Experimental Investigation into the Influence of a Keying Flap on the Keying Behaviour of Plate Anchors

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ABSTRACT

Plate anchors are used in deep and ultra-deep waters to anchor floating offshore structures. Once installed vertically under the seabed with the aid of a suction follower they must be rotated or “keyed” in order to mobilize full anchor capacity. A keying flap attached to the top of the anchor is commonly used, aiming at reducing the vertical translation component of the installation path during keying, although its efficiency appears to be uncertain. To quantify the performance of this keying flap and to understand its mechanism, centrifuge tests were performed on an anchor model, using Particle Image Velocimetry (PIV) to monitor the trajectory of the anchor and the behaviour of the keying flap through examination of the soil failure mechanism upon keying. Results indicated that the keying flap did not affect the anchor trajectory, except by introducing an offset to the loading.

KEY WORDS: Geotechnical engineering, centrifuge modelling, soft soil, anchor, keying, failure mechanism.

INTRODUCTION

SEPLA Concept

The Suction Embedded PLate Anchor (SEPLA) concept borrows installation techniques from conventional suction caissons yet during its operation life it is effectively a Vertically Loaded Anchor (VLA) and as such is appropriate for soft cohesive soils. A modified suction caisson known as a follower houses a plate anchor inserted in a vertical slot at the base end. During installation, the follower and plate anchor are lowered onto the seabed and installed to the design depth in the same manner as a typical suction caisson. Water is then pumped into the top of the follower in order to retrieve it from the sea floor for reuse while the plate anchor remains in a vertical orientation at the design depth.

The SEPLA incorporates the advantages of a conventional suction caisson, namely: proven installation methods along with known geographical position and penetration depth, together with the benefits of a VLA, namely: low cost, the ability to handle a high degree of vertical load and geotechnical efficiency (Wilde et al. 2001, Ehlers et al. 2004). Prior to 2004, SEPLA field application was limited to temporary moorings for MODU platforms. The first permanent application occurred in 2006 for a Floating Production Unit in the GoM (Rigzone, 2006). Today the anchor is commonly used in deep waters.

Similar to a VLA, the plate must be keyed (rotated) from its initial vertical position to an inclination normal to the load applied by the mooring line (Dove et al. 1998), hence exhibiting the maximum cross-sectional area (normal to the loading direction) and optimizing the bearing capacity. This is achieved, with minimal delay, by tensioning the mooring line and loading the anchor to typically 20 to 30% of its maximum holding capacity. During the keying process, the anchor experiences vertical motion, resulting in a loss of embedment. For offshore marine deposits, which usually exhibit an increase of strength with depth, any loss of embedment results in an unrecoverable loss of capacity, which may be significant.

Keying Flap

In order to limit the vertical displacement of the anchor during keying and hence the potential loss of embedment, SEPLAs often feature a keying flap (Fig. 1).