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Numerical modelling of offshore anchors for floating structures

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Introduction

Offshore floating structures are maintained on station using mooring lines that terminate at anchors embedded in the seabed. A variety of anchor types exist:

Driven pile

Dynamically Installed Pile (DIP)

Suction caisson

Drag embedded anchor (DEA)

Vertically Loaded plate Anchor (VLA)

Dynamically Embedded PLate Anchor (DEPLA)

Suction Embedded PLate Anchor (SEPLA)

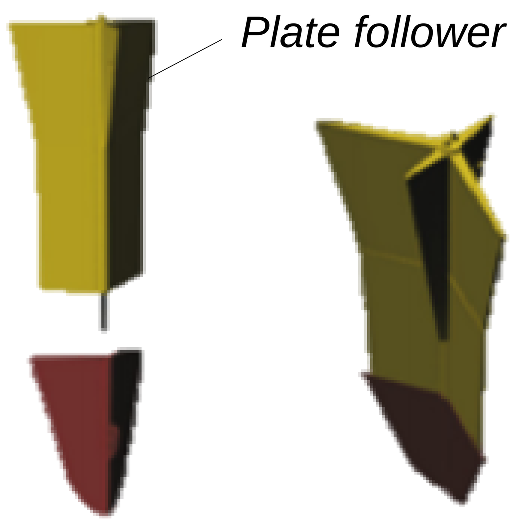
Pile Driven Plate Anchor (PDPA)

This project aims at studying the performance of two types of offshore anchors used as a part of the mooring system of floating structures for possible use in practice: Dynamically embedded plate anchors and helical anchors.

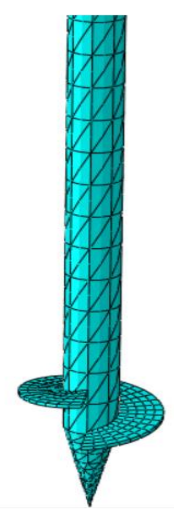
Problem statement

- Dynamically embedded plate DEPLA anchors are installed by allowing them to free-fall through the water column, such that the combination of their self-weight and the kinetic energy gained through free-fall embed them into the seabed. DEPLA anchors have been demonstrated to be performant in clay but were shown to be less suitable in sands due to their limited embedment potential in granular soil.
- An alternative new dynamically embedded plate anchor (named DEPLA_1) was recently suggested for the case of a sandy soil.
- Helical anchors may constitute suitable tools of anchoring of a tension leg platform TLP.

DEPLA



DEPLA_1



Helical anchor

Although many centrifuges tests have been performed on dynamically embedded plate anchors and helical anchors, few numerical studies have been conducted on these anchors. The existing studies did not generally consider the installation process of the anchor, which could obviously result in an inaccurate estimation of its uplift capacity.

Scientific procedure

Numerical simulations of the two types of anchors will be carried out using the finite element method. The modelling of the installation process will be carried out using a Coupled Eulerian-Lagrangian CEL approach that allows one to overcome the problems of the classical finite element approach when modelling of soil-structure interaction problems involving large deformations.

DEPLA anchor

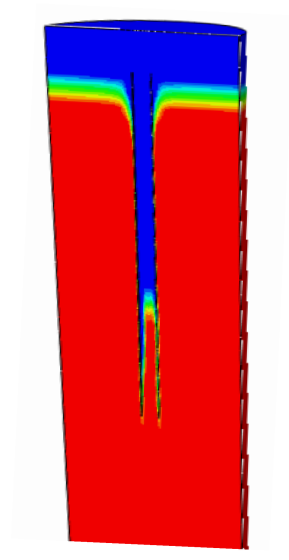
The aim of the DEPLA anchors simulations is to verify the penetration potential of the new anchor and to study the influence of the various parameters influencing the final anchoring depth. The parametric study carried out allows one to perform a geometrical optimization of the anchor in order to reach greater depths and thus increase the bearing capacity of the anchor.

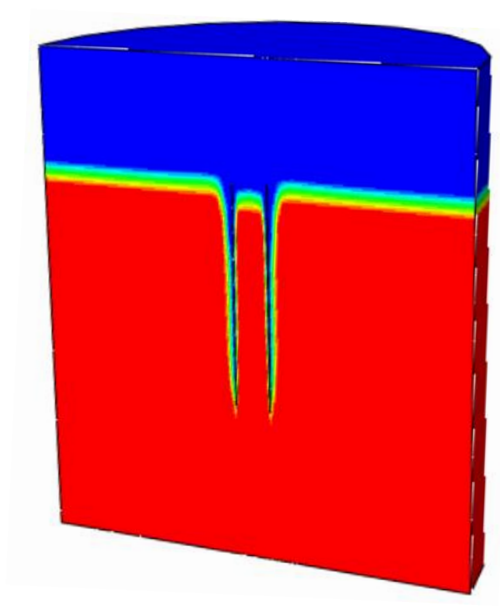
Helical anchor

Numerical simulations of the helical anchors will be performed first under monotonic loading and then in the presence of a cyclic loading. Finally, an attempt to establish a relationship between the installation torque and the bearing capacity of the anchor will be investigated as part of this project.

Current work

In the framework of the WEAMEC ROS-3D project, the installation process of a monopile foundation into the seabed was simulated. This was done via the Coupled Eulerian-Lagrangian CEL approach in Abaqus software. The objective was to investigate the degree of soil plugging which could significantly affect the resistance against penetration.





After the simulation of the installation process, some numerical simulations were performed under axial and lateral loading.

References

Chow, S.H., O'Loughlin, C.D., Gaudin, C., Lieng, J.T., 2018. Drained monotonic and cyclic capacity of a dynamically installed plate anchor in sand. Ocean Engineering, 148, pp. 588-601.

Chow, S.H., O'Loughlin, C.D., Gaudin, C., Knappett, J.A., Brown, M.J., Lieng, J.T., 2017. An experimental study of the embedment of a dynamically installed anchor in sand. In: Proceedings of the 8th Offshore Site Investigation and Geotechnics Conference (OSIG17), London, UK, pp. 1019–1025.

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