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Off-Shore Wind Turbines: The Issue of Soil Plugging during Pile Installation

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Abstract : Off-shore wind turbines are currently considered as a reliable source of renewable energy Worldwide and especially in the UK. Most of the operational off-shore wind turbines located in shallow waters (i.e. < 30 m) are supported on monopiles. Monopiles are open-ended steel tubes with diameter ranging between 4 to 6 m. It is expected that future off-shore wind farms will be located in water depths as high as 70 m. Therefore, alternative foundation arrangements are needed. Foundations for off-shore structures normally consist of open-ended piles driven into the soil by means of impact hammers. During pile installation, the soil inside the pile may be mobilized by the increasing shear strength such as to prevent more soil from entering the pile. This phenomenon is known as soil plugging, and represents an important issue as it may change significantly the driving resistance of open-ended piles. In fact, if the plugging formation is unexpected, the installation may require more powerful and more expensive hammers. Engineers need to estimate whether the driven pile will be installed in a plugged or unplugged mode. As a consequence, a prediction of the degree of soil plugging is required in order to correctly predict the drivability of the pile. This work presents a brief review of the state-of-the-art of pile driving and approaches used to predict formation of soil plugs. In addition, a novel analytical approach is proposed, which is based on the vertical equilibrium of a plugged pile. Differently from previous studies, this research takes into account the enhancement of the stress within the soil plug. Finally, the work presents and discusses a series of experimental tests, which are carried out on small-scale models piles to validate the analytical solution.

Keywords : off-shore wind turbines, pile installation, soil plugging, wind energy
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