

ABSTRACT

Open-ended pipe piles are deep foundation elements widely used in both onshore and offshore projects. When an open-ended pile is installed, soil enters it through the base to form a soil column inside the pile shaft called the “soil plug.” The plugging behavior of open-ended pipe piles and its influence in their load response, although fundamental in engineering practice, is still not fully understood. This dissertation explores plugging in sand through a comprehensive investigation that consists primarily of experiments performed in a large-diameter calibration chamber with imaging capabilities, complemented by X-ray computed tomography analyses to investigate the particle-scale behavior and digital image correlation analysis of collected images to determine the displacements field in the soil during pile installation or loading, and field-scale experiments in the literature to connect calibration chamber observations with the engineering practice. Throughout the document, a framework to design and perform experiments using model piles in half calibration chambers is developed. Then, results of model pile installations, compressive and tensile load tests in uniform and layered sand samples are presented. The plugging behavior is shown to be dependent mainly on the pile geometry and the layer configuration of sandy soil profiles. The degree of plugging determines the deformations near the pile base during installation, which in turn affect the soil state at the end of installation and, therefore, the capacity of piles to resist axial loading through both shaft and base resistance. The soil fabric near the piles also changes during installation, with sand particles gaining interparticle contacts in the direction of compression.