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Abstract

FULLY COUPLED NUMERICAL ANALYSIS OF A DIAPHRAGM WALL CONSTRUCTION

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In Macau the use of diaphragm wall becomes popular for the underground construction. During the construction that may cause change of stress regime and ground deformation. Therefore, a better understanding of the soil-structure interaction behaviors would be greatly benefited in terms of a safer and more economic design.

In this study, fully consolidation-coupled three-dimensional finite element analyses are adopted to model a diaphragm wall construction. Two cases namely single diaphragm wall panel and multi diaphragm wall panels are simulated. The use of the three-dimensional model is to predict the soil deformations and change of the stress during the period of trench excavating and concreting. Typical soil parameter in Macau is selected with typical ground profiles (fill, marine deposit, alluvium and completely decomposed granite) in order to reflect the ground response in the local region.

The first model, single diaphragm wall panel installation, analyzes the stress distribution around the trench. Behind the wall, horizontal stress is reduced from the initial K_o to the hydrostatic slurry pressure above the toe of the panel during the trench excavation. Subsequent concreting stage causes the stress to increase to a bi-linear concrete pressure. At the edge of the trench, the horizontal stress increases during the wall excavation but decreases at the stage of wall concreting. Moreover, noticeable stress changes occur beneath the toe of panel during the construction. It is concluded that stresses in the ground are transferred simultaneously in both vertical and horizontal directions, i.e. downward load transfer mechanism and horizontal arching mechanism. Meanwhile, shear stresses are mobilized around the trench during the construction. Influence zone in terms of stress distribution and ground movement are presented and discussed. At 1D distance away from the panel where D denotes the trench depth and 1/3D beneath the panel toe, the influence of the stress becomes insignificant. Both the vertical and horizontal ground movements are not significant at a distance of 3D away from the panel.

The second model, multi panel installation, analyzes the influence of the consecutive diaphragm wall panel construction. Noticeable variation of stress is observed at the edge of the finished panel at the end of construction. At distance of 3D, both horizontal movement and vertical settlement are insignificant. Furthermore, installation of a diaphragm wall panel does not cause any significant effects on a finished panel which is 3L away from it, where L is the panel length.

In long term, no significant horizontal movement is observed after the completion of diaphragm wall and a little vertical settlement is seen following 2000 days.

Furthermore, noticeable change of the stress path at the edge of the panel takes place on the marine deposit layer for the first 15 days after the wall panel completion. There is no insignificant change after the mentioned period.