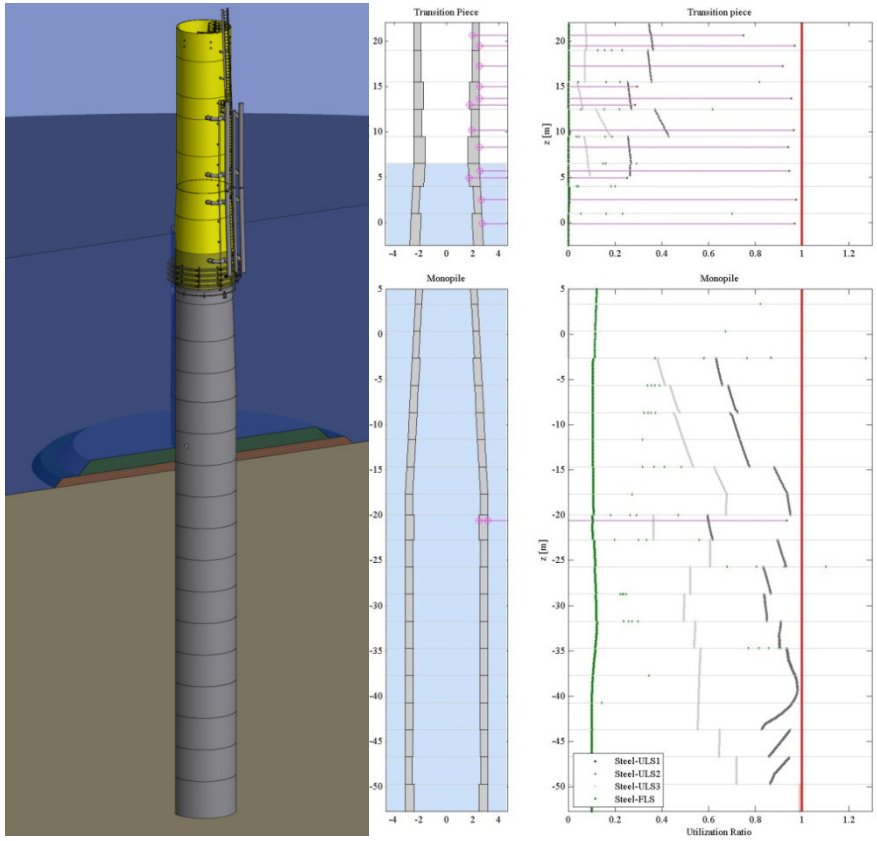
Loads

Average conditions



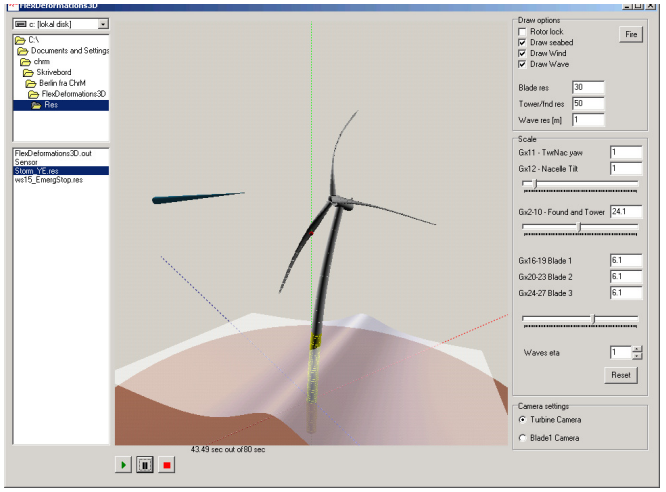
Design of Foundations
Iterative process

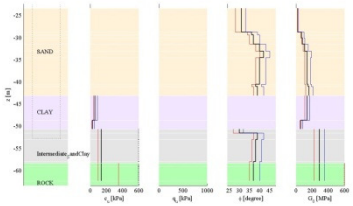
Calculation and optimisation



load and design iterations

Integrated wind/wave loading model





Soil resistance model

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Design of Foundation
Typical sizes

Transition piece:
Weight: 360 ton
Length: 22 m

Monopile:
Weight: 800 ton
Length: 65 m

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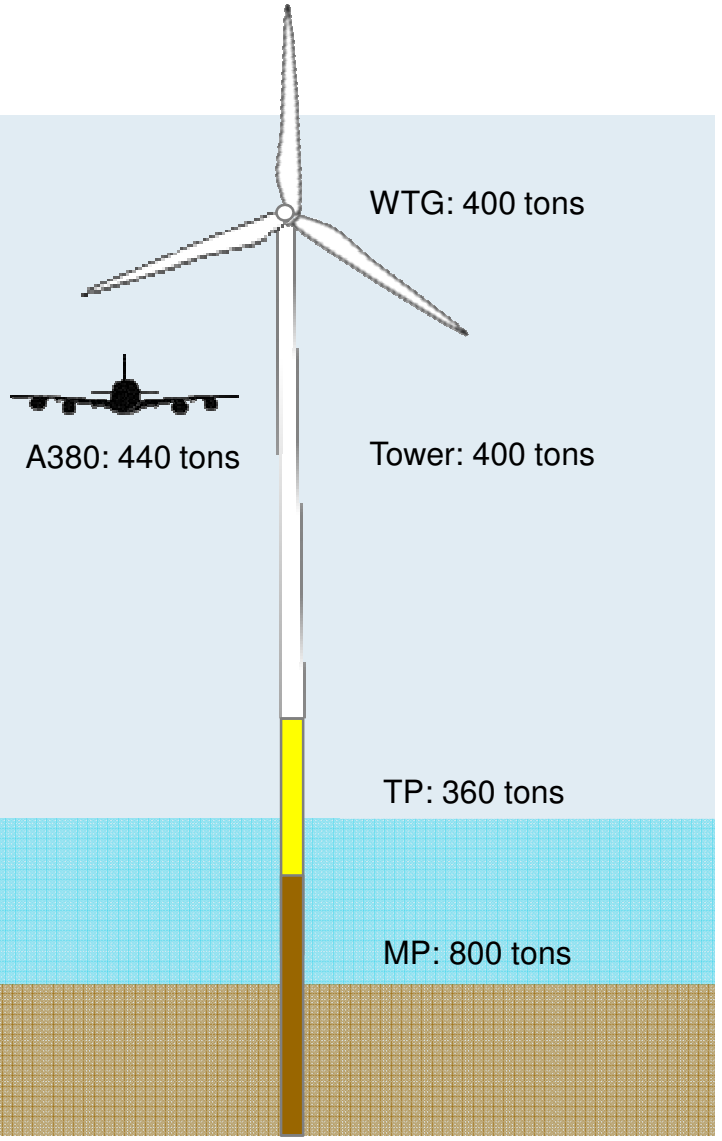
Design of Foundation

Average weigth

The weigth of WTG+TP+MP
= 1960 tons
= 4,5 x Airbus 380
= ~1600 cars

35 positions

A total of 68.600 tons steel



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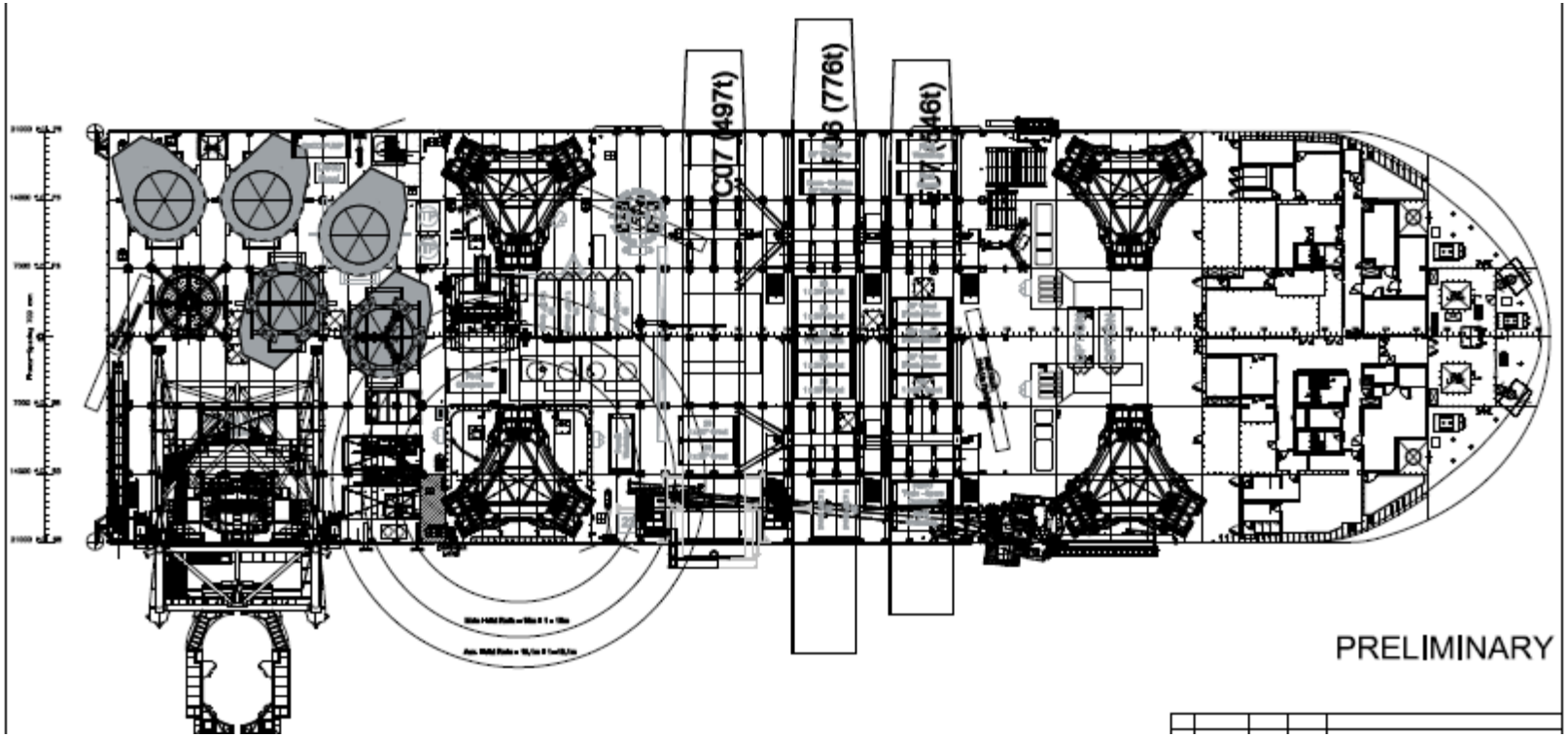
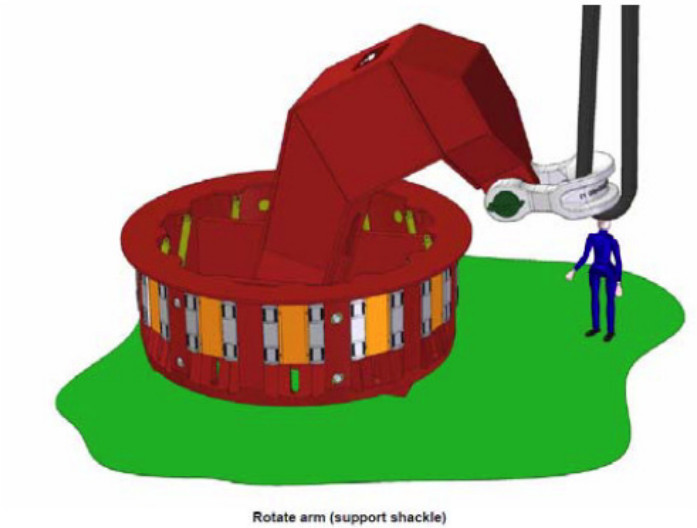
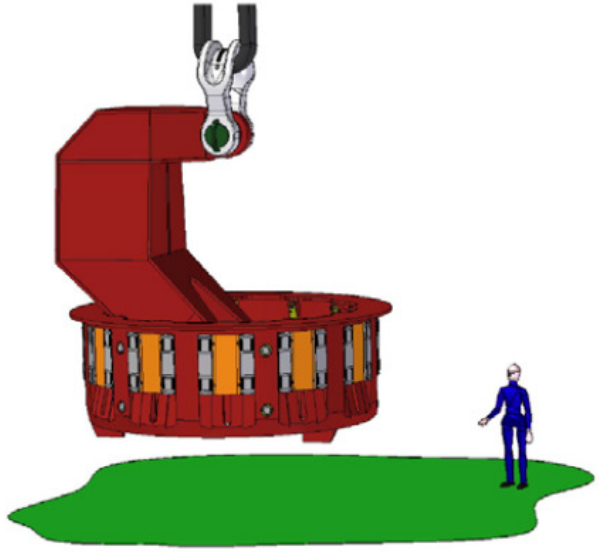
100T
50 0t


C07 (497t)
(776t)
(546t)
PRELIMINARY

DONG energy

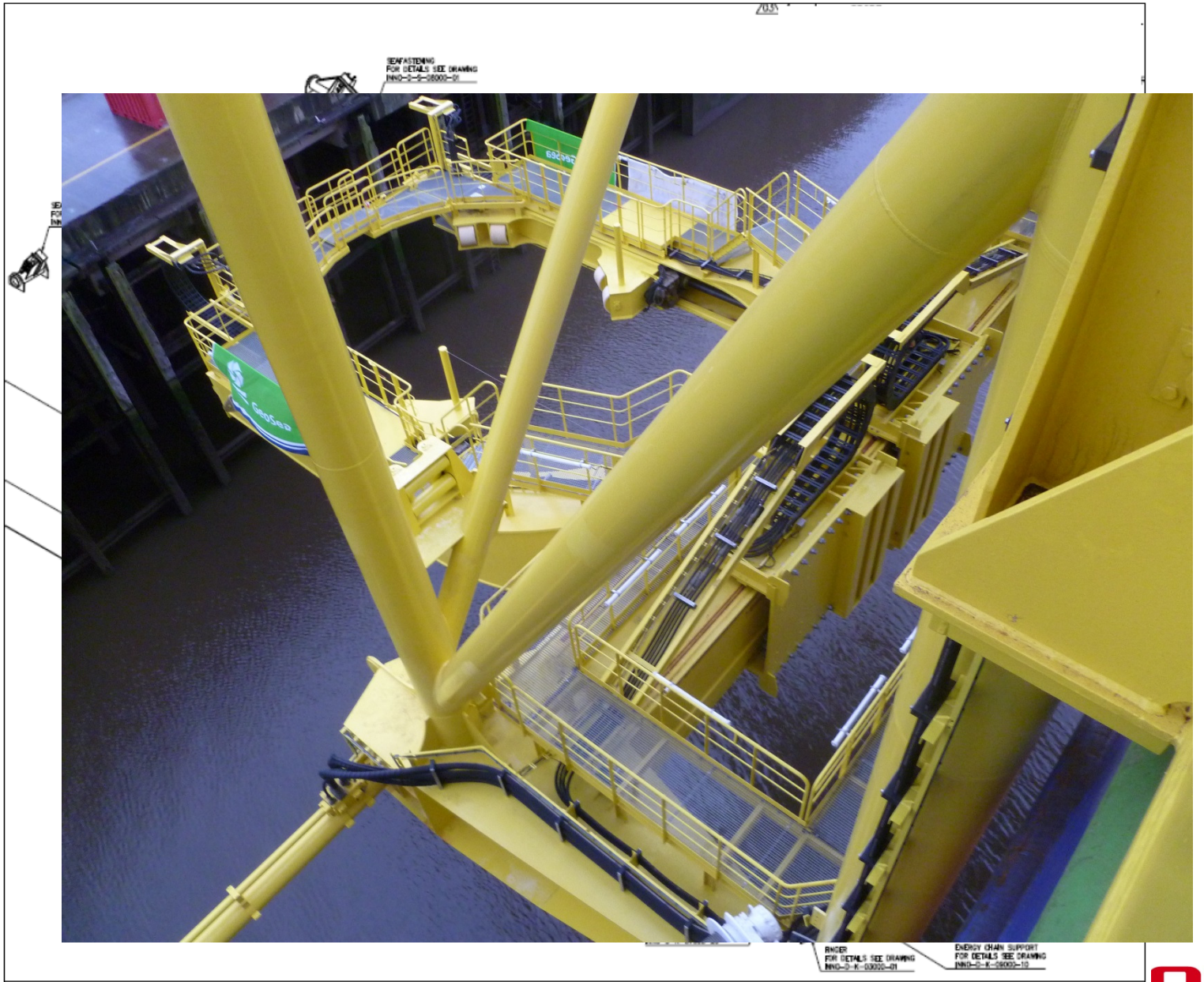


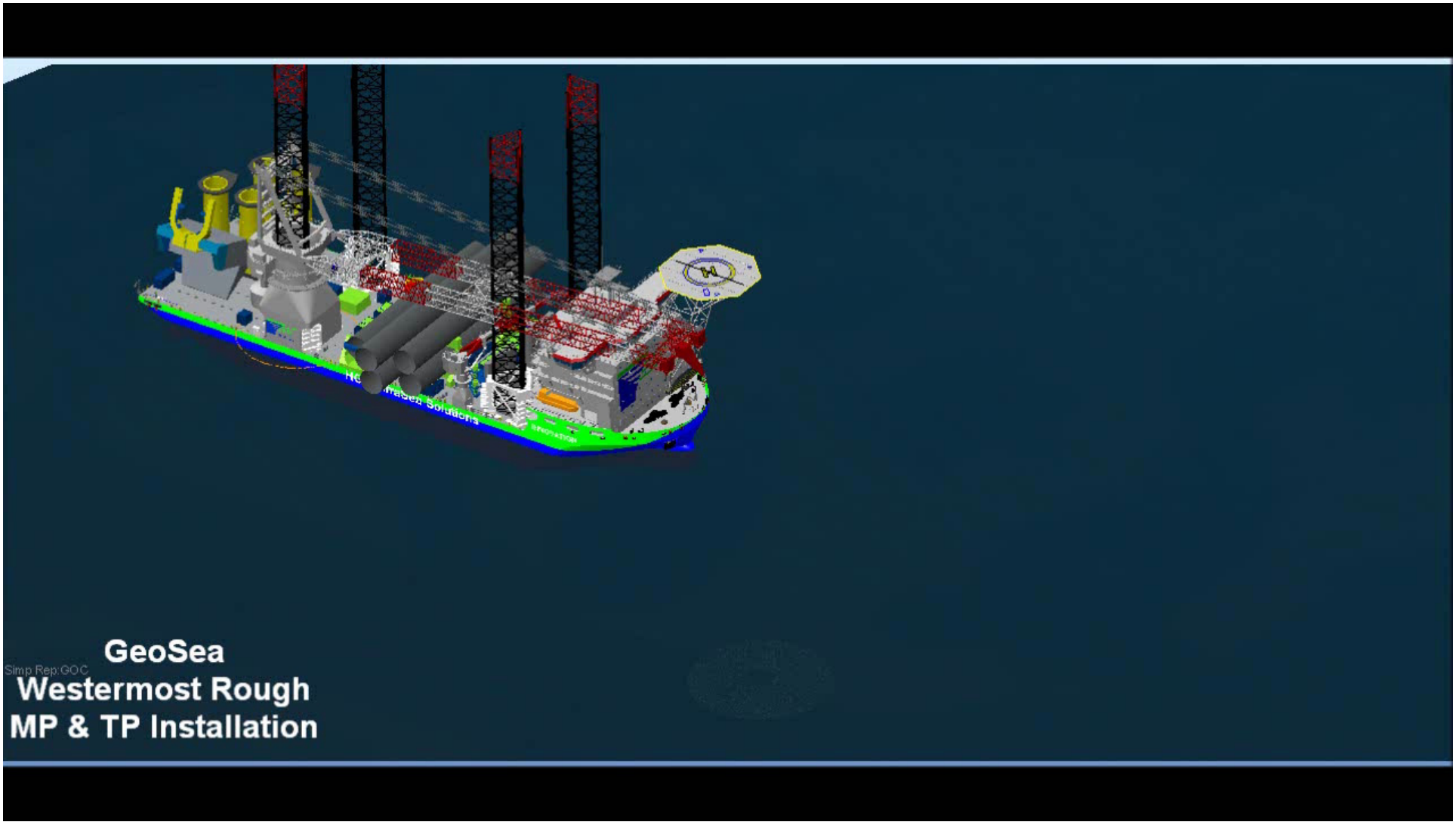
Rotate arm (support shackle)



Rotate tool

Insert in pile


SEAFASTENING
FOR DETAILS SEE DRAWING
RNGER
FOR DETAILS SEE DRAWING
ENERGY CHAIN SUPPORT
FOR DETAILS SEE DRAWING


GeoSea
Simp.Rep:GOC
Westermost Rough
MP & TP Installation


HGO InfraSea Solutions
INNOVATION

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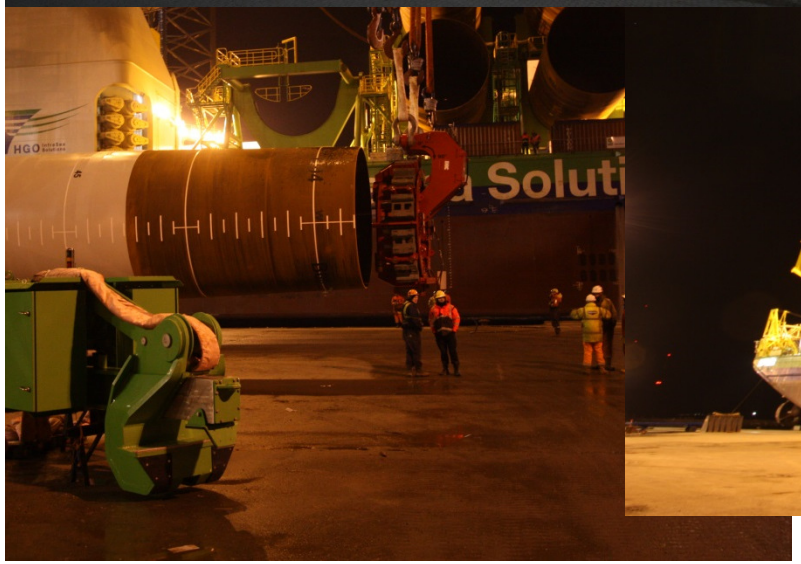
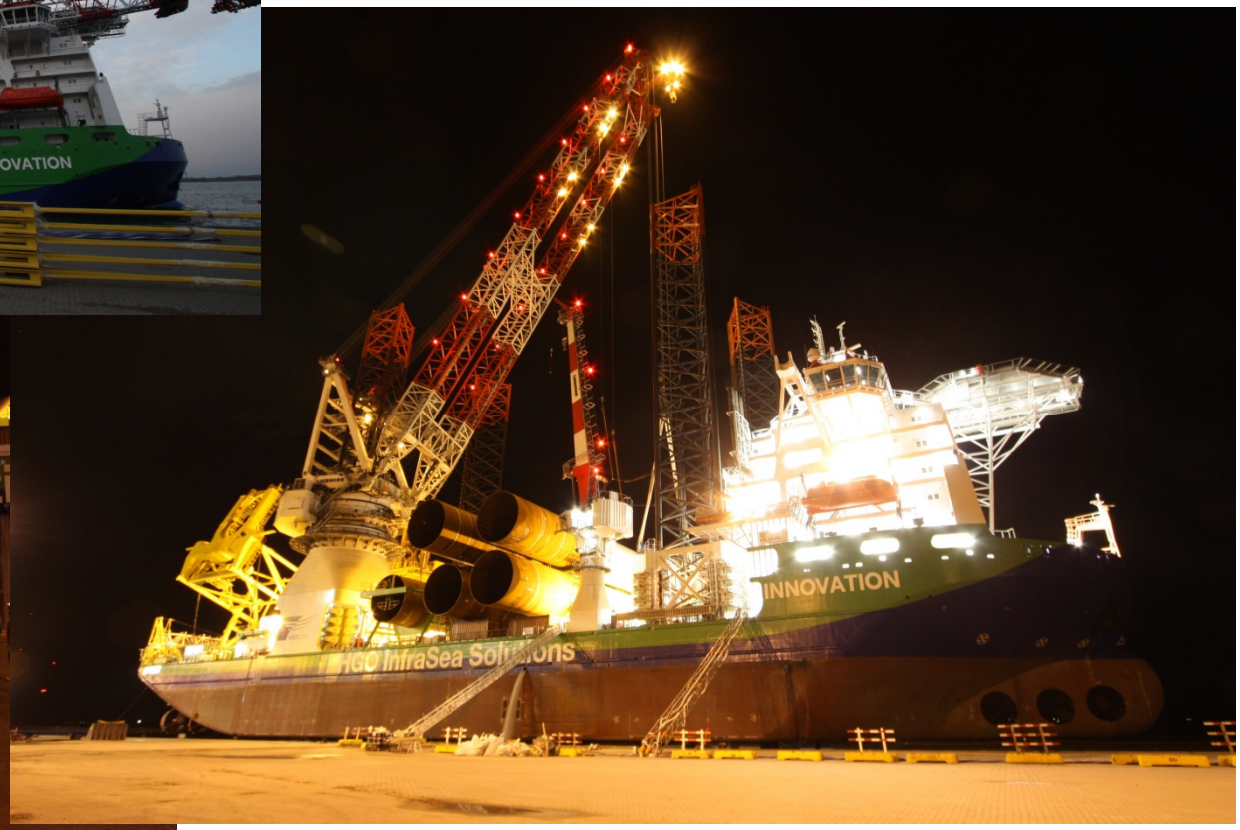
INNOVATION
HGO InfraSea Solutions




INNOVATION


WR
E02
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90°

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