Dr Katherine Kwa was awarded funding from the Supergen ORE Hub Early Career Researcher Fund October 2020 round. The Supergen ORE Hub grants this award annually, where applications are scored against assessment criteria of personal development, additionality, excellence, impact and alignment with the objectives of the Supergen ORE Hub.

Katherine's project, titled '***Development of an integrated anchor model via industry engagement***,' extended her recent work on the 'whole-life' time-dependent capacity of anchoring systems, which has revealed potentially significant 'hidden' anchor capacity that are not typically included in traditional geotechnical foundation design. The project involved collaboration with the Norwegian Geotechnical Institute and the Norwegian SFI BLUES project. It explored new methods for capturing beneficial seabed-anchor interactions during realistic whole-life loading conditions and resulted in the development of an efficient computational 'macro' model that is currently being integrated into existing anchor and mooring software numerical analysis packages (NAPs) and floating system models.

The macro model represents the averaged soil response around the anchor as a single node at the anchor point (Figure 1). It captures 'hidden' anchor capacity enhancements in soft-soil type seabeds from (i) 'whole-life' changing soil strength, (ii) viscous effects on soil strength and (iii) added soil mass effects, which are usually absent in geotechnical foundation design soft soils. The model enables easy integration of the soil-anchor interactions into mooring analyses in a simple and practical way, while unlocking the full potential anchor capacity provided by these mechanisms. This was achieved by using 'smart' mechanical analogue parameters (MAPs), including spring-slider, dashpots and added mass elements to represent the different soil-anchor interactions that evolve through the facility life.

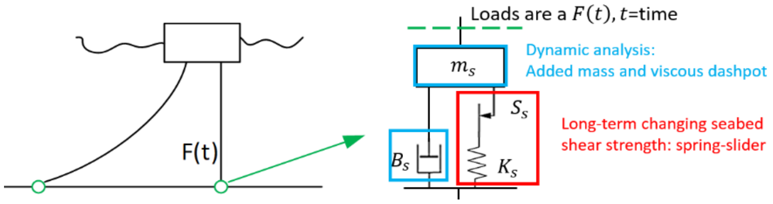

Figure 1*: Schematic of anchorage, consisting mechanical analogue parameter (MAP) components connected to floating ORE facility*

The model was connected and benchmarked with existing mooring software NAPs (e.g. *Bifurc*[1] and in the future, *Riflex*) and the results from applying the coupled NAP-MAP model to example cases demonstrated how the coupled model efficiently predicted changes in anchor capacity over a multiscale hierarchy of time processes, from wave period loads (10^0 to 10^1 s) through to geotechnical consolidation durations (10^6 s) through to full facility life (10^{12} s) (Figure 2). It provides a new basis for assessing the through-life changes in geotechnical anchor capacity and enabling a better understanding of the fully coupled soil-anchoring mooring behaviour of ORE infrastructure over its operational lifetime[2].

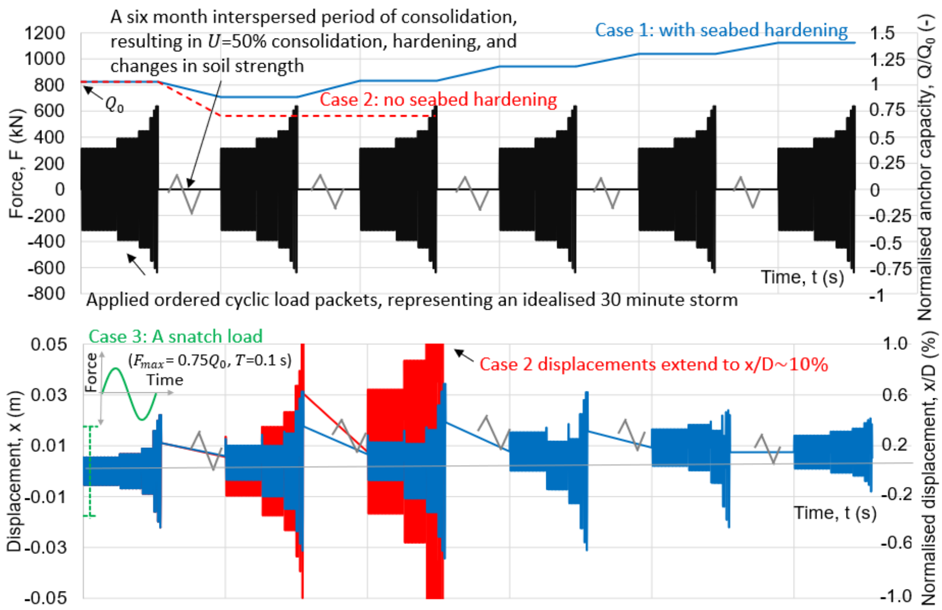

Figure 2: *Whole-life (a) force response of macro model allowing for consolidation and (b) the resulting displacements during cyclic loading (Cases 1 and 2) or a single snatch load (Case 3)*

[1] Jostad H. P., (1993). Report: Geotechnical properties of clay-shales. Description of BIFURC- a finite element program for bifurcation analysis of boreholes, For NGI

[2] 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*)