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Public Guest Lecture:

Centrifuge and DEM investigations into screw piles for offshore applications

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Abstract The development of offshore renewable energy is likely to grow exponentially in the following years to decarbonize our societies. As shallow waters have already been developed, floating wind turbines or wave energy converters are expected to populate seas and oceans. The offshore industry is facing two challenges: the need to provide anchors with sufficient tensile resistance and the necessity to install foundations with low underwater noise.

Screw piles are composed of one or several helices fixed to a shaft and meet these two challenges. Firstly, they can be installed in a 'silent' manner (by comparison to driven piles), by applying a torque at the pile head, which literally screws the pile into the soil. Secondly, they have a greater tensile capacity than straight-shafted piles, thanks to the helix's embedment, which acts like a plate. One of the key questions for screw pile design is the identification of the crowd force and torque necessary to install them at a desired embedment depth. The crowd force requirement is particularly critical for offshore operations, as the necessary force approaches the upper bound of what could be practically applied by installation vessels.

This work investigates how installation parameters can be varied to reduce the installation requirements, and particularly the crowd force. Geotechnical beam-centrifuge experiments were used to create a database of results and validate numerical simulations. The Discrete Element Method was used to investigate micro-mechanical processes underpinning the macroscopic behaviour of screw piles during their installation. The combination of both techniques enabled a meaningful description of installation mechanisms and the development of recommendations beyond current design guidelines.

One of the main findings of this study is that screw piles can be safely installed in sand by overflighting, i.e. by applying more helix rotations than recommended for a constant vertical displacement rate. This installation mode was shown to strongly reduce the necessary crowd force and even created some pull-in effect, with the pile actually pulling on the installation rig. This installation was not correlated with degradation of the pile tensile capacity, as could be expected, but by an increase in pile stiffness and capacity.

Benjamin Cerfontaine is an incoming BritInn fellow who is visiting the Unit of Geotechnical Engineering from 11 July - 15 July 2022.