Deep Sea Offshore Wind R&D Conference 2021

Early age movement in offshore structures with various bearing conditions

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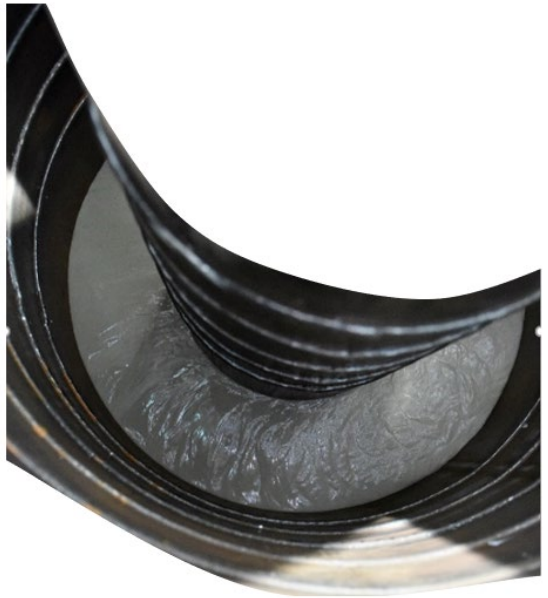
Leibniz Universität Hannover

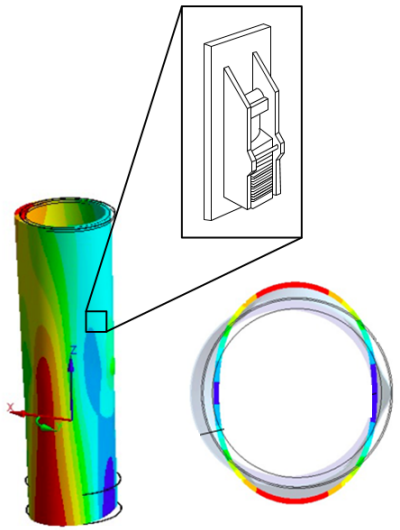
ForWind Center for Wind Energy Research
Bremen Hannover Oldenburg

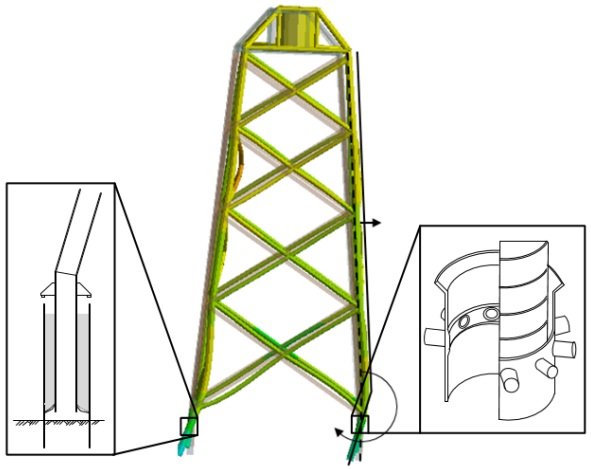
Institute for Steel Construction
Prof. Dr.-Ing. Peter Schaumann

Outline



- Motivation
  - Early age movement
  - Joint research project
- Seastate simulations and boundaries
  - Monoplies
  - Jacket structures OWT
  - Jacket structures OSS
- Summary and outlook





Motivation

What is early age movement (EAM)?

- Movements in the material during curing
- Movements due to variable loading conditions

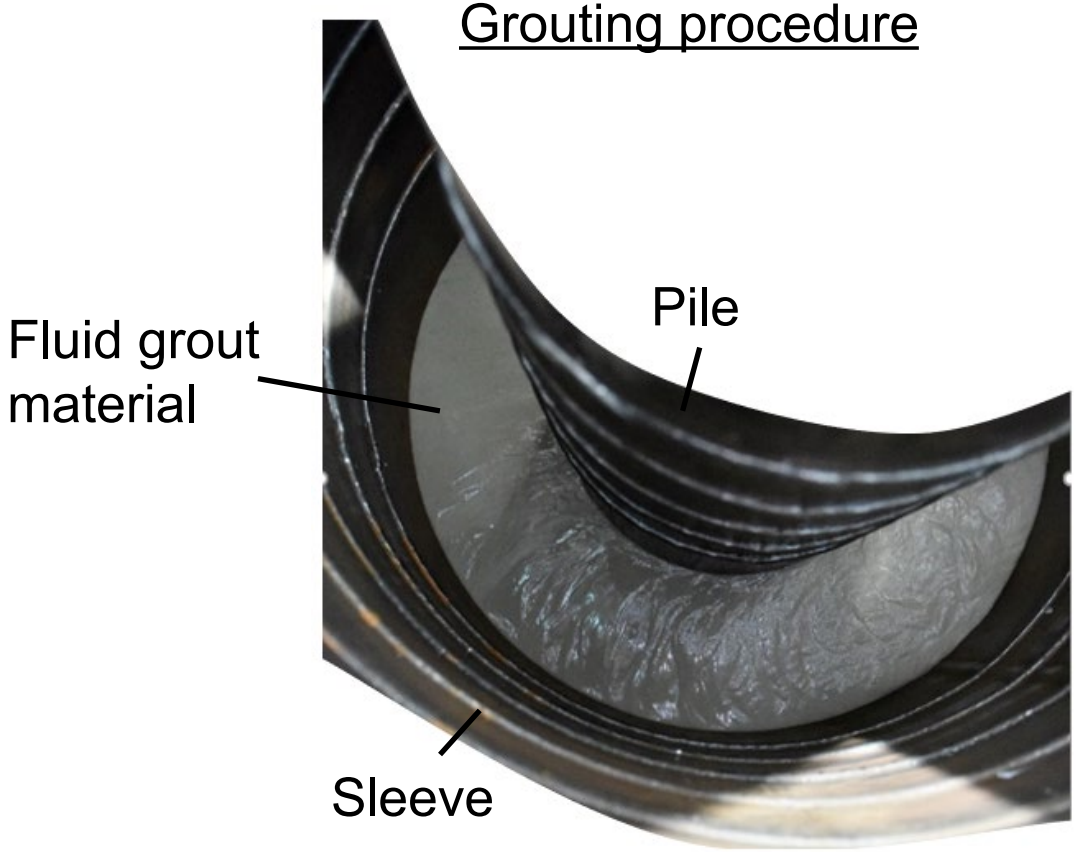
→ Strength development during curing

→ E.g. sedimentation and segregation

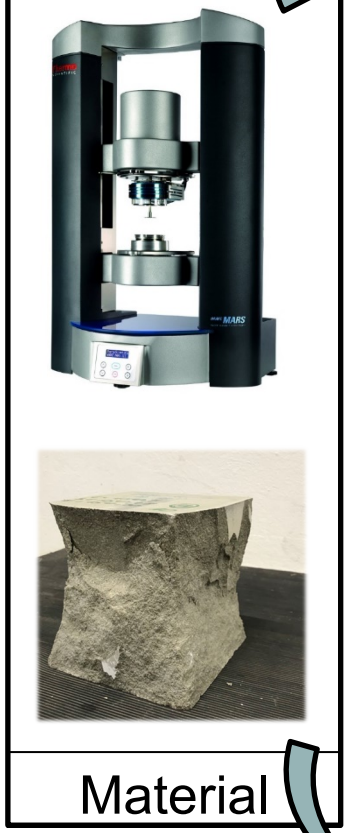
→ Bond defects

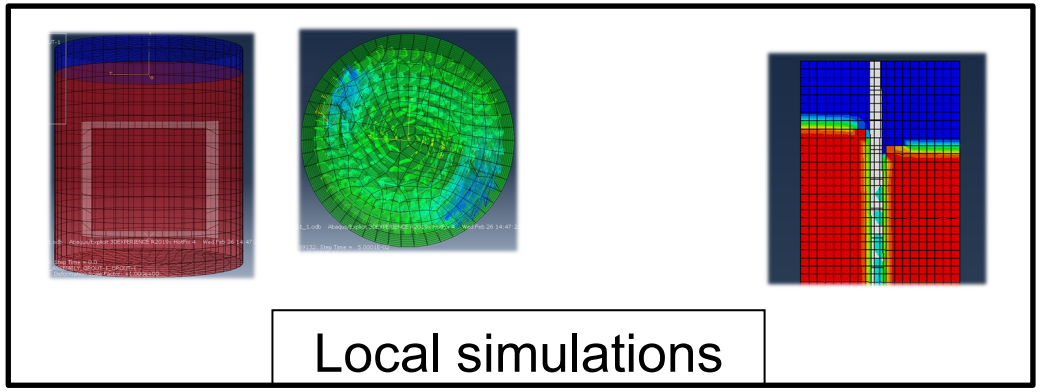
→

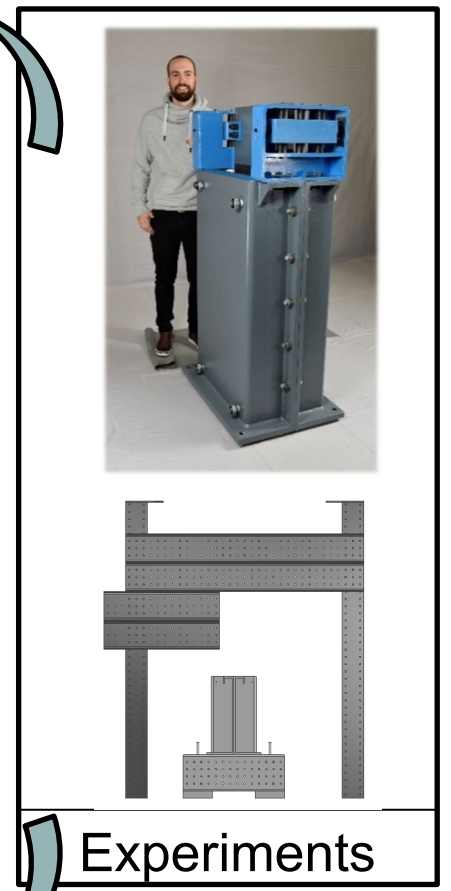
Grouting procedure



Joined research project GREAM







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IfB Institute of Material Science

GREAM

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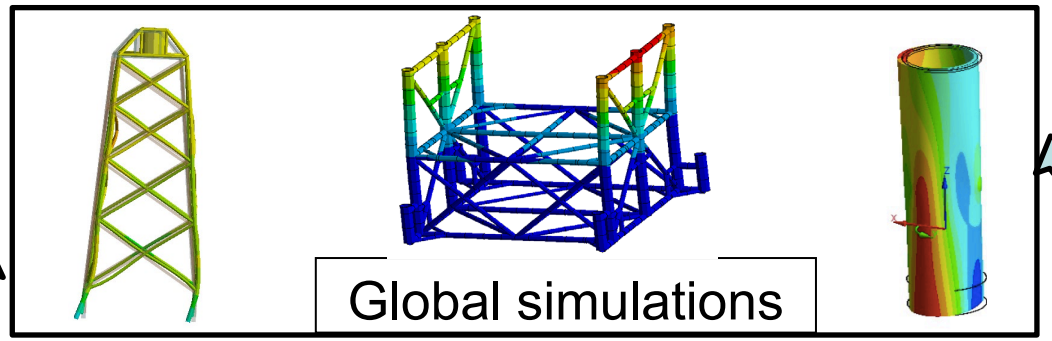

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Joined research project GREAM

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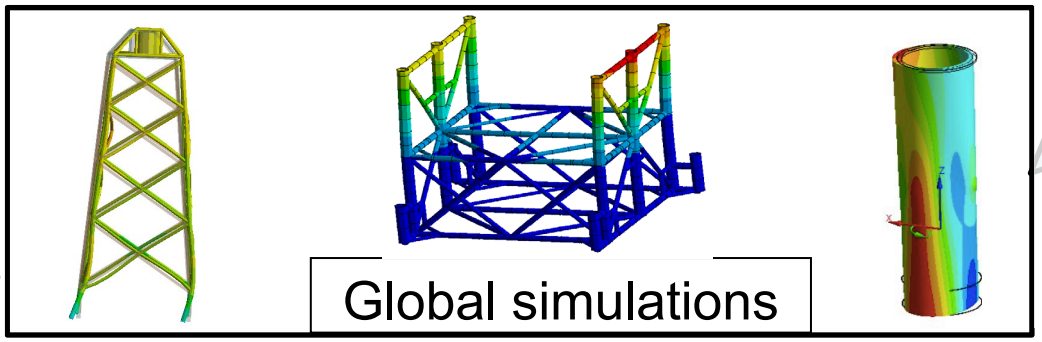

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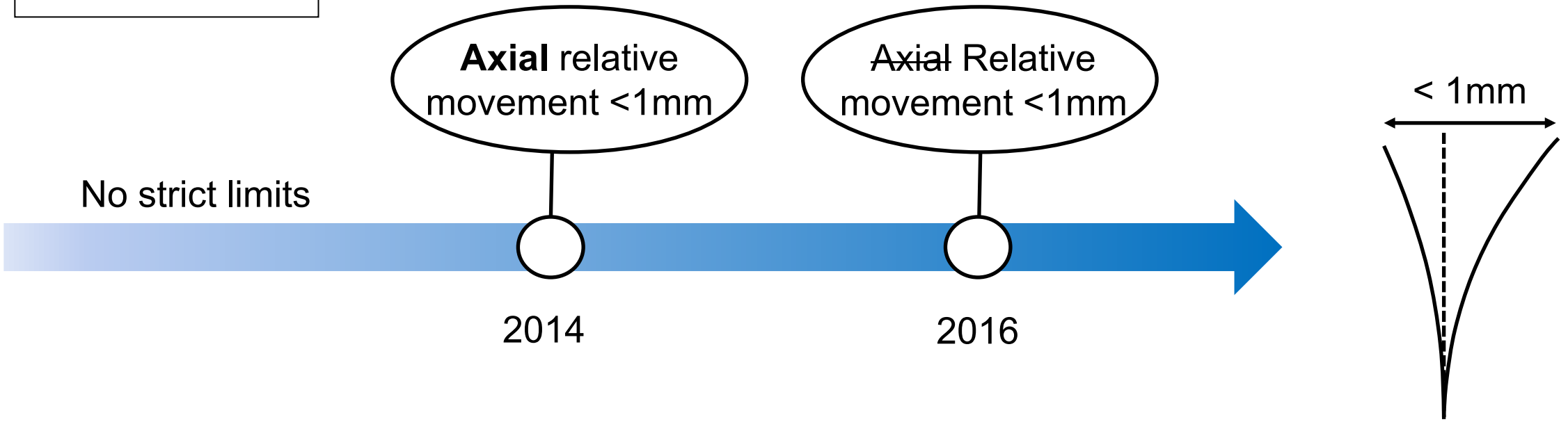
Motivation

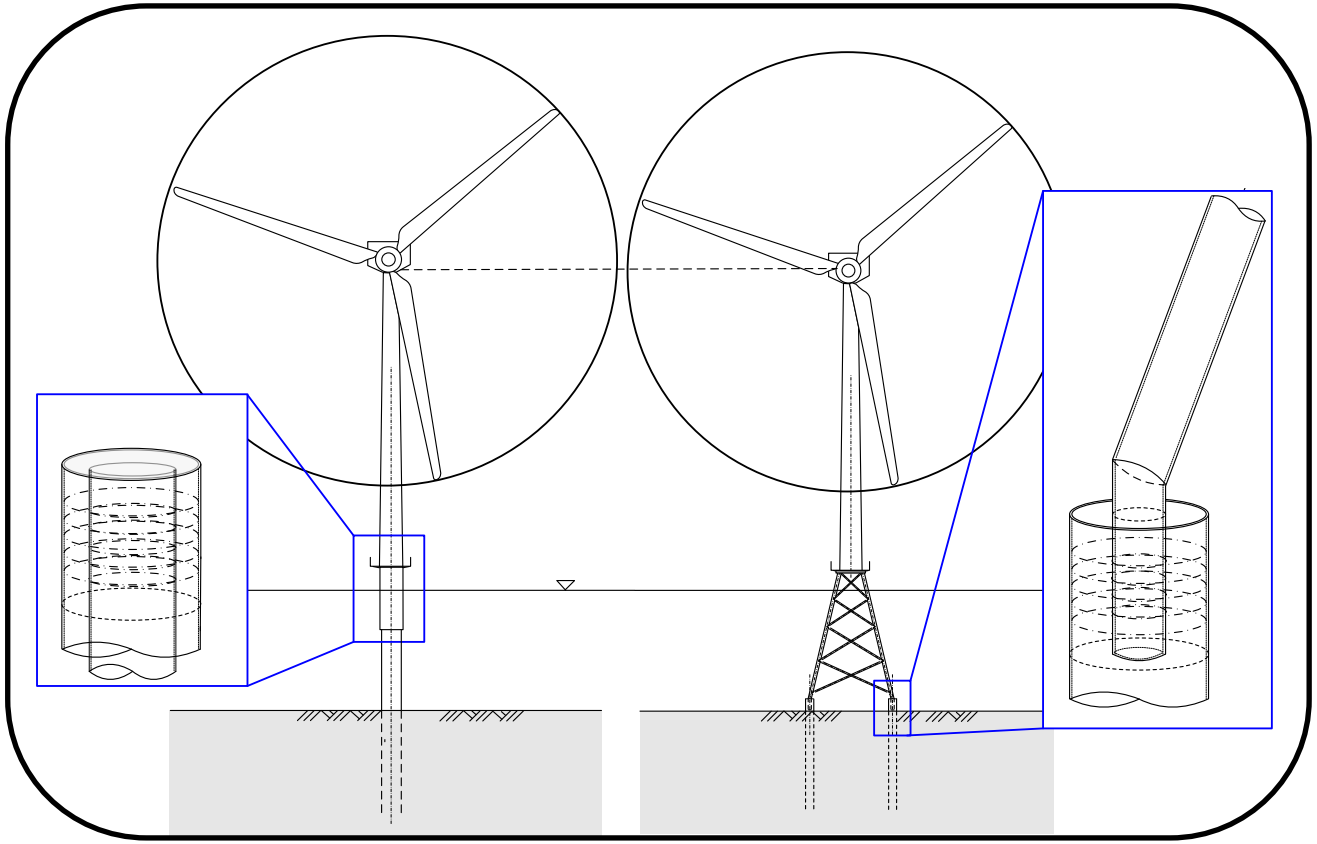
DNV / DNVGL



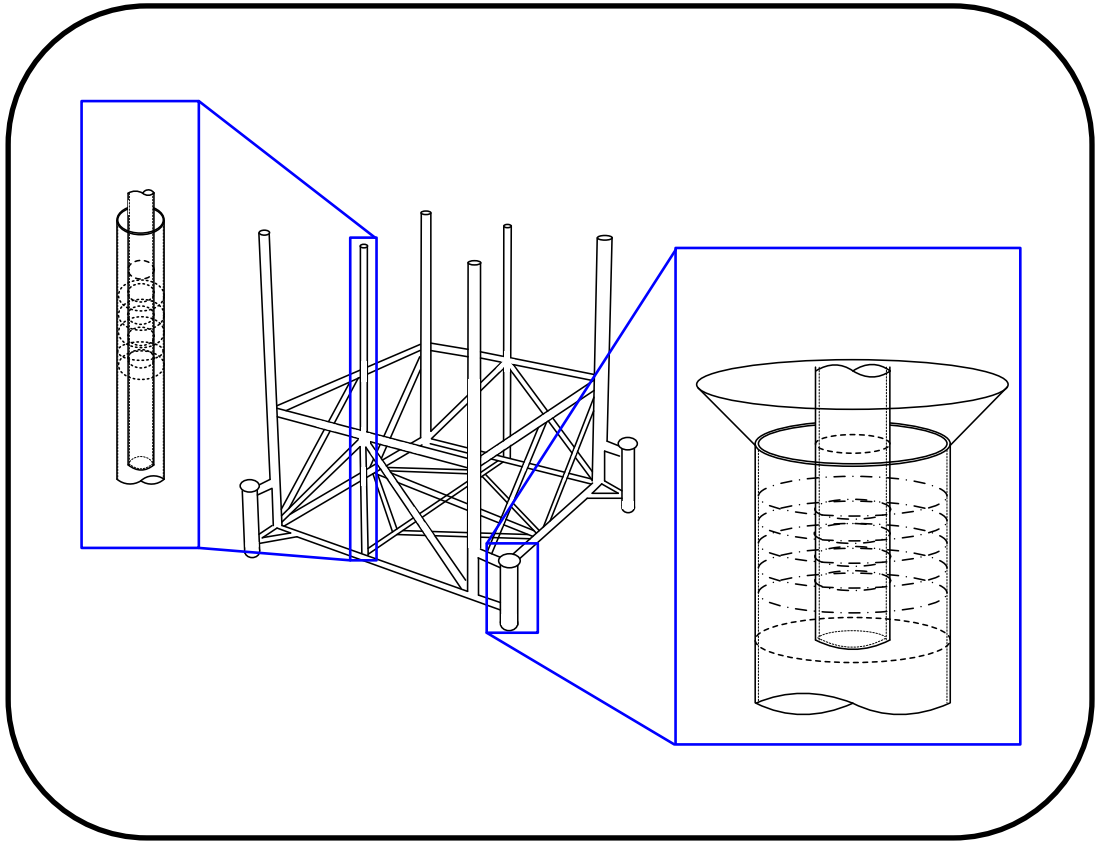
➡ Strict limit due to small amount of tests (primarily 35 years ago)

➡ Influence of horizontal movement not investigated

Offshore structures with grouted connections

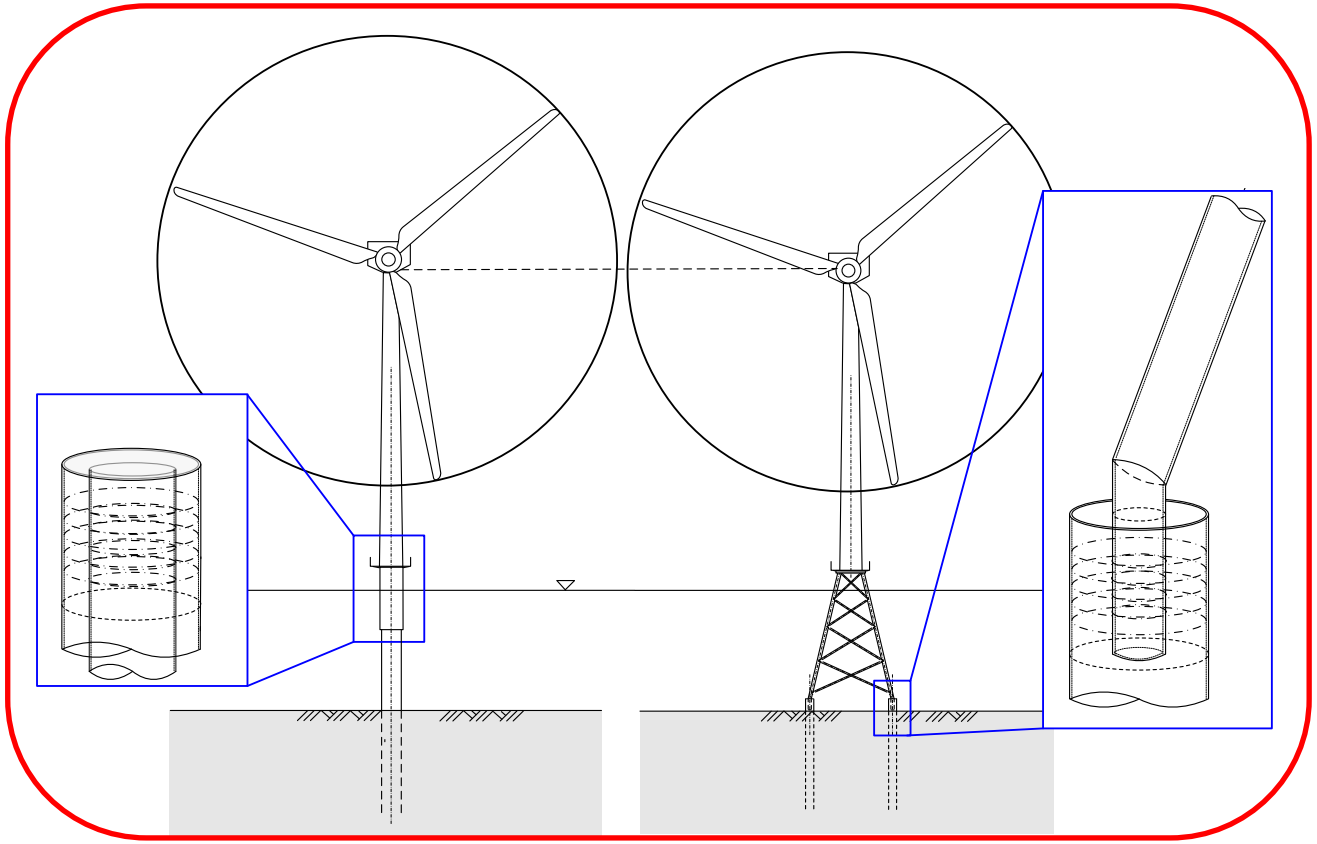


Offshore wind turbines



Converter platforms

Offshore structures with grouted connections



Offshore wind turbines

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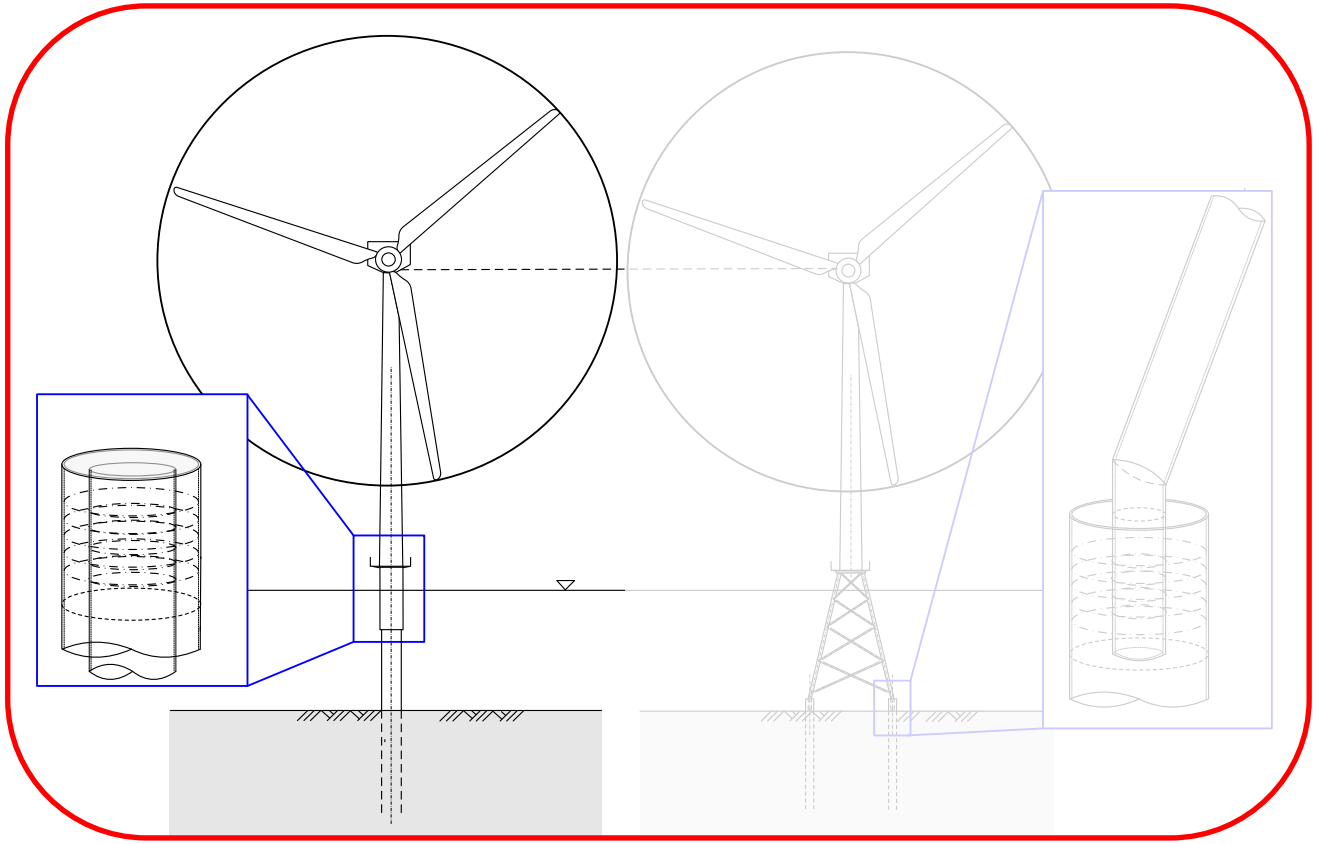


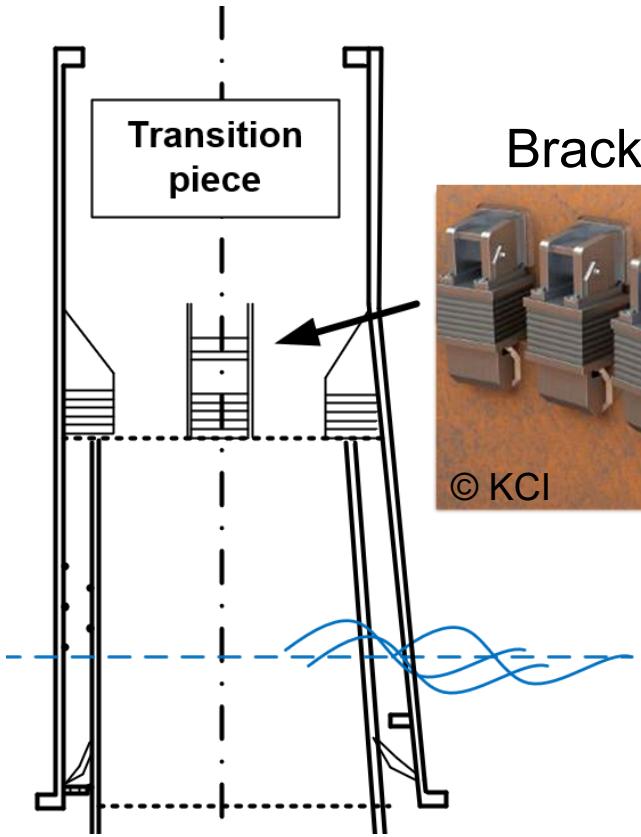
Offshore wind turbines

Converter platforms

Offshore structures with grouted connections

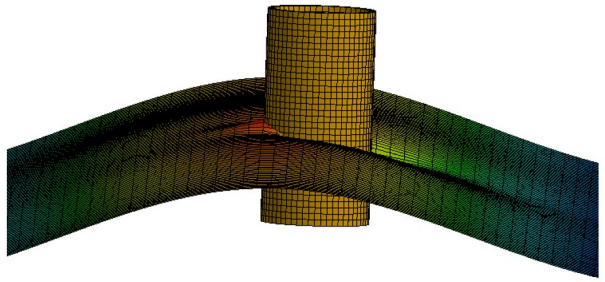
Installation procedure

- Positioning and leveling (using brackets “ hydraulic jackups”)



Brackets

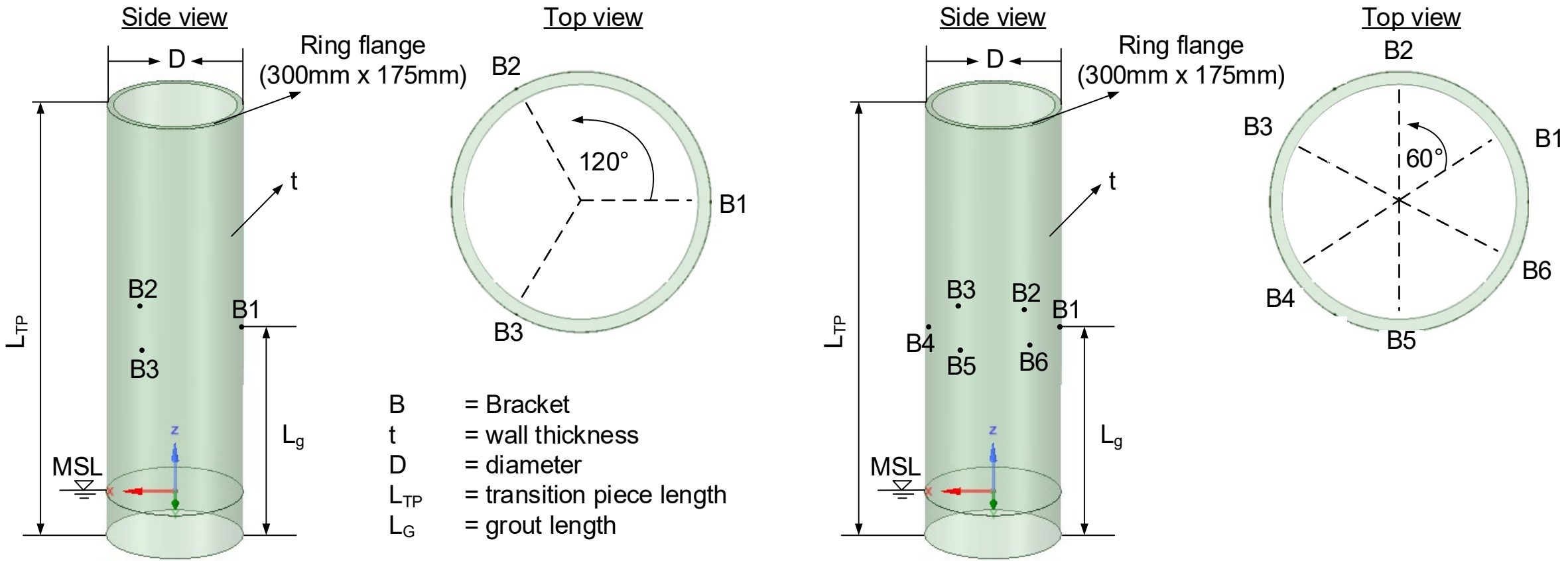
Installation weather window:



H_s = 0.5 - 3m
T = 5.6 – 8.47s

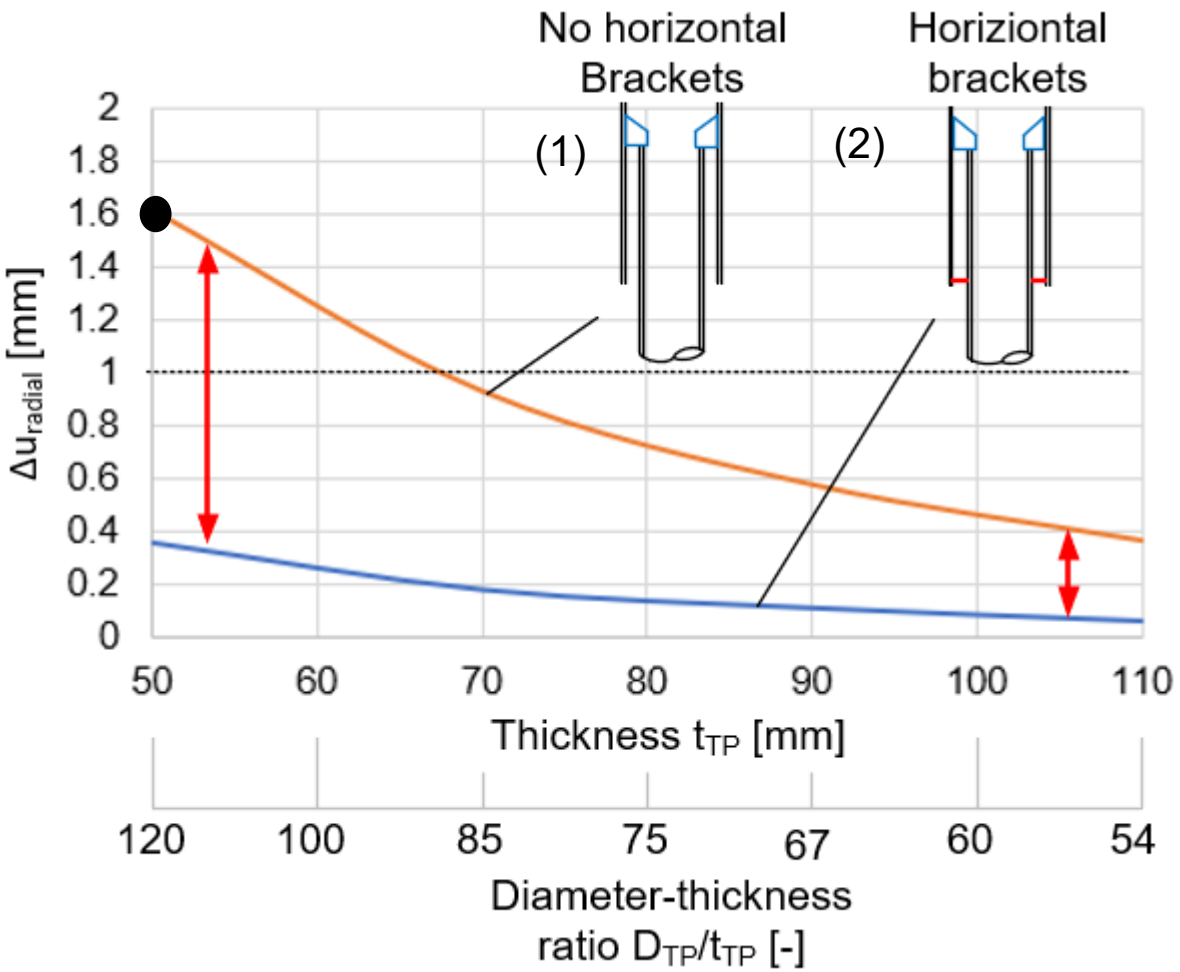
Early age movement in monopile structures

Geometry

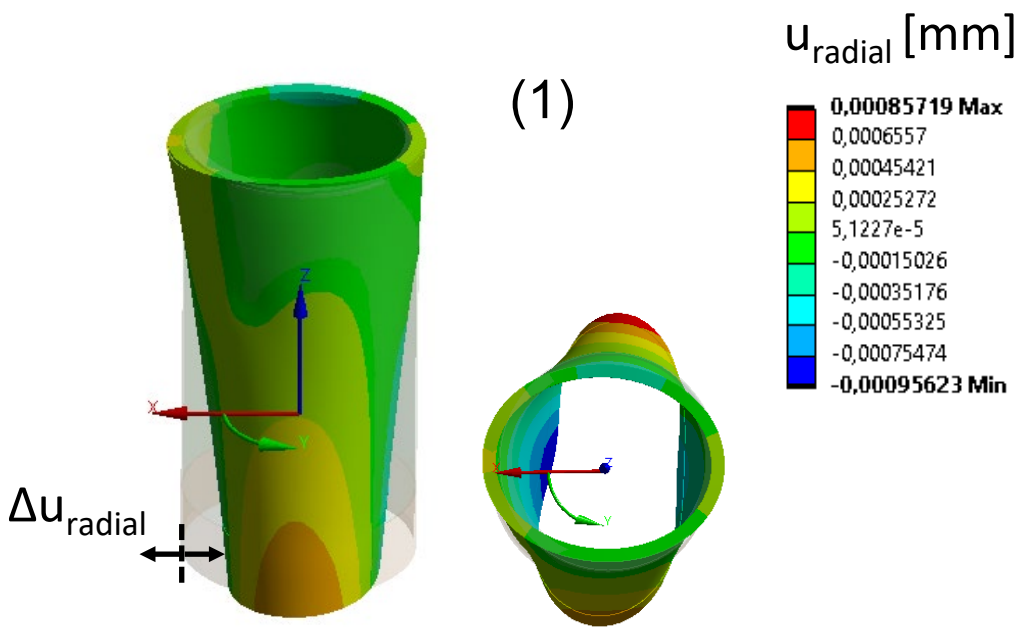


B	=	Bracket
t	=	wall thickness
D	=	diameter
L_{TP}	=	transition piece length
L_G	=	grout length

Early age movement in monopile structures



ANSYS AQWA + ANSYS Mechanical



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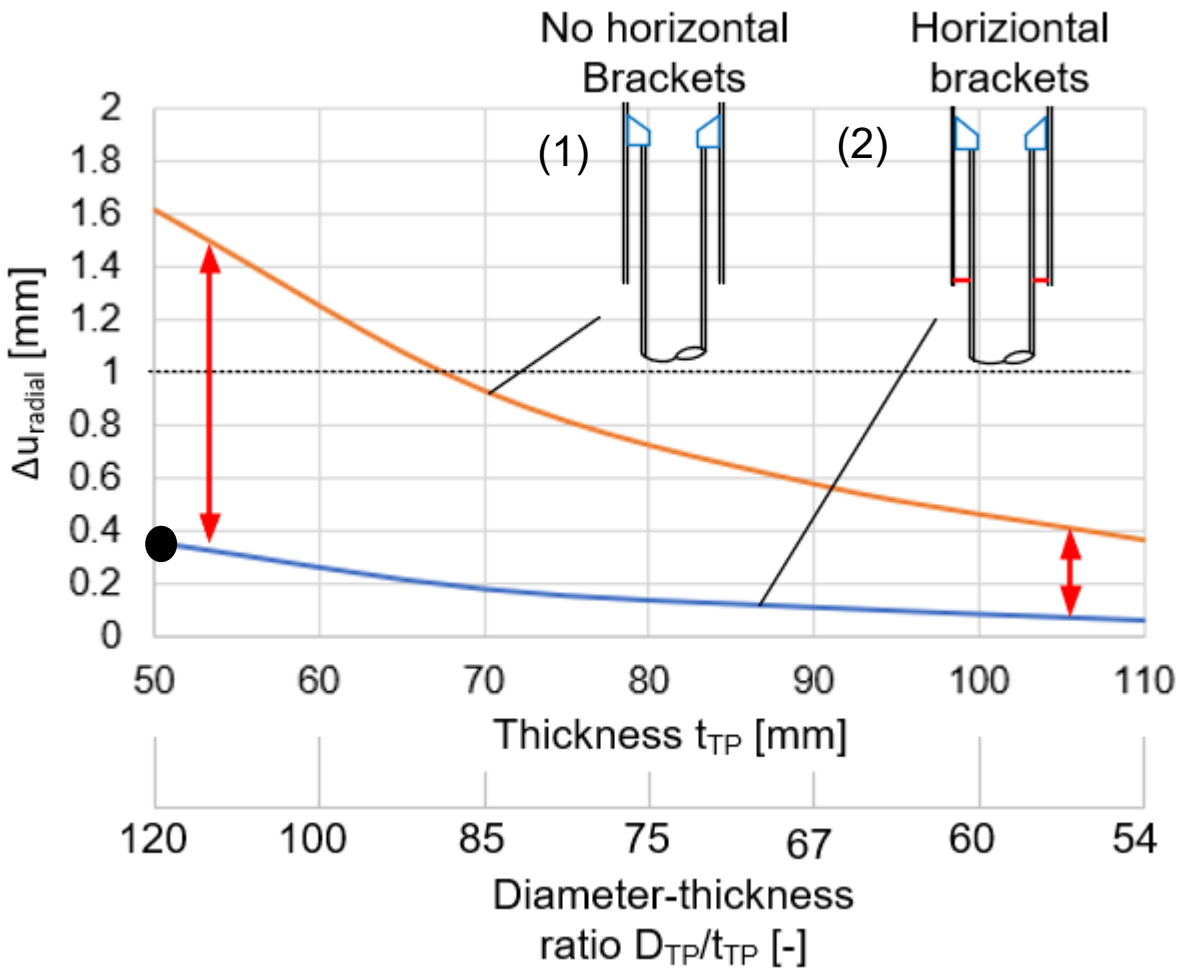
Early age movement in monopile structures



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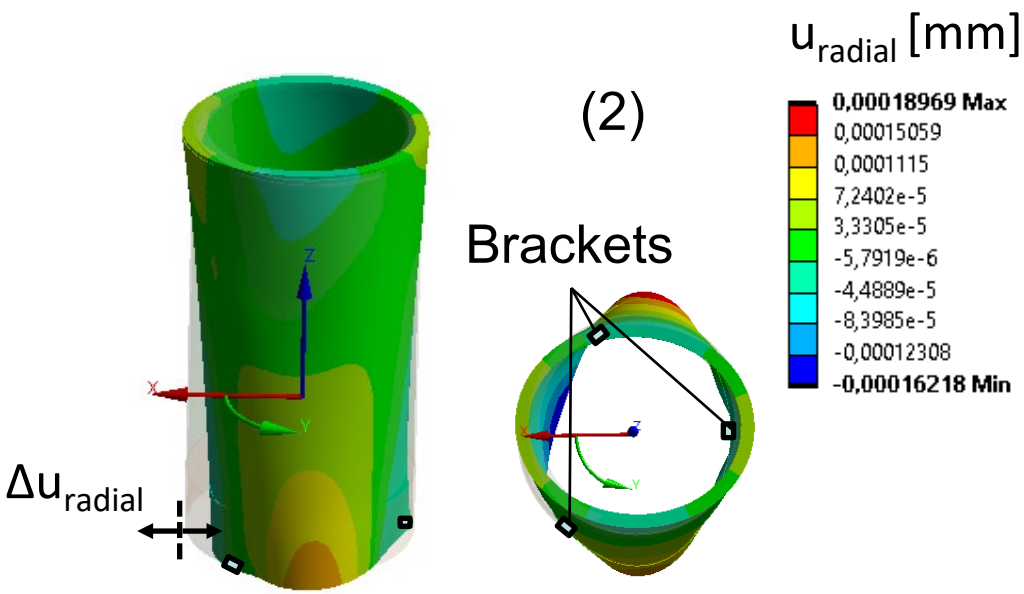

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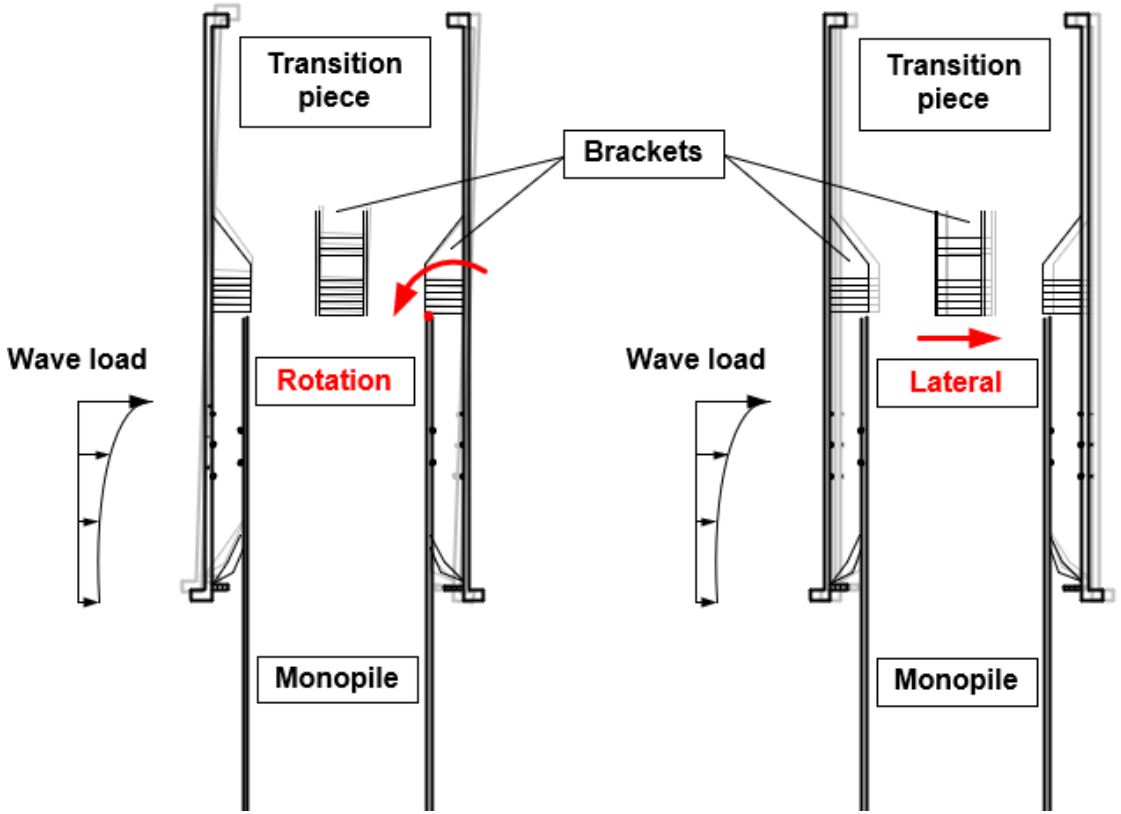
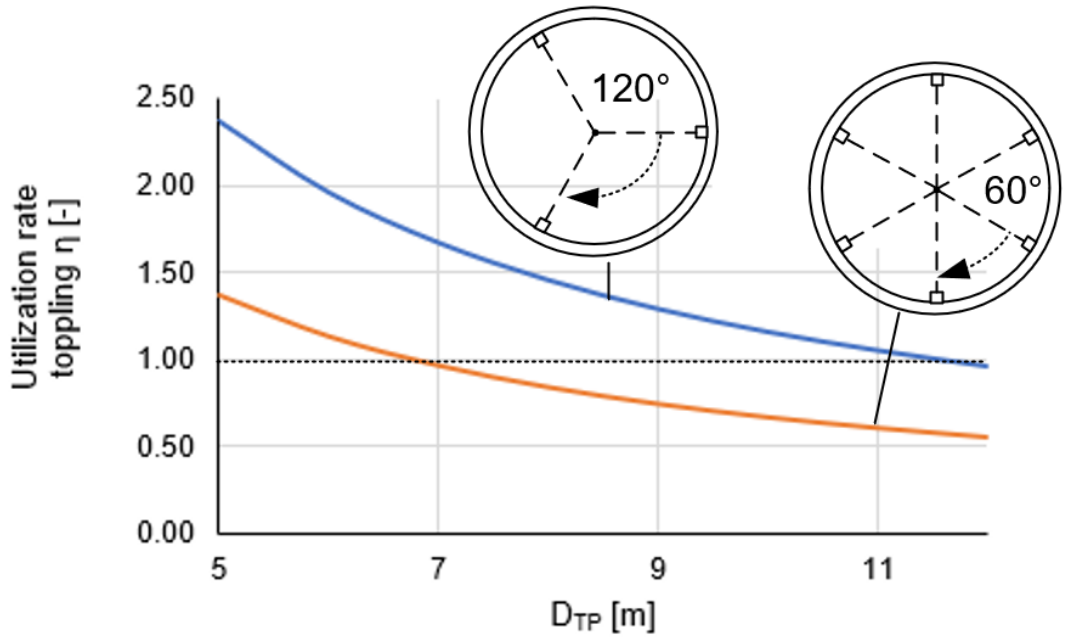
Early age movement in monopile structures



$$\eta = \frac{M_{Destablil}}{M_{Stabil}} \leq 1.0$$

$$\eta = \frac{F_{Destablil}}{F_{Stabil}} \leq 1.0$$



➡ Short grout length and TP length

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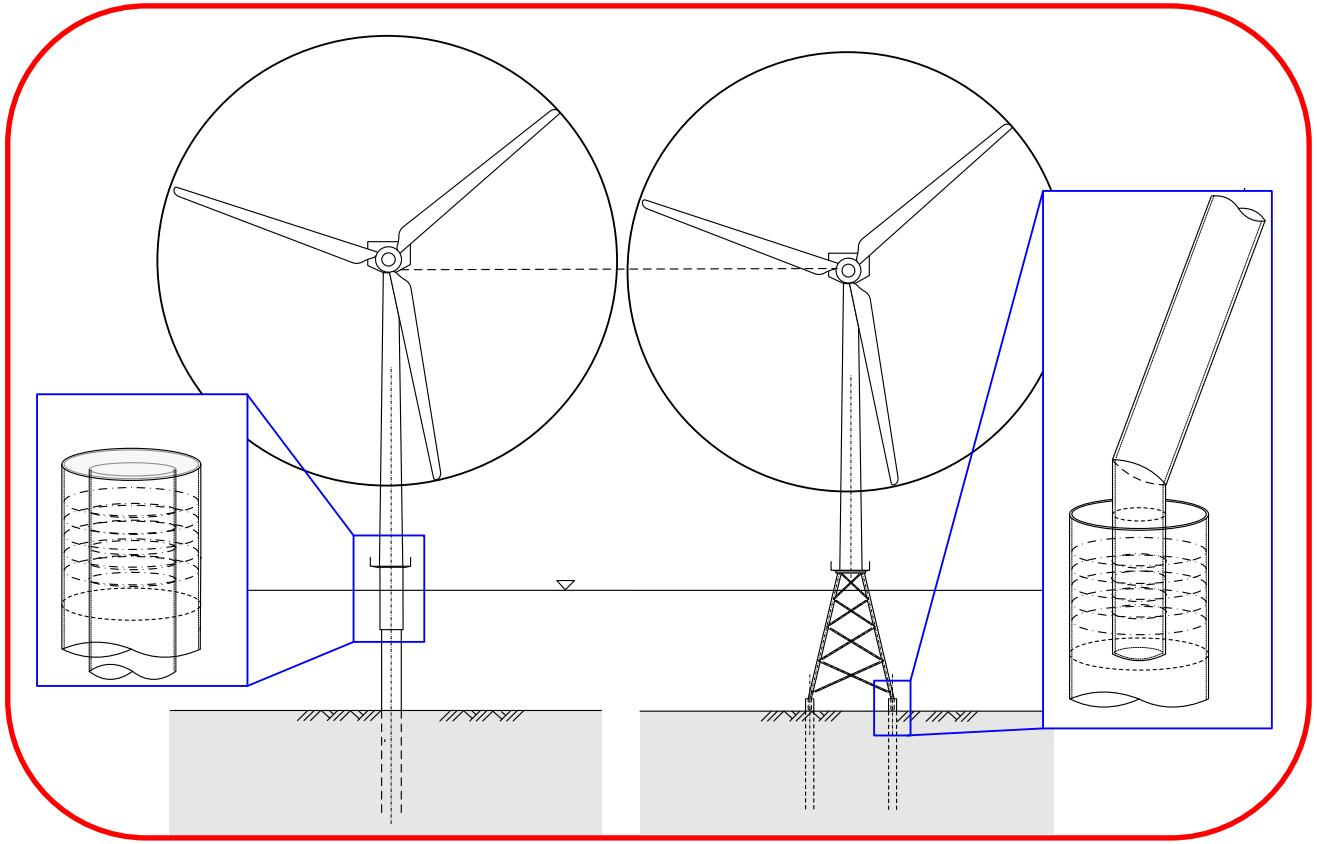
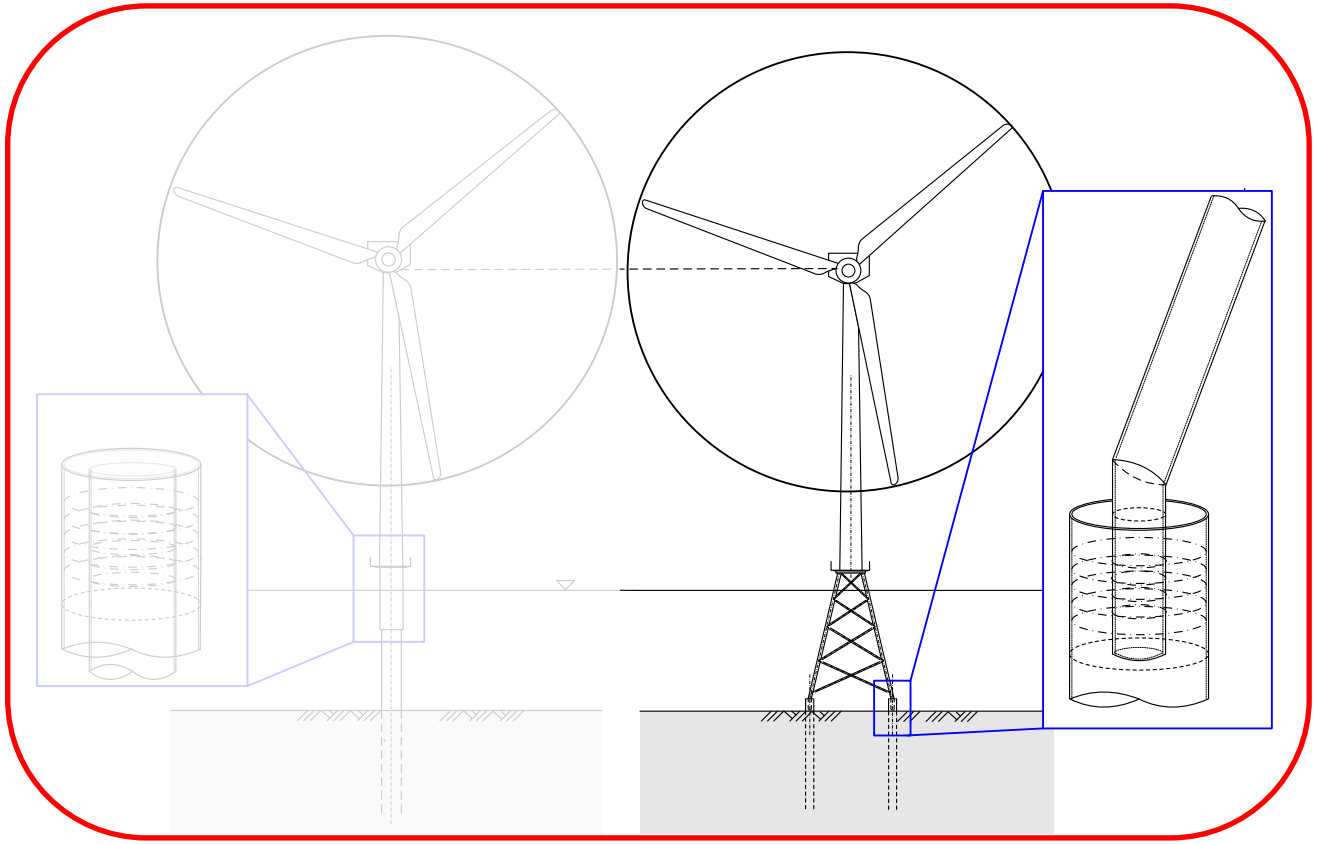
Offshore structures with grouted connections



Offshore wind turbines

Converter platforms

Offshore structures with grouted connections



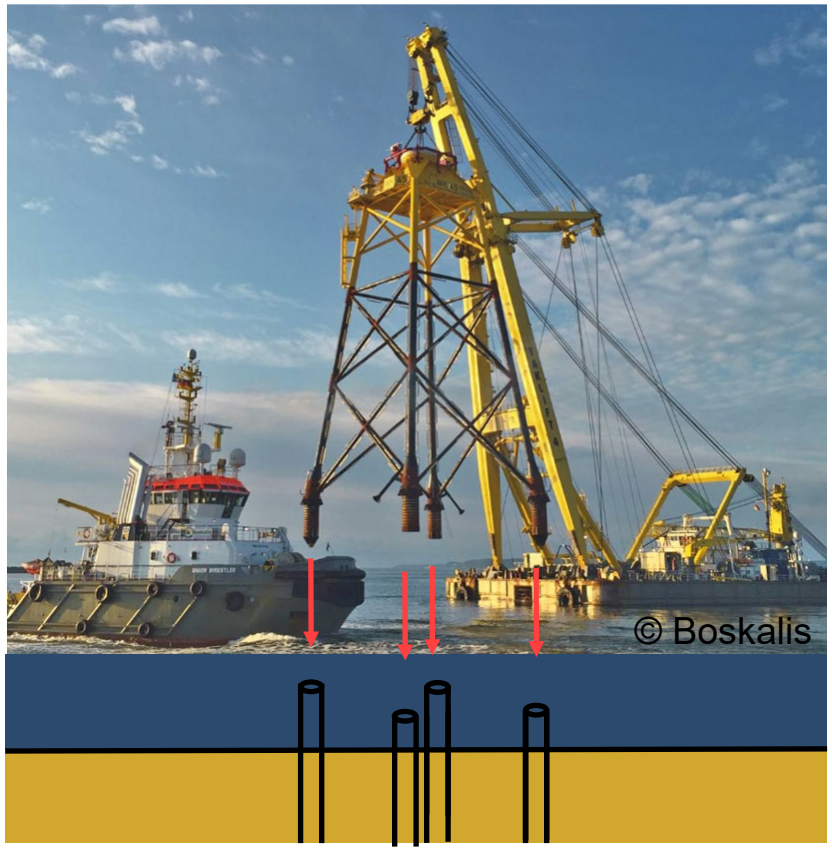
Offshore wind turbines

Converter platforms

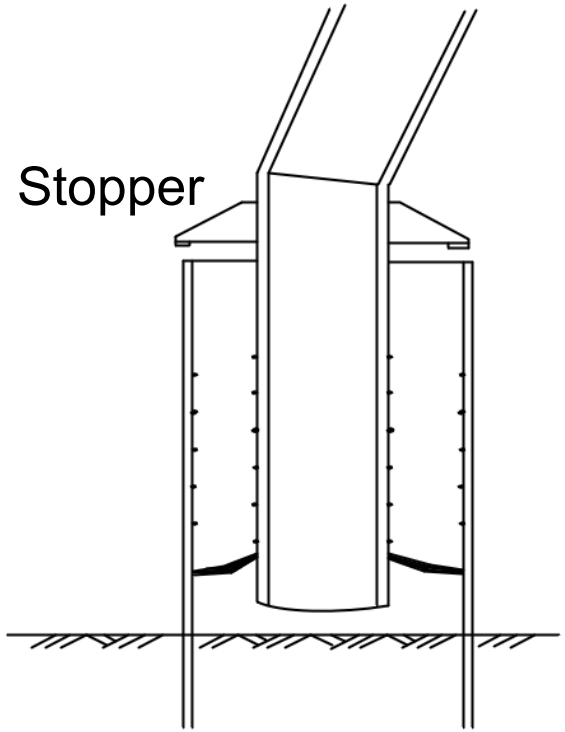
Early age movement at jacket structures of OWT

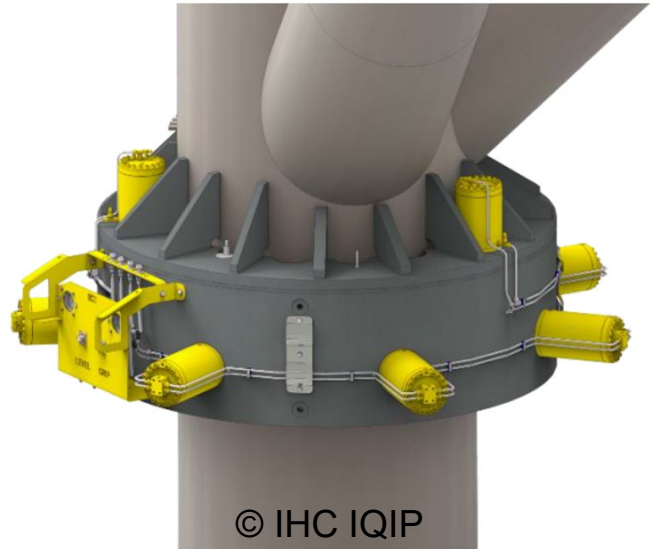
Installation procedure

- Positioning and leveling (using brackets “ hydraulic jackups”)



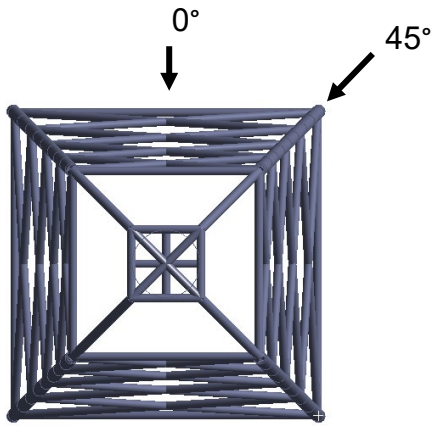
- Embracing (pile gripper, horizontal brackets, wedges and grout plugs)



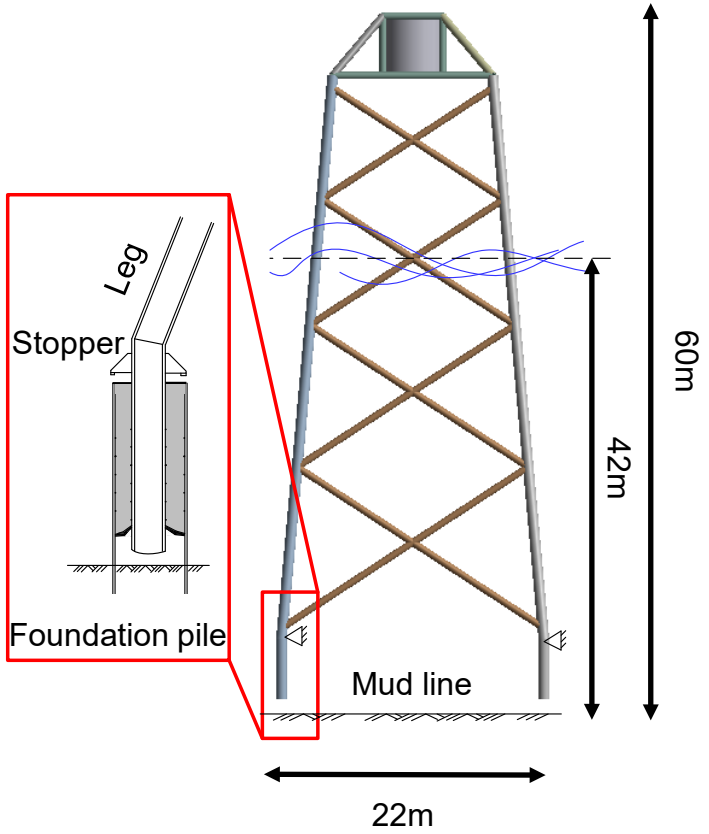


Pile gripper

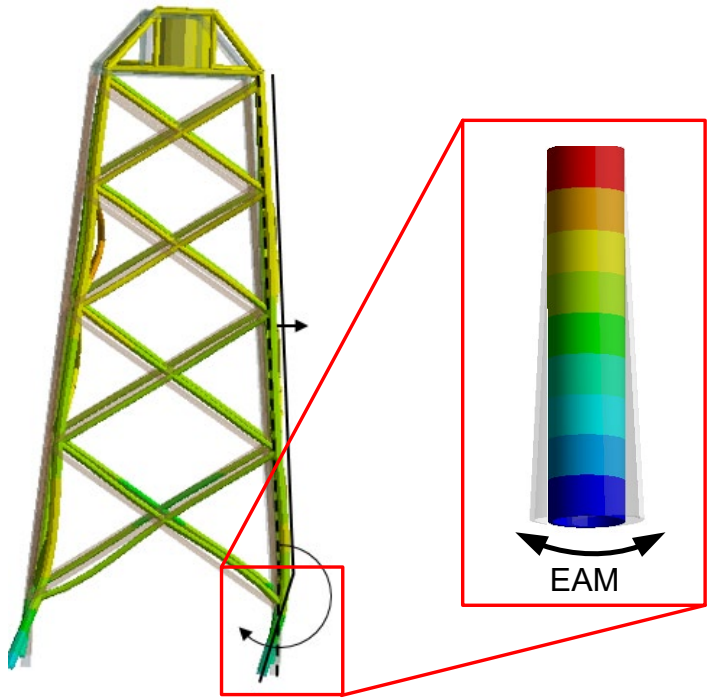
Early age movement at jacket structures of OWT



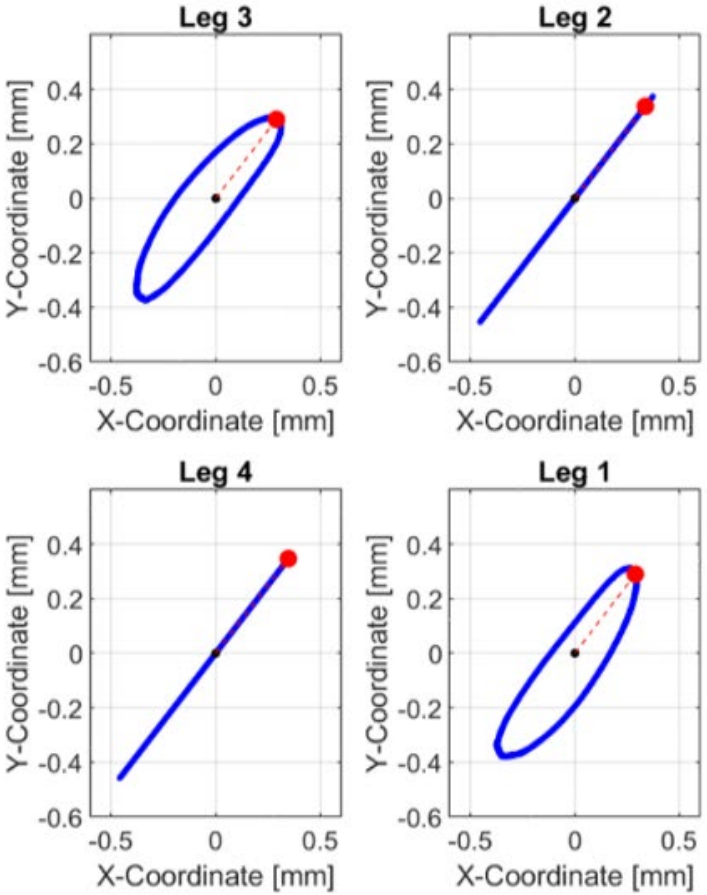
System and boundaries

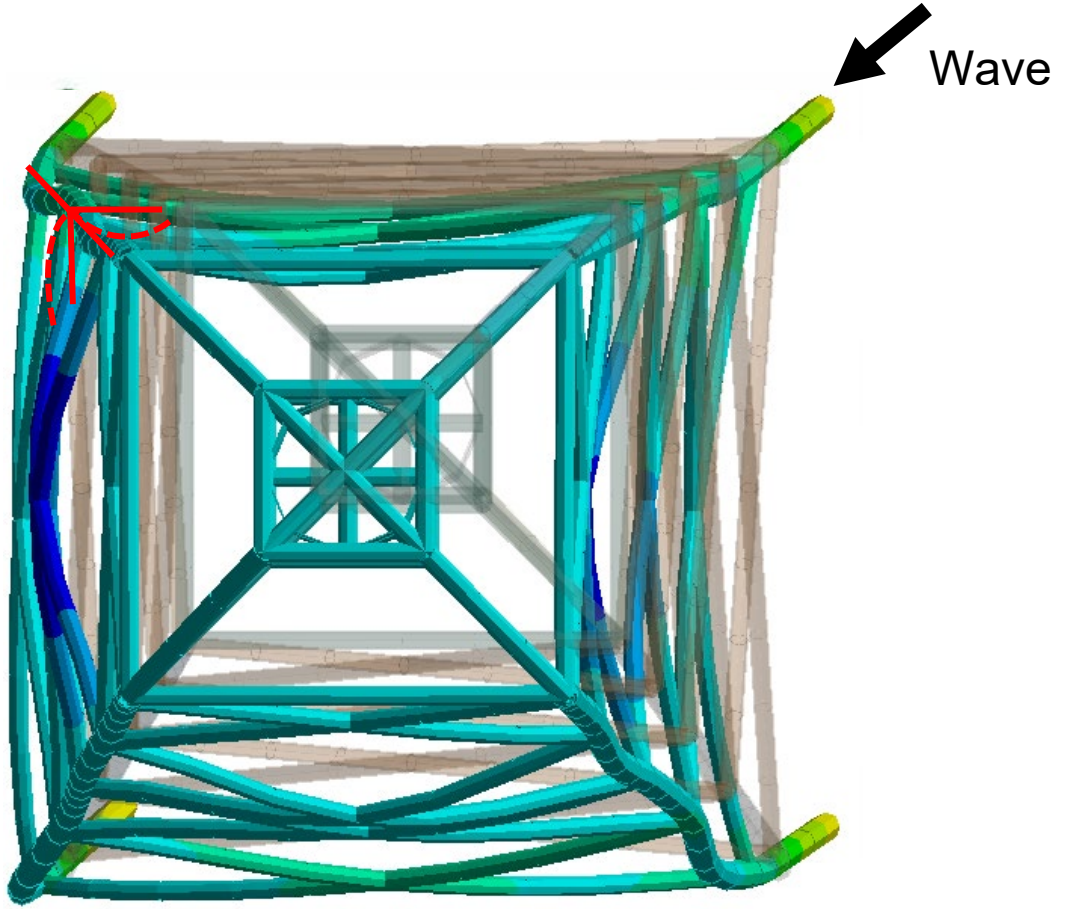


Simulation ANSYS WB



Early age movement at jacket structures of OWT





Δu_{rel} = 1.07mm

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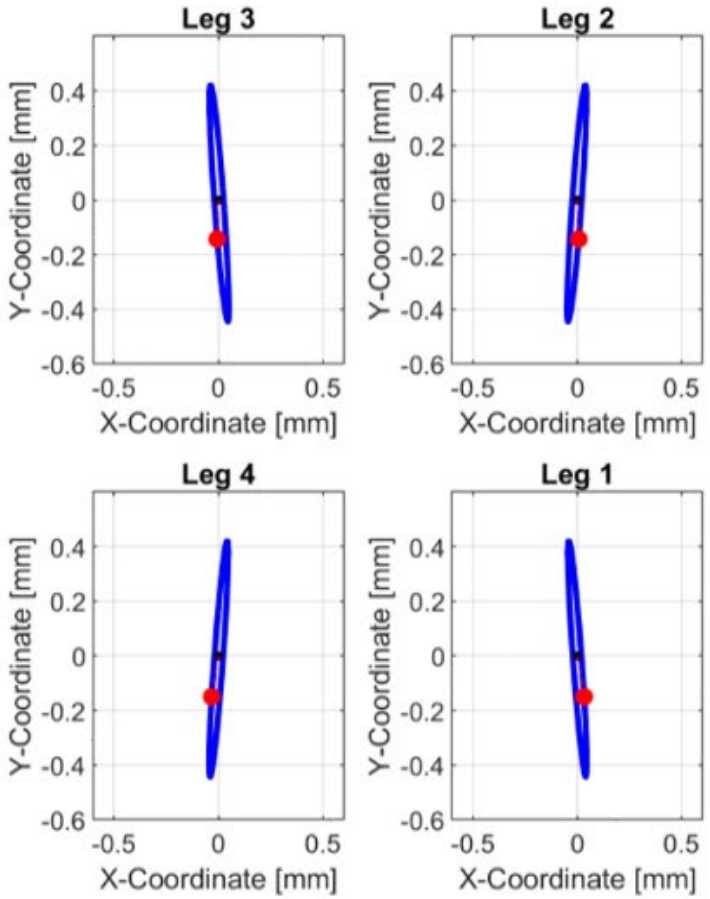
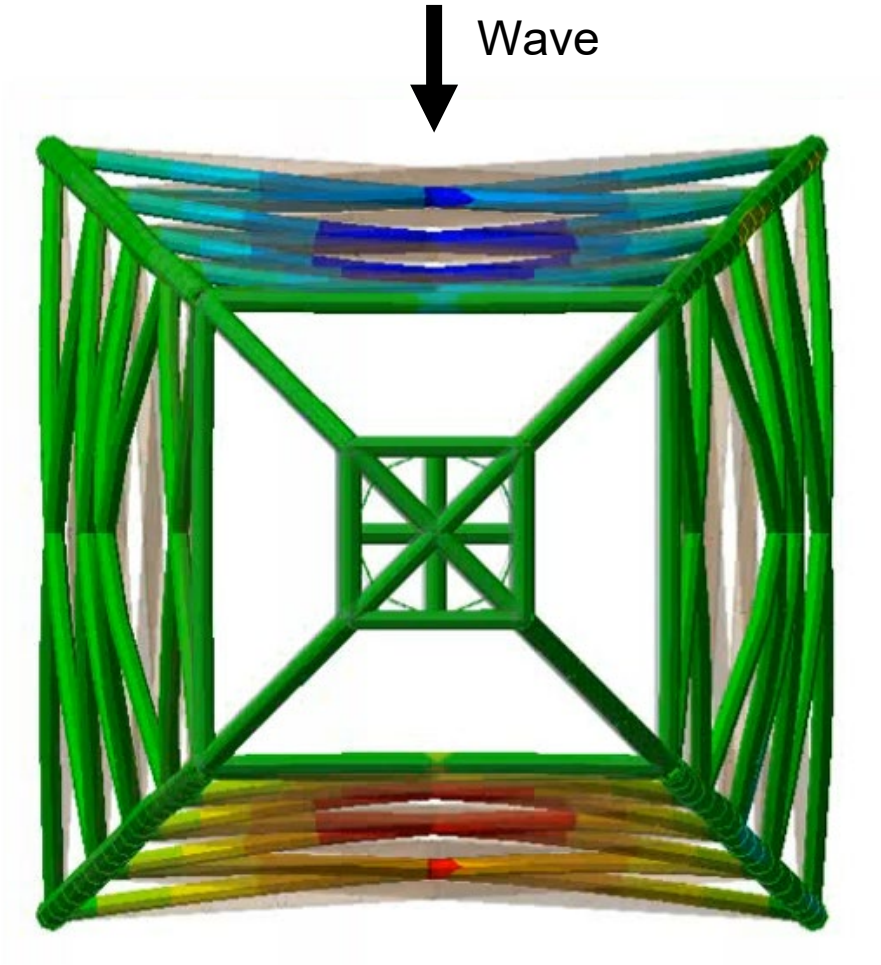
Early age movement at jacket structures of OWT





$\Delta u_{rel} = 0.82mm$

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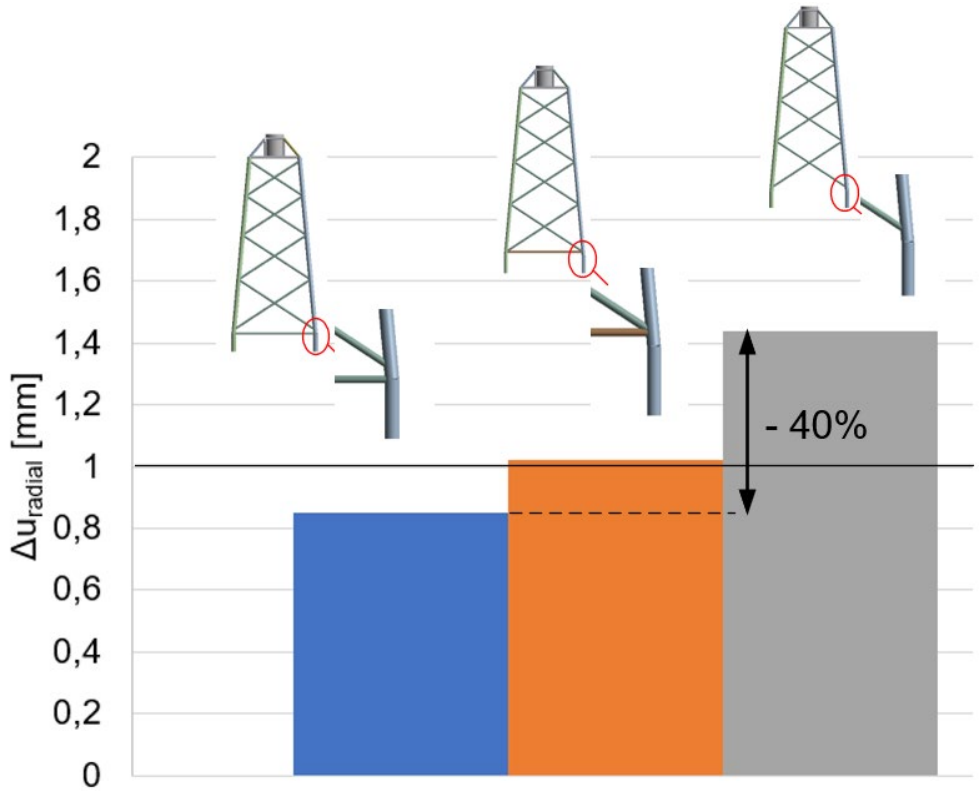
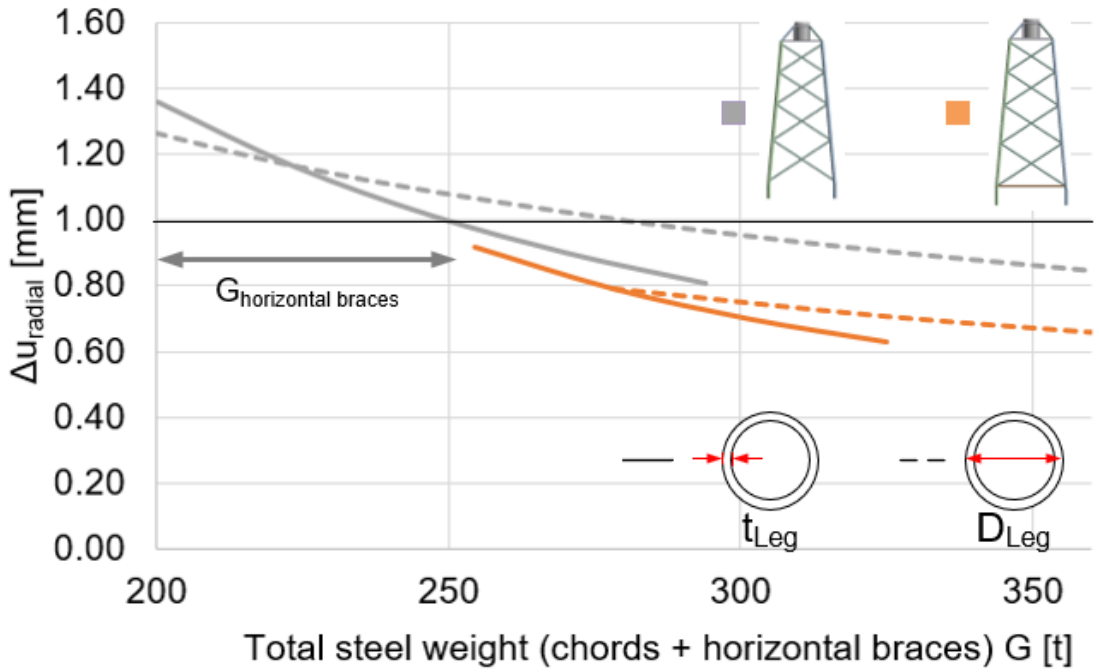
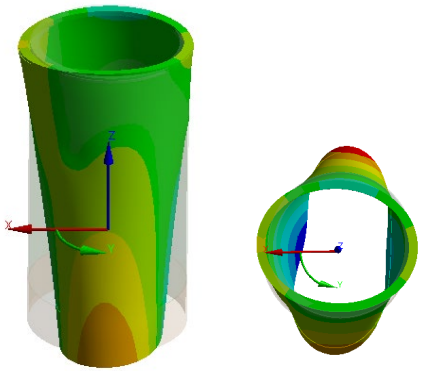




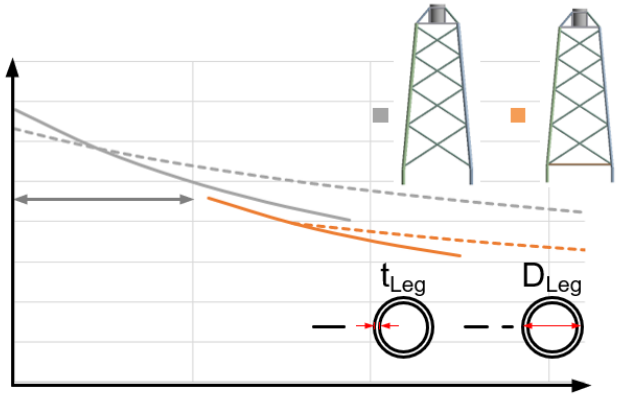
➡ Stiffness of bottom node important and thickness variation more effective than diameter variation

Summary

Analyses of early age movement according to current guidelines for kind and magnitude in different offshore wind structures



- Magnitude >1mm up to several milimiters (H_s = 3m)
- Monopiles: larger transition pieces toppling (-) local deformations (+)
- Increase structural stiffness is favourable
  - greater wall thickness better than greater diameter

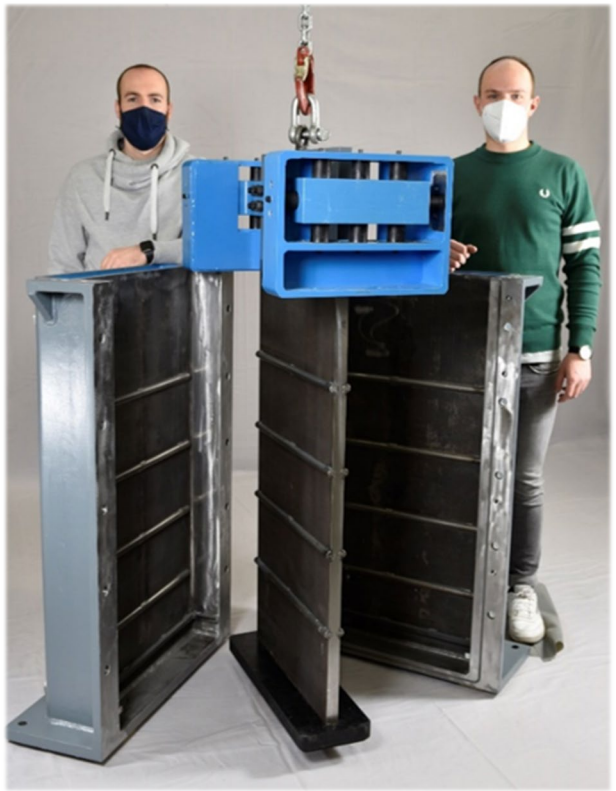


⟹ General trend to slender/optimized as well as increasing structures lead to increasing EAM

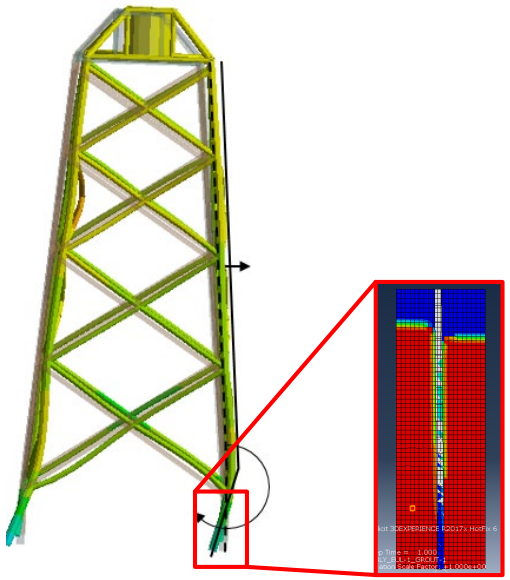
Outlook

What is needed to withstand occurring problems?

- Further experimental investigations on EAM



- Depiction of fluid grout resistance in on-bottom simulation
  - Submodelling and spring / damper approach



Thank you for your interest !

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