On the Suction Pile Relocation Distance

Ya Li and Jianfeng Zhang
Technip
Houston, TX, USA

ABSTRACT

Suction piles have been widely used for foundations supporting manifolds and other heavy subsea structures in deepwater developments where soft clay is usually encountered. If for some reason during the installation process or after the pile is installed the suction pile must be retrieved and reinstalled, common practice is often to relocate/reinstall the pile 3 diameters (3D) to 5 diameters (5D) away, measured from center-to-center. This practice is not attractive for projects with congested drill centers or where wells have been predrilled prior to installation of the suction pile. This paper investigates pile relocation over shorter distances in order to overcome potential challenges associated with the common practice.

KEY WORDS: Suction Pile, Clay, Relocation Distance, Drill Center, Numerical Simulation, Soil Disturbance, Piping.

INTRODUCTION

Suction piles have been widely used for foundations supporting manifolds and other heavy subsea structures in deepwater developments where soft clay is usually encountered, for advantages such as: (a) precise positioning in deepwater; (b) ease of removal and relocation; (c) less dependency on heavy installation equipment; and (d) large diameter that can develop considerable resistance against significant lateral and torsional loads generated by top structures. However, the potential for reinstallation of suction piles has always been an issue for engineers because of the potentially large relocation distances.

Retrieval and reinstallation of a suction pile may become necessary if one of the following scenarios is encountered: 1) the installation bias exceeds the allowed tolerance; or 2) unexpected soil conditions are discovered locally during and after the installation, either the soil is found weaker than expected that the pile will not be able to develop adequate in-place capacity, or a stronger layer is present causing early refusal to the suction pile embedment. Carefully planned and executed geotechnical and geophysical surveys can minimize occurrence of the latter case. Thus suction pile reinstallation often results from very stringent installation tolerances or non-compliance with proper installation procedures.

Common practice recommends that the suction pile be reinstalled at a location 3D to 5D (D=suction pile outer diameter) away, measured center-to-center, from the initial position. This common practice is particularly not attractive for many deep water developments for which the drill centers are congested. Fig. 1 presents the layout of a typical deepwater drill center. As shown, a series of manifolds are positioned about 21.3m (70ft) apart. Those manifolds are surrounded by wells that are connected to the manifold through jumpers of 18.3m (60ft) to 27.4m (90ft) long. Assuming a typical suction pile OD of 4.88m (16ft) for manifold foundations, even the minimum relocation distance of 14.6m (48ft) per common practice could change the drill center layout significantly, which is particularly concerning if some of the wells have been predrilled.

Figure 1  Example Drill Center Layout

On the other hand, the origin of this common practice is a mystery as no literature was found to support this statement. It is suspected that the recommendation was derived from the classic pile grouping effect. The pile in a group shares the supporting soil during loading with other piles but such mechanism does not present for a relocated suction pile. This is another motivation for this study.

Investigation of pile relocation over shorter distances (less than 3D) are performed mainly through the in-place analyses to obtain the load-displacement (or movement-reaction) curves for reinstalled suction piles. These are FE (Finite Element) analyses that have considered...