KL Gateway @Kerinchi

Corner Strutted Wall: Comparing Actual Wall Displacement Against Predicted Results by 3-D Finite Element Analysis Using Plaxis 3D

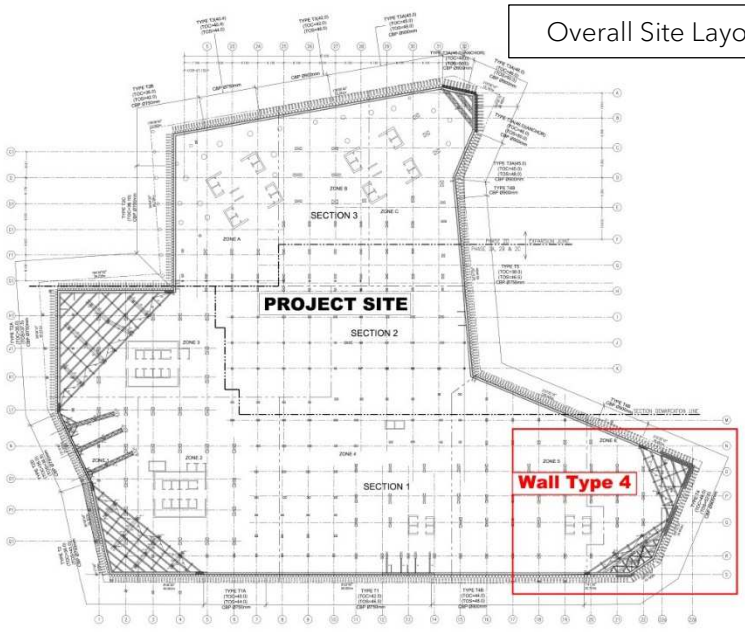
(By Ir. Oh Chin Wah, Executive Director) (2013 Oct-Dec)

Introduction

This development consists of 4 blocks service apartments, 2 blocks commercial offices and 7 storeys car park and a shopping mall. The entire site is divided into 3 sections. The basement wall is using contractor's proposal of contiguous bored pile (CBP) with steel strutting and temporary removal anchor tied back system. There are approximately 600 nos. of CBP with sizes ranging from 750mm to 900mm and approximately 330 nos. of bored pile foundation with sizes ranging from 900mm up to 3000mm.

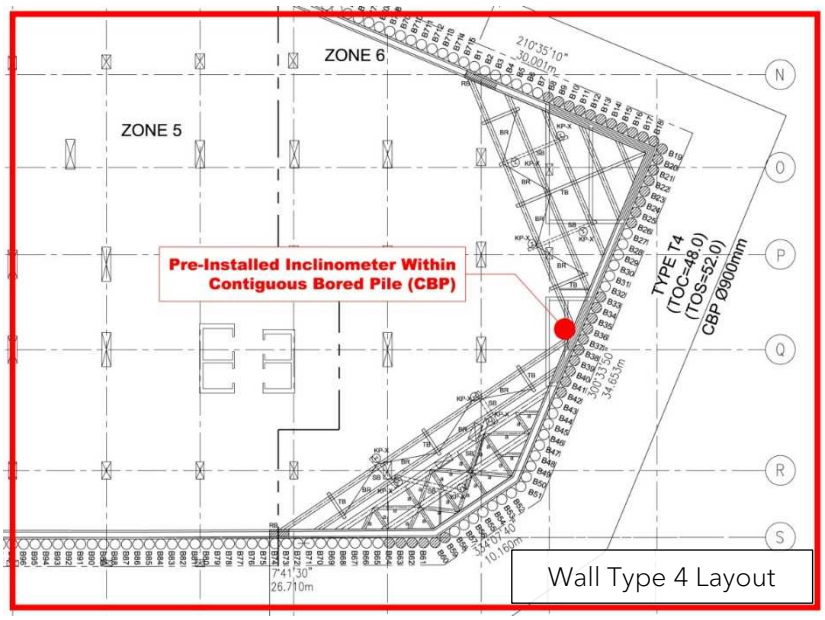
Overall Site Layout

This is considered one of the deepest excavations throughout the entire site, from existing ground level of RL52.00m excavated down to final platform level of RL28.5m which is equivalent to 23.5m excavation depth to facilitate the six level of basement floor. During the earthwork excavation, each floor level was strutted with temporary steel strut at 1m above the floor level before continuing excavate to the next floor level. After the installation of steel strut at each level, the strut was preloaded with the

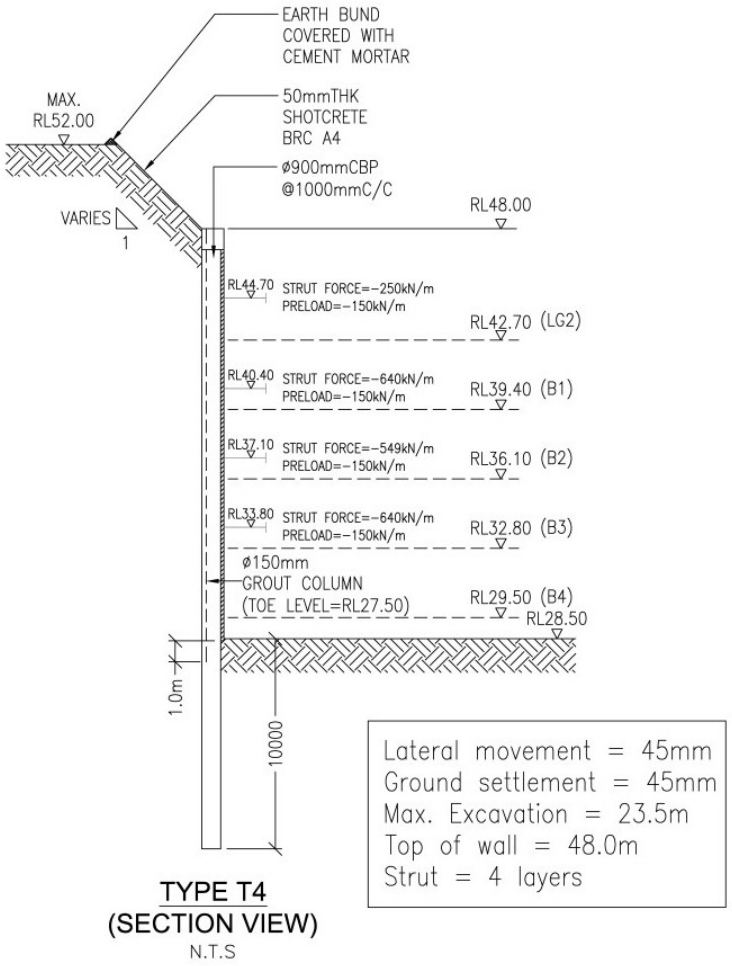


Overall Site Layout

jacking force equivalent to the 150KN/m in order reduce the movement of wall. The wall movement is continuing being monitored through the installed inclinometer at the middle position of both side corner strutted wall. Since both side of the wall is not symmetrical in shape, the design of the strut arrangement and the forces within the member for the both side of corner strut may be different too. In order to study the actual wall behavior, 3D wall modelling analysis using Plaxis 3D was being carried out to check and verify the preliminary results based on the Plaxis 2D analysis.



Wall Type 4 Layout



TYPE T4
(SECTION VIEW)
N.T.S

Site Geology

Generally, this site is on undulating ground with existing ground level varies from RL55.0m to RL40.0m. The geology formation of this site is Kenny Hill which consists of a monotonous sequence of inter-bedded clastic sedimentary rock such as sandstones, shales and mudstones. This formation is also referred as meta-sedimentary, considering that the sedimentary rocks have been partly metamorphosed into quartzite and phyllite.

Subsoil Conditions

The entire site has a various subsoil conditions which reflected in the earlier borehole results obtained from the soil investigation report. The nearest bored hole results were chosen to represent the actual subsoil condition for the wall modelling and analysis. Existing ground water table was being observed at RL44.5m from the standpipe results which is located around 7.5m below the existing ground level.

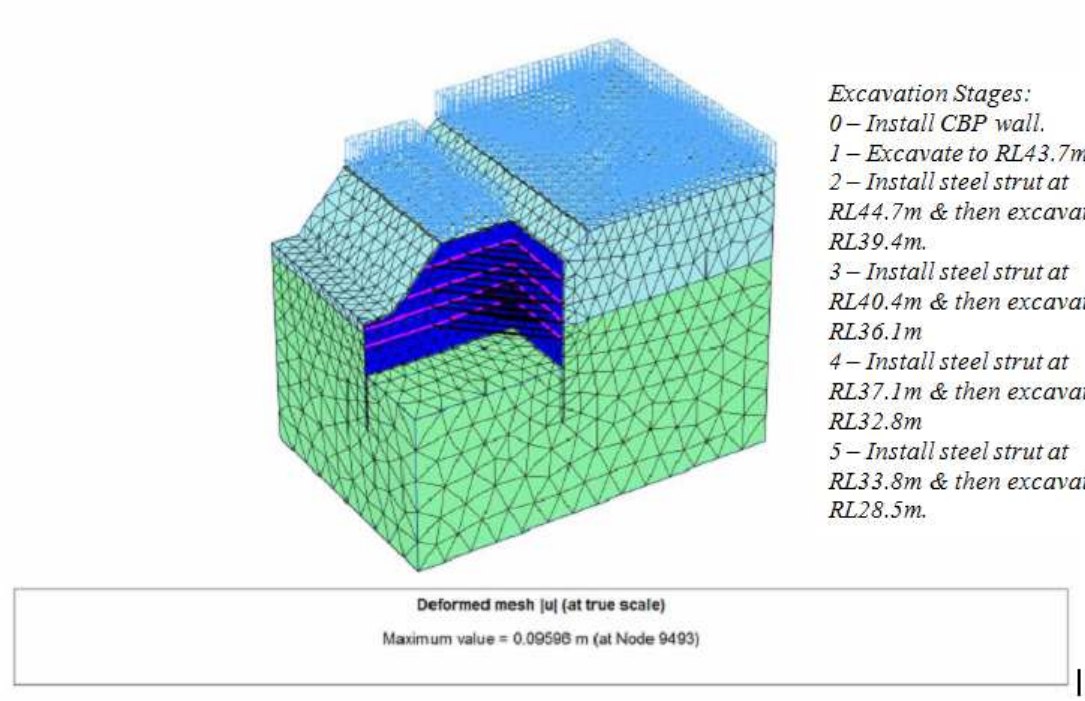
Soil Profile Parameters adopted:
The Hardening Soil model (Schanz and Vermeer, 1999) was used to model the stress-strain behaviour of residual soils. The soil stiffness parameters used were derived based on a correlation of 2000 x SPT (N) kPa for trial (E^{ref}_{50}) and oedometer (E^{ref}_{oed}) stiffness, as for unloading reloading stiffness (E^{ref}_{ur}), a correlation of 3 x 2000 SPT (N) kPa was adopted.

Soil layers	Properties	SPT (N)	E^{ref}_{50} (Mpa)	E^{ref}_{oed} (Mpa)	E^{ref}_{ur} (Mpa)	c' (kPa)	φ' (^{0})
0 – 10.5m	Loose Sandy Silt	10	20	20	60	5	30
> 10.5m	Hard Silty Sand	120	240	240	720	15	35

3-D Modelling

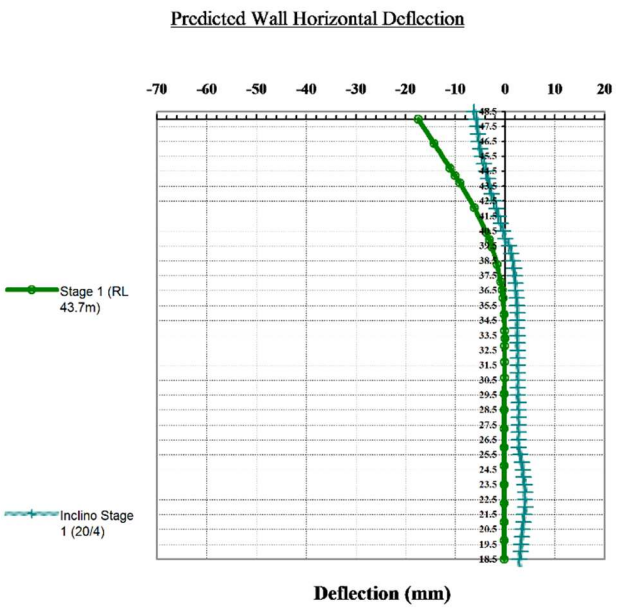
The 2-D modelling is only limited to the plane strain problem. Therefore, the 3-D modelling was used to investigate the actual behaviour of wall under excavation with the present of corner stiffening effect and non-symmetrical boundaries condition in this project.

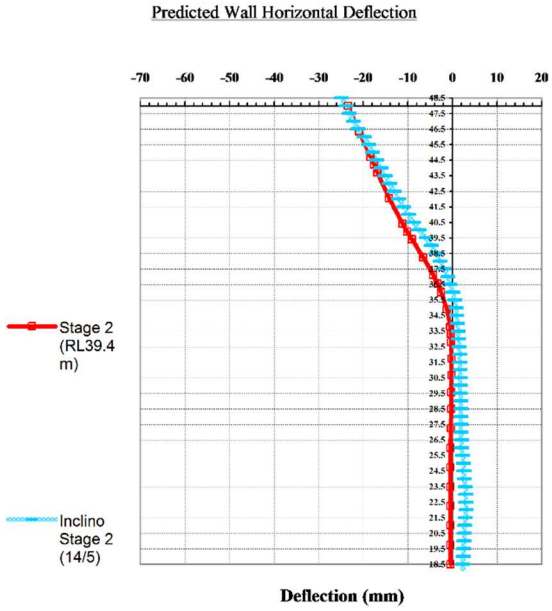
3-D FE analysis has been carried out using Plaxis 3D program. Figure below shows the model set-up for analyzing the deep excavation for wall Type 4 corner strutted CBP wall. The model geometry is 75 x 50 x 50 m, comprising 26500 nos. of 15 noded wedge elements. The model boundary distances in the in-plane and into-the-plane directions are set sufficiently far to eliminate any boundary effect. The CBP is modelled as "Plate" structural elements with anisotropic linear elastic behaviour and equivalent section properties. While, the waler and the steel strut are modelled as "Beam" and "Node to node" structural element with isotropic linear elastic behaviour respectively.

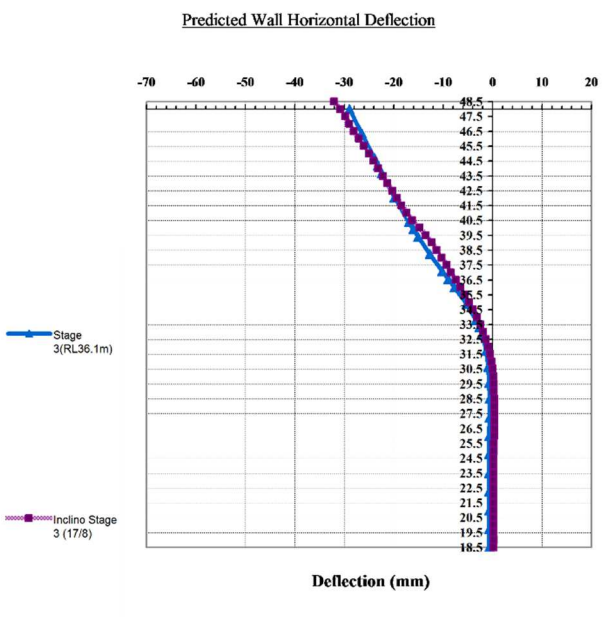


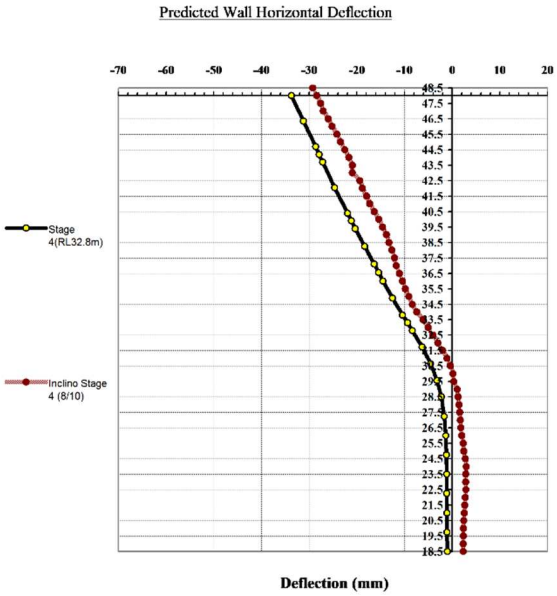
Excavation Stages:
0 – Install CBP wall.
1 – Excavate to RL43.7m.
2 – Install steel strut at RL44.7m & then excavate to RL39.4m.
3 – Install steel strut at RL40.4m & then excavate to RL36.1m
4 – Install steel strut at RL37.1m & then excavate to RL32.8m
5 – Install steel strut at RL33.8m & then excavate to RL28.5m.

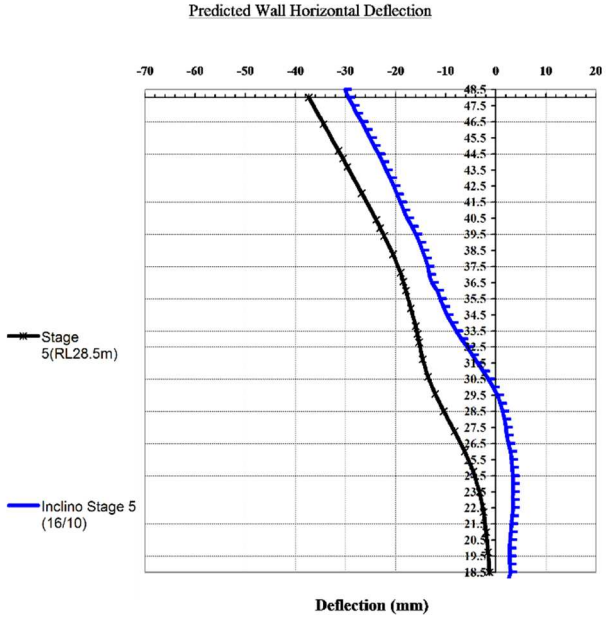
Prediction and Actual Monitoring Results.











Observation

The recorded initial wall movement at stage 1 & 2 is larger and very closed to the predicted results. This is most probably due to the initial movement required to mobilise the compressibility of the steel strut. From the observation, may be the required preload should be adjusted to the even higher load in order to reduce the initial movement. The subsequent recorded wall movement at the later stage of 3,4 & 5 did not show any further movement as comparing to the predicted results. In brief, the wall performance is better than the predicted results even though with the 3-D FE analysis.