

Deformation of Vertical Excavation with Self-supported Double Soldier Pile Wall System

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ABSTRACT

A self-supported double soldier pile wall system used in the vertical excavation is eminent for its superiority on easy and rapid construction and its capability of reducing the deformation of retaining wall. A series of centrifuge model tests in an acceleration of 30 g were conducted to study the behaviors of self-supported single and double soldier pile wall system in sandy soils. The models were performed to investigate the external stability of wall and deformation behaviors in the different test conditions. The double soldier pile wall system can effectively reduce the surface settlement, horizontal displacement and tilt angle of wall and maximum bending moment on the wall to more than a half of those experienced in the single soldier pile wall system. In the study, a relation of the maximum horizontal displacement on the wall and the surface settlement trough are proposed to evaluate the degree of impact on neighboring buildings.

KEY WORDS: Self-supported double soldier pile; external stability; surface settlement; bending moment; centrifuge modeling.

INTRODUCTION

Many excavation methods are used to construct different types of infrastructure. The majority of excavation works in urban areas utilize wales and struts for lateral supports; however, the strutted vertical excavation is not an economical way when a large area of open excavation is required. Installing and removing struts one by one during construction always slow the construction processes down. Since most of the supporting walls in an open cutting work are considered only as temporary structures, large deformation may be acceptable as long as failure states are prevented and the stability of the wall is the main interest in the design. However, excess deformation behind the wall sometimes causes serious damages to neighboring buildings. Therefore the deformation of wall and the settlement of surrounding ground must be one of concerned issues in the design and construction of such a retaining wall system.

Soldier piles with horizontal timber lags have been used extensively as an excavation support system, particularly in stiff soil conditions. The main advantages of using soldier piles are their low cost and ease of

installation, reusability, and resistance to hard driving. A cantilever soldier pile wall system is frequently used for retaining soil in gravel soil sites and sandy soil sites where ground water ingress into the excavated area is not problematic. However, the excavation depth is generally limited to about 4 m in depth. A cantilever retaining wall resists the overturning moment due to the earth pressures from the retained soil, by developing a restraining moment due to the earth pressure along the embedded portion of the wall. How to increase the excavation depth by means of improving the stiffness of the cantilever soldier pile wall system to reduce the settlement of surrounding ground becomes a key topic for both designers and contractors.

A double sheet pile wall cofferdam is a structure that consists of two parallel steel sheet pile walls, connected by horizontal tie rods in single or more layers, with soil infill between the walls. It has been used in open water construction works as a cofferdam, quay wall, breakwater or ship way to hold the water pressure, lateral earth pressure and wave forces (Ruhul et al. 2006). Recently a self-supported double soldier pile wall system or a two-row sheet piles (Chen, 1999) used in the deeper vertical excavation are eminent for its superiority on easy and rapid construction and for its capability of reducing the retaining wall deflection. The construction of the self-supported double soldier pile wall is first driving two rows of soldier pile around the excavation area. The distance between the front row of and the rear row of pile is about 60-120 cm. The distance of two piles in a row is about 40-60 cm. A reinforced concrete cap beam is constructed to integrate both two rows of pile into a retaining wall system. This type of self-supported retaining wall system was used in two excavation sites in Taiwan. One is successful and the other is failed (Hsieh et al. 2003). Table 1 lists the basic excavation information of these two cases. However, the deformation characteristic and the failure mechanism in the cases are not well known yet from these two in-situ cases. No appropriate design procedure is currently available.

The basic principle of centrifuge modeling is to recreate the stress conditions that are present in full-scale constructions in models of greatly reduced scale. The full-scale system modeled with a centrifuge model (with dimensions N times larger than those of the model if it is tested in an acceleration that is N times earth gravity) is referred to as the prototype. It is intended that the prototype should include all the important characteristics of the field situation of interest. Centrifuge modeling provides an opportunity to study for example both the ground