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Bearing Capacity and Keying of Plate Anchor in Normally Consolidated Clay

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ABSTRACT

In this paper, finite element analyses of plate anchor keying in Normally Consolidated (NC) clay were performed. Bearing capacity of plate anchors was investigated with various embedment ratios and pullout inclination angles. Both vented anchor base (no suction on rear face) and fully attached (bonded) anchor base were considered in the analysis. Anchor rotation was analysed using RITSS (Remeshing and Interpolation Technique with Small Strain model) method. It is found that the bearing capacities of inclined plate anchors are associated with both of the loading inclination angles and the anchor base conditions. The soil weight plays an important role in the bearing capacity analysis. The soil non-homogeneity has minor effect on anchor rotational behaviour.

KEY WORDS: Plate anchor, Keying, Bearing capacity, Loading inclination, Finite element analysis.

INTRODUCTION

In recent years, oil and gas mining has moved into increasingly deeper water in search of undeveloped fields. For water depths in excess of 500 m, conventional platforms are replaced by floating facilities, anchored to the seabed using catenary or taut-wire moorings. The latter type of mooring imparts significant vertical loading to the anchor, and consequently many different types of anchoring system have been developed (Ehlers et al. 2004). The SEPLA (Suction Embedded Plate Anchor) is one of such systems, which comprises a plate anchor that is penetrated in a vertical orientation using a caisson, and subsequently rotated by applying the anchoring force at some eccentricity until the plate becomes perpendicular to the applied force. This process is schematically illustrated in Fig. 1. It has been conceived to combine the advantage of suction caissons (known penetration depth and geographical location) and vertical loaded anchors (geotechnical efficiency and low cost).

The uplift capacity of anchors in soil has been a subject of study for the last three decades, with the majority of past research being horizontal anchors pulled out vertically. The important effect of anchor inclination has received very little attention by researchers. Merifield et al. (2005) studied inclined plate anchor bearing capacity by using limit analysis. Consideration was given to the effect of embedment ratios and anchor inclination angles. The ultimate anchor capacity is found to increase linearly with overburden pressure up to a limiting value that reflects the transition from a non-localized to localized or "deep" failure mechanism. A simple empirical equation is proposed to estimate collapse load.

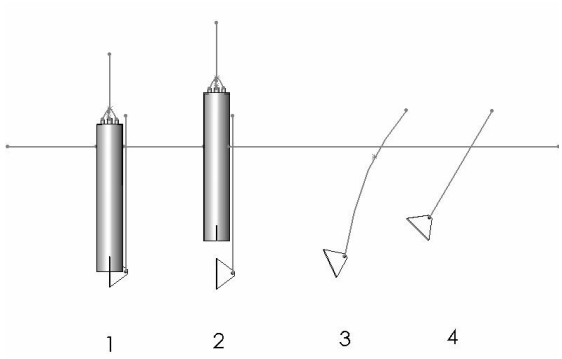

Fig. 1 Keying processes for the Suction Embedded Plate Anchor (SEPLA)

A limited number of experimental results for the capacity of inclined square and strip anchors can be found in the works of Meyerhof (1973) and Das and Puri (1989). The study of Das and Puri (1989) appears to be the most significant experimental attempt to quantify the capacity of inclined anchors. In their tests, the capacity of shallow square anchors embedded in compacted clay with average undrained shear strength of 42.1kPa was investigated. Pullout tests were conducted on anchors at inclinations ranging between 0° (horizontal) and 90° (vertical) for embedment ratios (H/B) of up to four. A simple empirical relationship is suggested for predicting the capacity of square anchors at any orientation which compares reasonably well with the laboratory observations.

Song et al. (2005) studied anchor bearing capacity in uniform clay with inclination angle form 0° to 90°. It is found that the pullout capacity increases with increasing embedment, with an ultimate capacity factor