Effect of Pore Pressure Dissipation on the Behaviour of Anchors in Clay

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ABSTRACT

Analysis of anchors subjected to a vertical uplift force has been carried out by using finite element analysis of a circular anchor embedded in a porous elasto-plastic material. The analysis takes into account the initial stress state, and makes allowance for breakaway if the effective stresses at the underside of the anchor fall to zero. A new axisymmetric joint element which can allow for the effects of fluid pressure has been used to examine the effects of breakaway. Two loading cases for the anchor are considered, rapid (or undrained) loading and slow (or completely drained) loading. Analyses are presented for “shallow” (2 diameters) and “deep” (4 diameters) anchors. The results show that the pore pressure reduction is not large enough to produce negative pore pressures behind the anchor.

KEY WORDS: Anchors, breakaway, pore pressure, finite elements, pullout load.

STRESS AND PORE PRESSURE EFFECTS

When a buried anchor is pulled in uplift, stress changes are induced into the surrounding soil mass. These stresses are discussed below in relation to the zones in Figure 1. When a small load is applied there is an increase in stress immediately above the anchor (Zone A) and a corresponding decrease in stress in the area immediately below the anchor (Zone B). For “shallow” anchors, the surface of the seabed will bulge upwards, and because of the “beam effect” of the bulging of the surface there will be a decrease in horizontal stress near the surface immediately above the plate (Zone C). Tension cracks may develop near the surface if this decrease exceeds the initial horizontal stress.

During loading, pore pressures will increase in Zone A and decrease in Zones B and C. The reduction in pore pressure in Zone B is often referred to as “suction”, however pressures below

INTRODUCTION

The use of vertical lift anchors in offshore marine applications has given new impetus to the need for a better understanding of the behaviour of anchors in uplift in soft clays. In particular the effects of rate of loading on the behaviour of such anchors is of interest because of the mix of short and long lasting loads in such applications. This paper examines the behaviour of anchors under rapid (undrained) uplift loading and slow uplift (drained) loading. Comments are given on the pore pressures developed around the anchor, the extent of separation of the base of the anchor from the soil, and the mechanisms of failure.