Development of an Integrated Anchor Model via Industry Engagement

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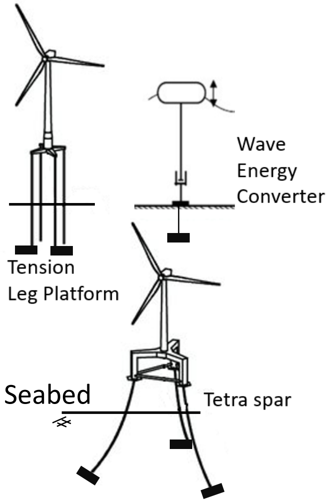
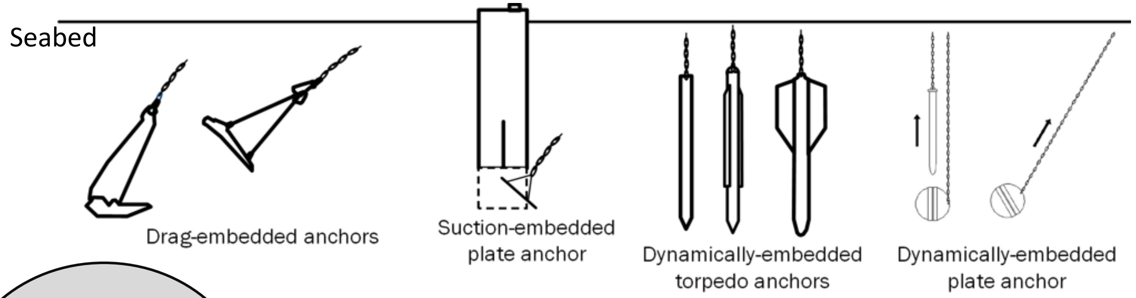
The contrasting design challenge of past oil and gas facilities and future floating ORE facilities:

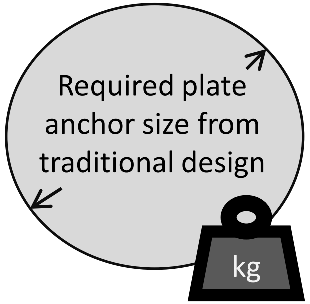
Wheatstone project (https://australia.chevron.com/our-businesses/wheatstone-project)

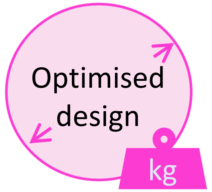
Historic		Emergent
Manned	➡	Unmanned
Spill risk	➡	Oil/gas-free
One-off	➡	Multiple
Point-located	➡	Spatially-distributed
Rigid	➡	Flexible
Inherent risk high	➡	Inherent risk low
Innovation appetite low	➡	Innovation potential high



These emergent floating facilities will need to be supported by anchoring systems, e.g.





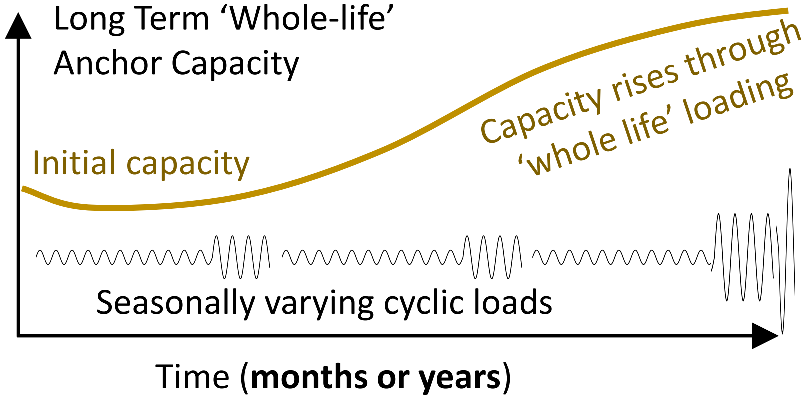


Aim: To characterise beneficial seabed-anchor effects → enhanced anchor capacity: smaller, more efficient and cost effective anchoring systems

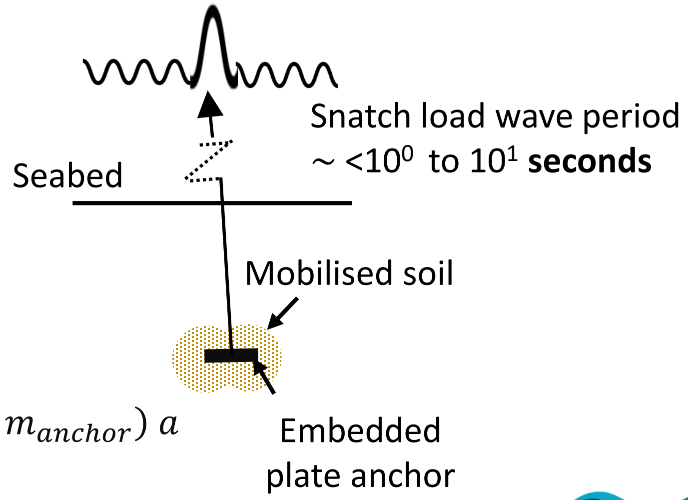
'Hidden' anchor capacities

(typically not considered in traditional geotechnical foundation design)

1.



2. Added soil mass



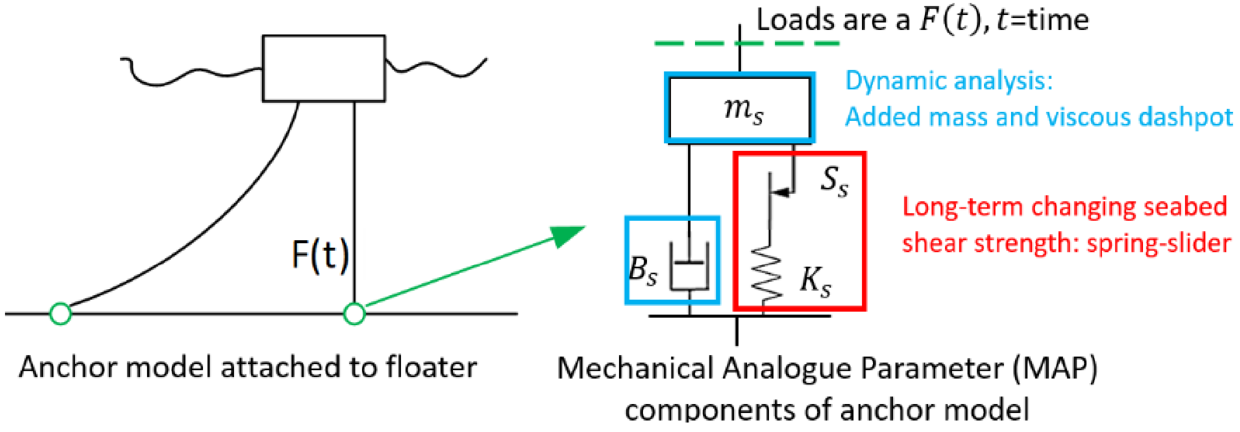
$$F_{AM} = (m_{soil} + m_{anchor})\,a$$

Outcomes:

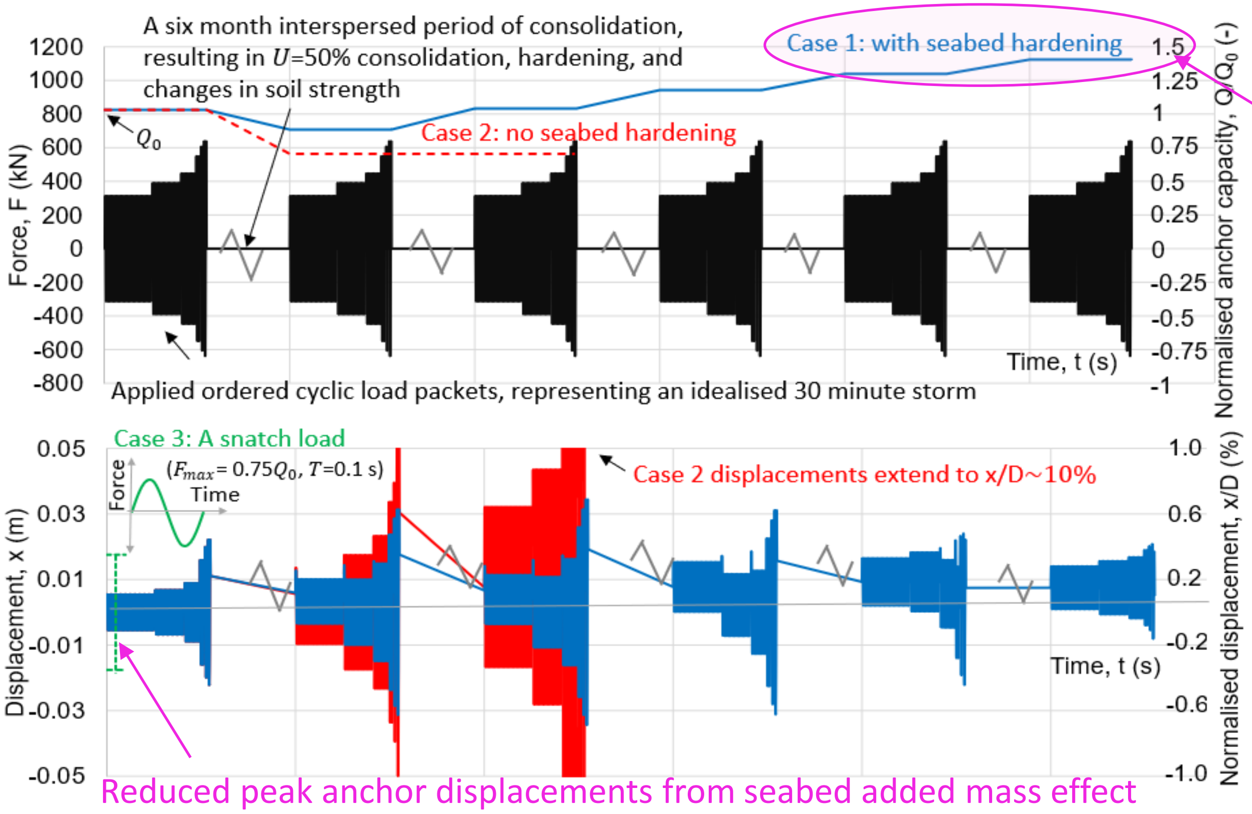
Developed a numerical computational '*macro model*' in collaboration with the **Norwegian Geotechnical Institute (NGI)** and the **Norwegian SFI BLUES project**.

The *macro model*:

1. captures 'hidden' **anchor capacity enhancements**
2. allows for **easy integration** of soil-anchor interactions into mooring analyses via using 'smart' mechanical analogue parameter (MAP) components (i.e. spring-slider, dashpots and added mass elements) to represent different soil-anchor interactions that evolve through the facility life.



Schematic of anchorage, consisting mechanical analogue parameter (MAP) components connected to a floating ORE facility



Whole-life (a) force response of macro model allowing for consolidation and (b) the resulting displacements during cyclic loading (Cases 1 and 2) or a single snatch load (Case 3)

Up to 50% extra anchor capacity
& potential halve required anchor size

The *macro model*

1. efficiently predicts changes in anchor capacity over a **multiscale hierarchy of time process** from wave period loads loads **(10^0 to 10^1 s)** through to geotechnical consolidation durations **(10^6 s)** through to full facility life **(10^{12} s)**
2. provides a **new basis** for **assessing the through-life changes** in geotechnical anchor capacity
3. enables a better understanding of the **fully coupled soil-anchoring mooring** behaviour of ORE infrastructure over its operational lifetime

Further reading

Kwa et al. (2022) A numerical macro model to simulate the whole life response of anchors for floating offshore renewable energy systems ASME 2022, 41st Int Conf. on Ocean, Offshore & Arctic Engineering, OMAE 2022.

Kwa et al. (2022) Report to NGI: A Whole-life anchor macro model for floating offshore systems (UoS GEO: 21010)