PFEM analysis of installation effects on axial performance of jacked piles in chalk

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ABSTRACT

Chalk is a weak highly porous rock formed by cemented calcite grains. It covers areas of the UK and is widespread under the North and Baltic Seas where OWT are currently being installed and where future offshore expansion will be sited. Large piles are often driven in chalk to support OWT and other onshore infrastructure. The installation of pile foundations in chalk causes the intact rock surrounding the pile to crush (generating high pore-water pressure build up) and deteriorates into a putty characterised by a mechanical behaviour very different from the intact chalk. Such complexity is the underlying reason for inadequate current design guidance for pile in chalk which currently relies on empirical methods or partial (wished-in-place) numerical simulations. Installation effects such as grain crushing and pore pressure generation are conservatively estimated (if considered at all), as the change of rock properties around the pile duringthe installation process cannot be easily quantified. In this paper it is shown how advanced numerical modelling can be used to capture such damaging effects and hence guide the design of pile foundations in chalk. The coupled hydro-mechanical effects developing during pile installation are investigated numerically using a robust and mesh-independent implementation of an elasto-plastic constitutive model for chalk [1] recently reformulated in large strains [2]. The model implemented into an open source Particle Finite Element (PFEM) code [3], is able to capture the damage of the rock until the formation of a chalk putty layer around the shaft of a small diameter pile. Installation effects are highlighted by comparing the axial performance between wished in place piles and piles which considered the full installation process. The numerical results are then used to critically address the limitation of current design specifications of displacement piles in chalk [4].

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