Medium Scale Field Testing of Monopile Foundations Under Cyclic Lateral Loading

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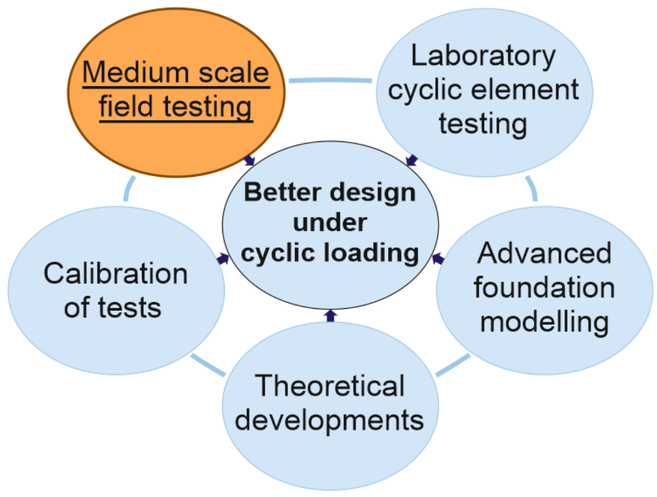
Introduction

- This project aims to improve geotechnical design methods for offshore wind turbine monopile foundations with a focus on cyclic lateral loading.
- Cyclic response is currently designed using empirical methods which do not accurately reflect the behaviour of monopile foundations.
- Medium scale field testing is required to obtain data on pile behaviour for the validation of theoretical design methods. Similar testing was conducted for the PISA project focusing on monotonic lateral loading. This test program will focus on cyclic lateral loading and rate effects.

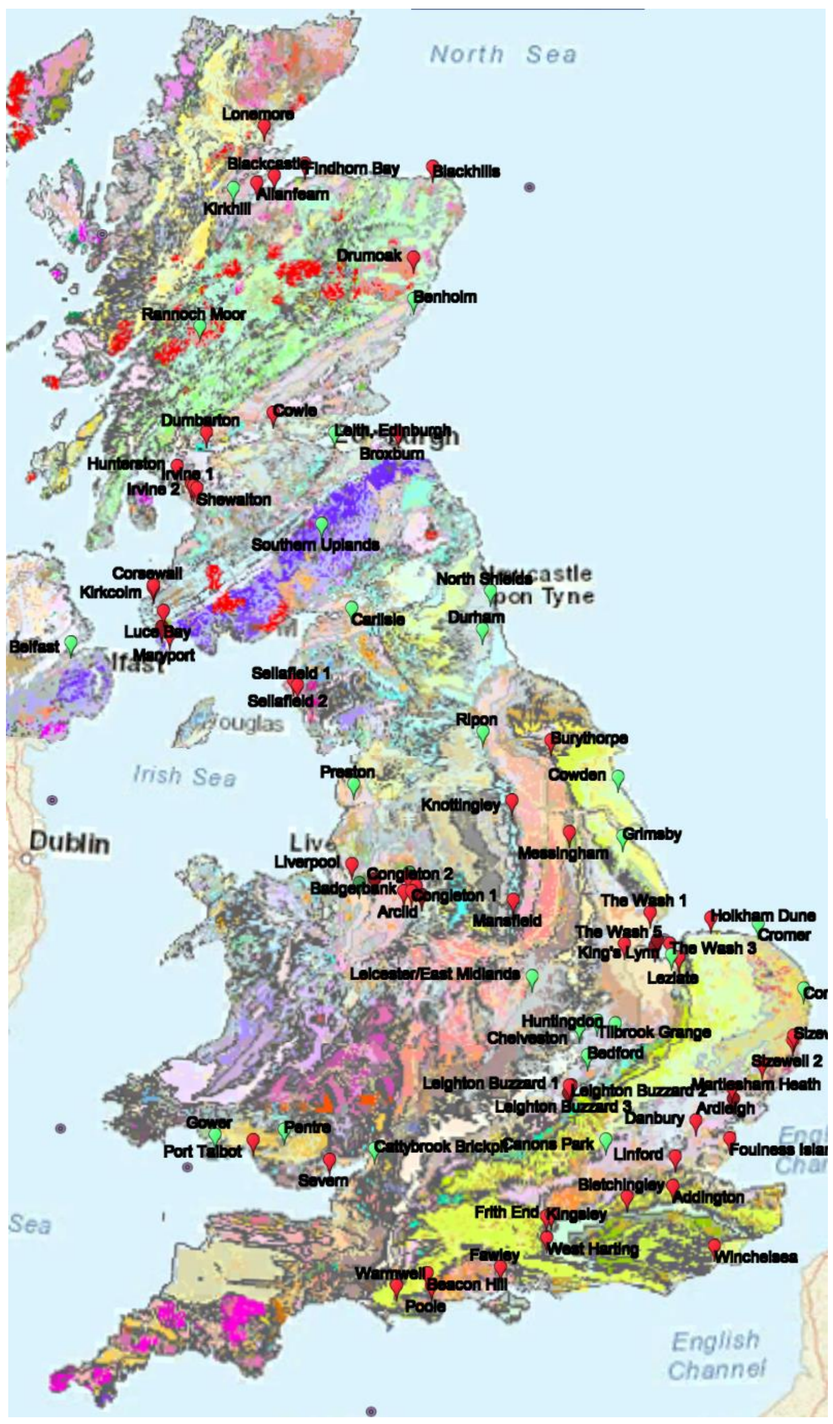
Medium Scale Field Testing for PISA[1]



Project Framework

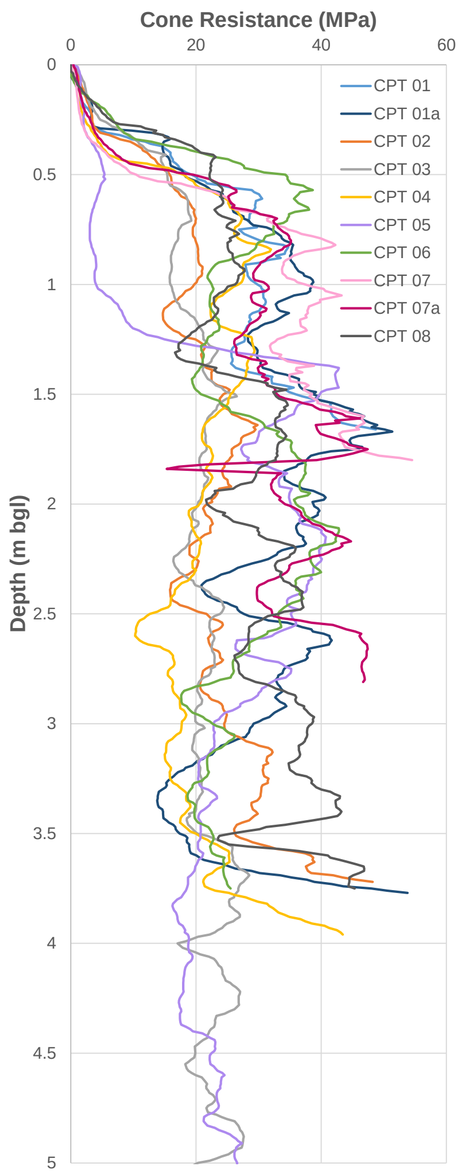
Site Selection

- Test site requirements – groundwater table at or near surface, at least 10m thickness of overconsolidated clay (Site 1) / medium dense to dense sand (Site 2) below the water table level
- Geology review and literature search – 63 sand sites and 28 clay sites considered throughout the UK
- Preliminary investigation – final site selection still underway



Sites Considered with Geology[2]

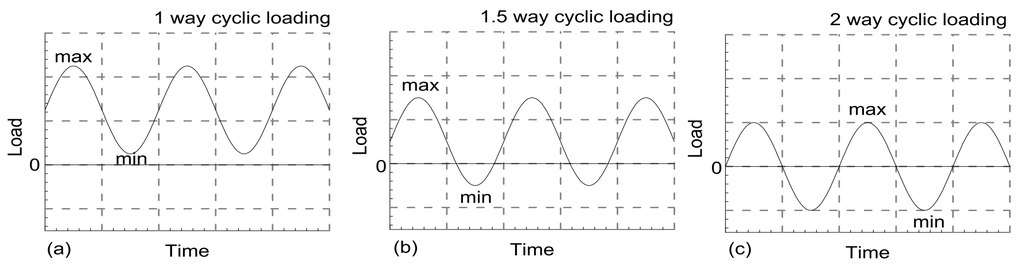
Preliminary Investigation



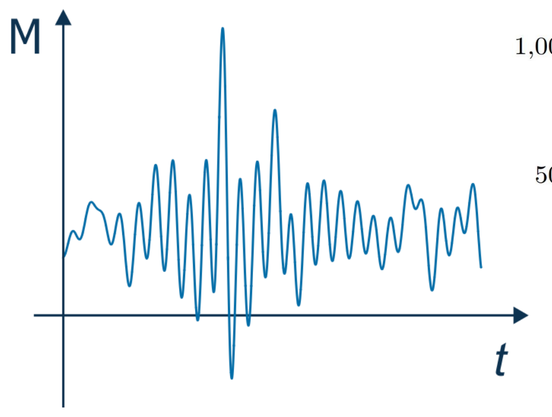
CPT Results from Preliminary Investigation – Kings Lynn Quarry

Proposed Testing

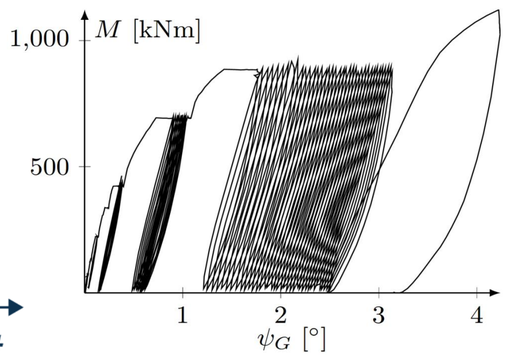
- At each of 2 sites (Site 1 – Clay and Site 2 – Sand), 9 × 0.76m diameter piles and 3 × 2.5m diameter piles will be tested.
- Piles will be subjected to a variety of loading regimes including:
  - Monotonic – single rate and multi-rate
  - Uni-directional cyclic – 1 way, 1.5 way, 2 way and random
  - Multi-directional cyclic
- Instrumentation including fibre optic strain gauges, vibrating wire piezometers, inclinometers, displacement transducers and temperature sensors



1, 1.5 and 2 Way Cyclic Loading Test Patterns



Example Pattern of Random Cyclic Loading



Example Moment Rotation Response under Cyclic Loading from PISA[3]

Acknowledgements

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References:

1) Byrne, B.W. et al., 2017. 'PISA: New Design Methods for Offshore Wind Turbine Monopiles'. *Proceedings of the 8th International Conference on Offshore Site Investigation and Geotechnics*, 12-14 September 2017, London, UK, pp.142-161.
2) British Geological Survey (BGS), 2019. *Geology of Britain Viewer.* UK Research and Innovation. Available at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html.
3) Beuckelaers, W.J.A.P., 2017. *Numerical Modelling of Laterally Loaded Piles for Offshore Wind Turbines*. PhD thesis. University of Oxford.

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