KVMRT V6 @Tmn Suntex

Problems Encountered In Excavation of Large Diameter Hand-Dug Caisson

(by Ir. Oh Chin Wah, Executive Director) (2014 Jan-Mar)

(1) Introduction.

Recently, hand-dug caisson is becoming popular choice of pier foundation for the elevated deck highway especially in the urban area. For instance, like Klang Valley Mass Rapid Transit (KVMRT), the hand-dug caisson pile foundation is being designed and constructed at the area where there is constraint of space and inaccessibility by the boring machine. The sizes is ranging from 2.8m to 5.0m in diameter. Most of the time, the design of hand-dug caisson pile is in big diameter single pile in order to support the single pier column. The purpose is to reduce the excavation and avoid the temporary shoring for the big pilecap of pile group. Other than forming as foundation pile, large diameter hand-dug caisson shaft of 8.0m in diameter was successfully constructed for the purpose of launching shaft for pipe jacking boring machine.

Site Photo

Site Photo

(2) Problems encountered.

Dealing with the excavation of large diameter hand-dug caisson is much different as comparing to the small diameter caisson. The amount of excavated spoil and also the vast volume of ground water that need to be removed is posing a lot more challenge and effort to overcome and forming the lining of the shaft.

The stability of the large diameter shaft is controlled by the exposed height of the excavation face especially on the soft overburden soil before reaching to the stiff and stabile ground. As such, the excavation height for each lining have to limit to the sustainable height in order to cast the caisson lining within the same day. If the excavation face is not lined and left to the second day, the excavation face will collapse and cause the instability or disturbance to the surrounding soil. Hence, the subsequent excavation will be dampened by the collapsible soil and possible of base heaving too. Other than above, the following problems are commonly found in caisson excavation too such as;

1. High water table and loose sand will lead to the collapse of soil and piping in the base, especially in the alluvial soil of limestone formation.

2. Base heave due to the soft soil and hydraulic pressure. This can cause the loss of soil from the side and eventually lead to the formation of sinkhole on the adjacent ground.
3. Penetrate into highly permeable layer, i.e. sand layer or aquifer zone causing the gushing of ground water into the caisson.
4. Dewatering during caisson excavation may cause extensive groundwater drawdown resulting in excessive ground settlement and cause the damage to the surrounding utility services and structure.

(3) Recommended solutions.

In view of the high risk and high uncertainty of the ground condition that possible encounter during excavation, it is highly recommended to carry out detail soil investigation work on each and every large diameter caisson. The reason is to identify the possible problems that may encounter during excavation and to propose the suitable solution/prevention to carry out prior to the actual excavation work. Our experiences tell us that any rectification work on the caisson in the mid of excavation can incur a lot more cost and time loss too. Therefore, it is always wise to carry out the necessary ground strengthening or improvement work before carrying the excavation work in the soft ground. The following measures are the recommended solutions/prevention to be carried out prior to the excavation;

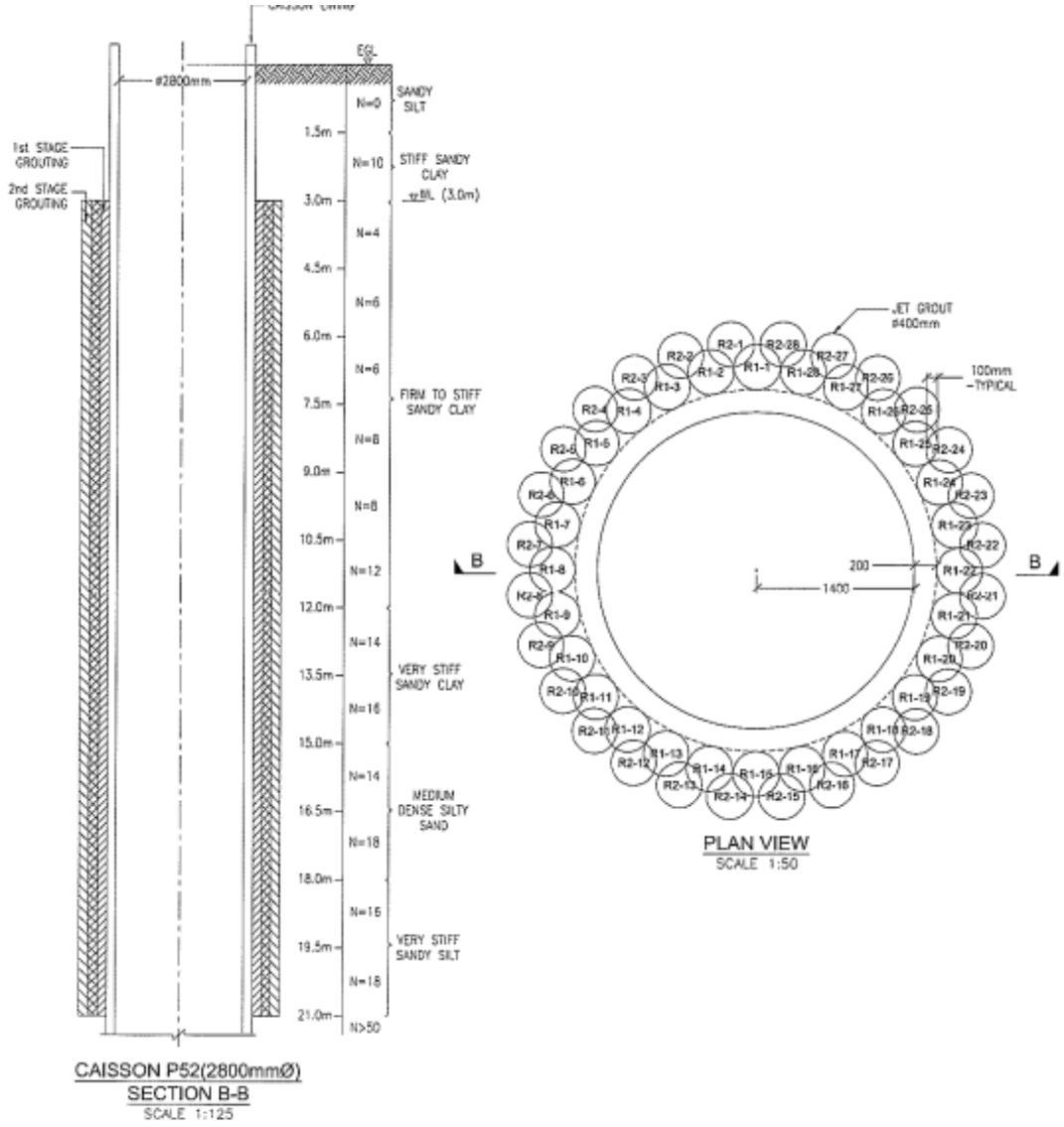
- Installation of jet grout curtain or cut off wall surrounding the caisson and extending down to the level of stiff ground in order to form a cut-off to the ground water and limit the inflow of water.

- Carry out pressure grouting or chemical grouting below the lining at each excavation stage before the next level of excavation in order to strengthen the ground below and cut down the seepage of ground water.

- Installation of sheet pile cofferdam or big diameter casing to form the cut-off wall until penetrating into the stiff ground.

- Reduce in the depth or exposed height of each caisson excavation stage.

- Installation of dewatering wells within the site and carry out the dewatering in advance of the caisson excavation.



Proposal of Jet Grout Curtain