

Rate Effects for Monopile Foundations

Kuen-Wei Wu (kuenwei.wu@eng.ox.ac.uk)

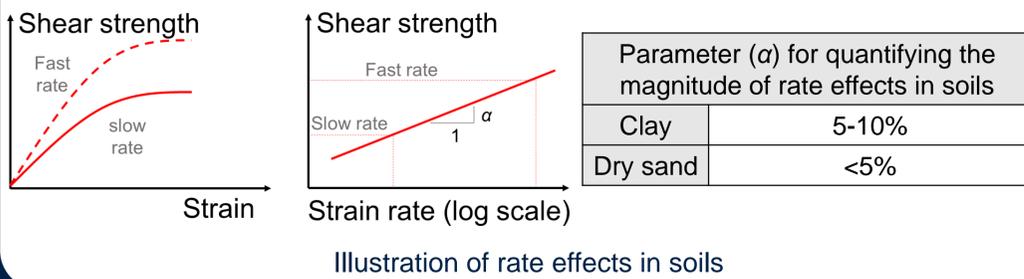
Supervisors: Prof Byron Byrne, Prof Guy Houlsby

Industry Supervisor: Amin Aghakouchak (Ørsted)

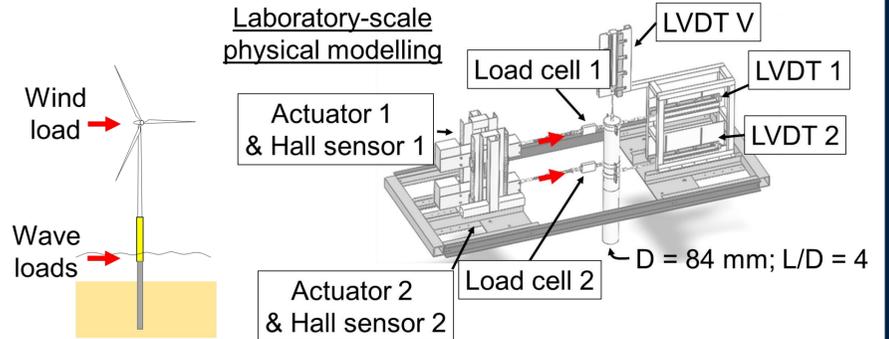


Research Questions

- Transient loads act on offshore wind turbine (OWT) foundations, and monopiles are most frequently used in Europe (81.9% of the installed foundations)^[1].
- Soil stiffness, shear strength and pile capacity can increase with loading rate^{[2][3]}.
- In current design practice, the p - y method^[4] uses a static analysis approach and rate effects are not taken into account → *over-conservative design*

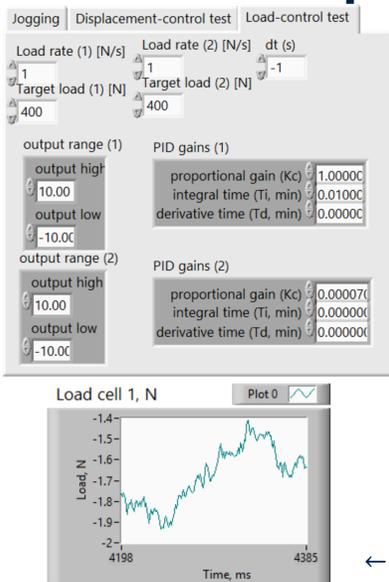


Methodology

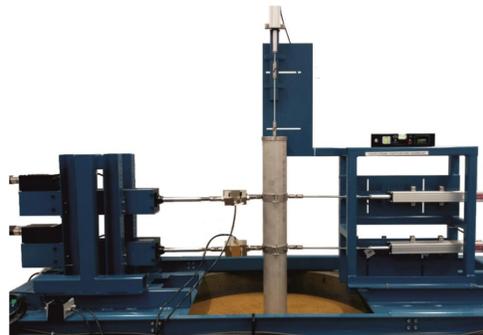


Develop a new loading rig to explore rate effects and simulate various loading conditions (e.g. wind and wave loads)

Development of the System



- LabVIEW® control and data acquisition system
- High-speed loading system
- Changeable loading eccentricity



← Control panel & real-time monitoring data

Future Work

Continue to develop the system and shorten the loop rate (from kHz to MHz range)

Carry out model tests in dry sand and clay as well as element tests to characterise soil strength behaviour and rate-dependency

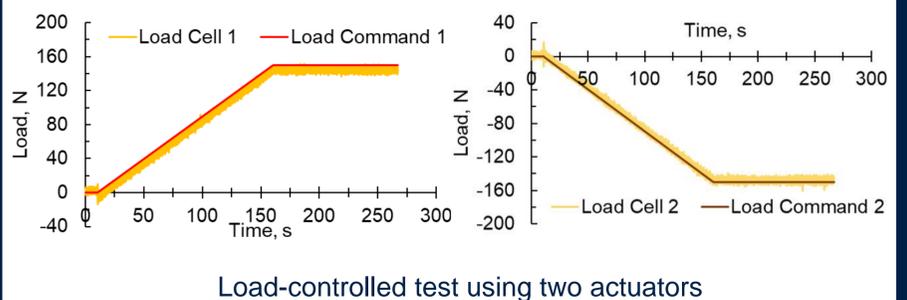
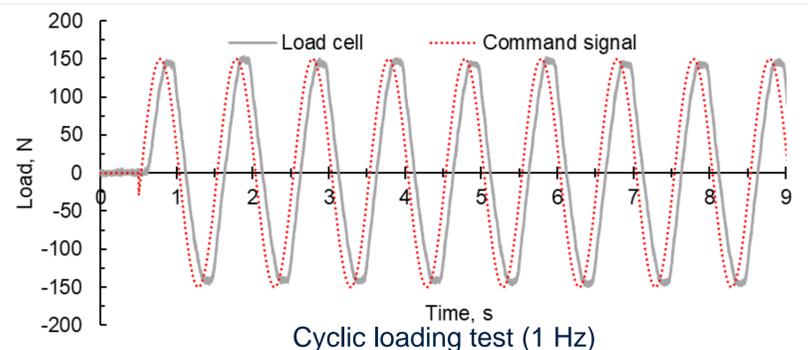
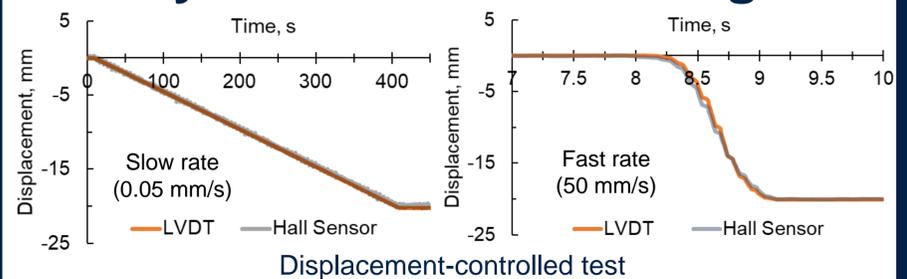
Build links between element and model tests to quantify the magnitude of rate effects for different soils

Improve current design practice

Summary

- Rate effects are observed in element and pile load tests.
- A rig has been developed and a series of commissioning tests have been successfully carried out.
- Through physical modelling, it is expected that the test results will provide observations to update the current design practice.

System Commissioning



Acknowledgement

The author acknowledges Ørsted for providing the DPhil studentship at the University of Oxford through the Centre for Doctoral Training in Renewable Energy Marine Structures (REMS CDT).



References:

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2. Vaid, Y.P., and Campanella, R.G. 1977. Time-dependent behavior of an undisturbed clay. Journal of the Geotechnical Engineering Division, ASCE, 103(7): 693-709.
3. Byrne, B.W., McAdam, R.A., Burd, H.J., Beuckelaers, W.J.A.P., Gavin, K., Houlsby, G.T., Igwe, D., Jardine, R.J., Martin, C.M., Muir Wood, A., Potts, D.M., Skov Gretlund, J., Taborda, D.M.G., and Zdravković, L. 2018. Monotonic laterally loaded pile testing in a stiff glacial clay till at Cowden. Géotechnique (Accepted).
4. American Petroleum Institute. 2003. Recommended practice for planning, designing and constructing fixed offshore platforms—working stress design. Northwest, DC.