Geotechnical Performance of Suction Caisson Installation in Multi-layered Seabed Profiles

M. Mehravar[1]*, O. Harireche[2], A. Faramarzi[3]

[1]School of Engineering and Applied Science, Aston University, Birmingham, UK
[2] Department of Civil Engineering, Faculty of engineering, University of Medina
[3]Department of Civil Engineering, University of Birmingham, Birmingham, UK

Abstract

Suction caissons consist of large cylindrical buckets made from steel. In or-der to serve as foundations for various offshore structures, suction caissons are pushed into the seabed under pressure differential exerted on their lid by an imposed suction. Despite their wide use in the oil and gas industry, there are still some uncertainties regarding their installation process as a result of changes in seabed profiles such as the existence of low permeability layers as well as the variation in soil properties with depth (e.g. permeability decreasing with depth due to an increase in soil density). It is known that seepage condi-tions play a pivotal role in the installation process, particularly in sand. In-deed, pressure gradients generated by the imposed suction inside the caisson cavity cause an overall reduction in the soil resistance around the caisson wall and at caisson tip, thereby assisting the penetration into the seabed. Successful installation of caisson foundations relies on accurate prediction of soil condi-tions, in particular soil shear resistance during the installation. Existing knowledge of the prediction of soil conditions and required suction during caisson installation has some limitations which often resulted into rather con-servative design methods. Most design procedures used to control suction dur-ing caisson installation assume an isotropic and homogenous seabed profile. Moreover, the actual variation of pressure gradient around the caisson wall at different penetration depths is often ignored, although it significantly affects soil resistance. Natural seabed can possess a heterogeneous property where it may comprise of different layers of soils including the presence of layers with low-permeability i.e. clay or silt. In this paper, the effect of seepage on soil conditions during caisson installation is studied within the frame of the pres-ence of a substratum that consists of silt. Suction induced seepage described throughout the installation process and its effects on frictional and tip re-sistance are considered. For this purpose, a numerical simulation is conducted on a normalised geometry of the suction caisson and surrounding soil, at dif-ferent penetration depths. The distribution of pressure gradient on both inside and outside of the caisson wall is taken into consideration in both soil shear and tip resistance. Particular conclusions will be drawn on the implications of the presence of a low permeability silt layer on caisson installation.