EXCAVATION ADJACENT TO THE EXISTING BUILDING: A STUDY CASE

M. F. Ma'ruf [1] and H. Darjanto [2]

ABSTRACT: A 17 stories building is planned to be erected at the crowded area. A 4 floors office and 2 floors house are its right and left neighbors. 2 floors surgery building of the hospital is right behind the project area. Of 3.2m depth will be excavated at the area for basement in which the ground water table is at 2m depth. The excavation could trigger instability for the surrounding buildings, especially when the dewatering process takes place. This paper intends to describe the analysis of the excavation process and the inferred ground stability. The model simulation by means of Plaxis 2D 2011 recommends the modification of construction stages drastically. Local excavation at the pile cap area is the best method to generate the smallest deformation on the nearby area.

Keywords: *excavation, ground stability, construction stage, dewatering*

INTRODUCTION

The high rise building has been planned to be built in the middle crowded building. A 4 floors office and 2 floors house are its right and left neighbors. 2 floors surgery building of the hospital is right behind the project area. Of 3.2 m depth excavation will be conducted at the area for pile caps in which 4.5 m depth has to be dug at lift area. The water table exists at 2 m depth. The excavation work is susceptible to affect the surrounding building. Careful planning of excavation should be carried out to minimize those effects.

The excavation next to existing building is one of the most problems in geotechnical practices. Research and investigation in this area had been conducted till recent time. Ramadan et al. (2013) revealed that contiguous pile succeeded to reduce lateral movement but not below the piles and the bottom of excavation. Sanjay et al. (2005) proposed grouting method combined with bore foundations to stabilize the slope of deep excavation. Meanwhile, a careful investigation was conducted by Hui (2014). He did numerical simulation on three different condition of deep excavation: slope excavation, cantilever sheet pile wall and retaining pile combined with bracing support. He recommended the retaining pile combined with bracing support among other methods. However, he revealed also that the stabilization method fully depend on the field and soil condition. Moreover, Koff (2009) did scrutiny work to access the excavation effects in the soft soil area. He proposed damage criteria to classify the building condition affected by the excavation stages. He demonstrated that the excavation induced displacement to cause the building damage depended on the stiffness of the building in axial and bending modes and the interface between soil and foundation and between foundation and building.

This paper intends to discuss about excavation case in a commercial high rise building project in Surabaya. The paper emphasizes on the excavation construction stage sequence.

PROJECT DESCRIPTION

The project was construction of 17 stories building. It had 42 columns. The number of piles to support column are vary from 3 to 12 piles. The piles had 21 m long. The piles were jacked to 24 m depth. The 3 m space above the piles to the ground surface was prepared for the pile caps and the basement. The basement was planned at 1.5 m depth supported by 50 m thick plate floor and pile caps with 1 m thickness. To stabilize the excavated soil, 6 m soldier piles was installed with 50 cm spacing. Meanwhile, the dead man piles were set 1 m from the soldier piles with 1 m spacing. The detail actual piles installed in the area can be checked in Fig. 1.

In the beginning, the contractor planned to do 3.2 m depth excavation at all the building area. However, the experience on the excavation project at the neighborhood location led the contractor to do careful examination on the excavation stage planning.

Standard Penetration Test (SPT) results shown in Fig. 2 show that the soils were soft to medium types. The upper layers to 8 m depth were loose and medium sand. About 3 m thick of very soft soil layer was found at 10 m depth. Meanwhile, the deeper soil layers were medium soil. Such soil conditions had high possibility to have lateral displacement due to excavation work.

[1] Civil Engineeering Department, Jember University, Jember, 68121, INDONESIA email: farid.teknik@unej.ac.id
[2] Civil Engineeering Department, Narotama University, Surabaya, 60117, INDONESIA

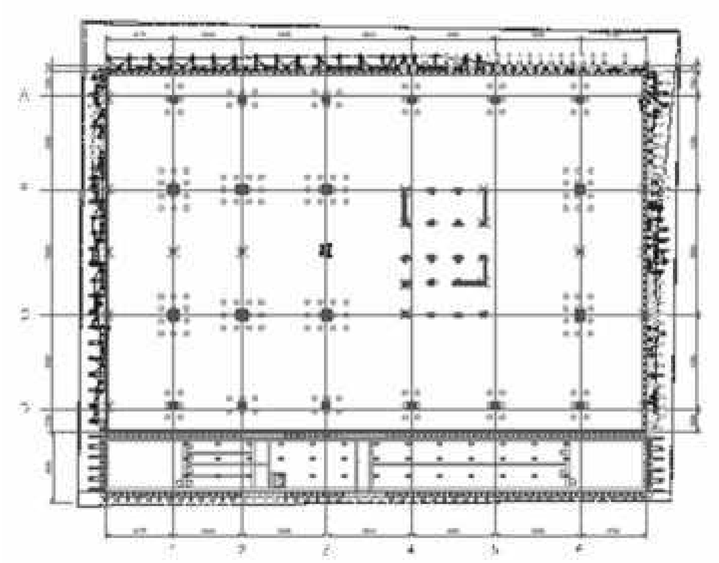

Fig. 1 The actual lay out of installed piles

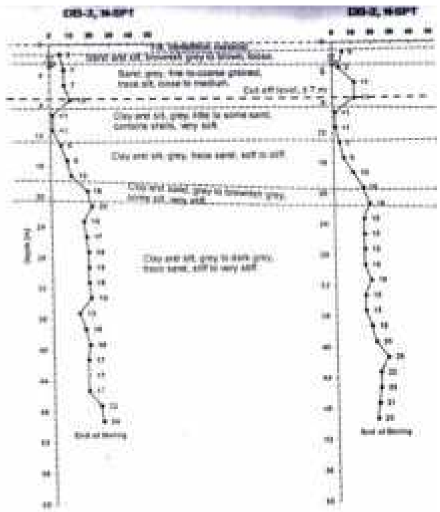

Fig. 2 SPT results

SOIL PARAMETER AND GEOMETRY

3.2 m excavation of the whole area would induce very large lateral displacement that causes serious problems to the neighborhood existing buildings. The excavation stages then turned from the whole area to local excavation. At the first stage, 1 m depth excavation was conducted to the whole area. It was followed by 0.5 m excavation in the middle with average distance of 7 m from the soldier pile wall. The rest of excavation to 3.2 m depth was carried locally for each pile cap sequentially. The next pile cap excavation had been conducted after the previous pile cap casting finished. To be noticed, the sheet pile wall was installed prior the excavation process. The detail layout of the excavation is demonstrated at Fig. 3. Since the analysis was in 2D condition, 5 cross sections were chosen in which 3 of them were in vertical direction and the rest were in horizontal direction. This paper presents only a cross section of each direction (P1 and L2).

Table 1 Soil parameters.

Parameter	Fill soil	Silty clay 1	Sand	Clay 1	Clay 2	Silty clay 2
γ_{unsat} (kN/m^3)	17	16.3	18.5	15.1	16.8	17.5
γ_{sat} (kN/m^3)	18	17	19	16	18	19
E' (kN/m^2)	10E3	15E3	15E3	2500	20E3	25E3
ν	0.3	0.2	0.3	0.2	0.2	0.2
c' (kN/m^2)	5	20	7	17	47	30
φ (^{o})	30	15	33	1	9	10

The simulation of the excavation was utilized commercial finite element software named PLAXIS 2D 2011. The model geometry developed for the simulation can be seen in Fig. 4. It had 6 soil layers. Each soil layer parameters can be checked in Table 1. The model utilized in this simulation was Mohr-Coulomb. The model was chosen due to the soil data availability. Meanwhile, for dewatering and consolidation analysis, the soil permeability was chosen based on the grain size distribution classification available in PLAXIS.

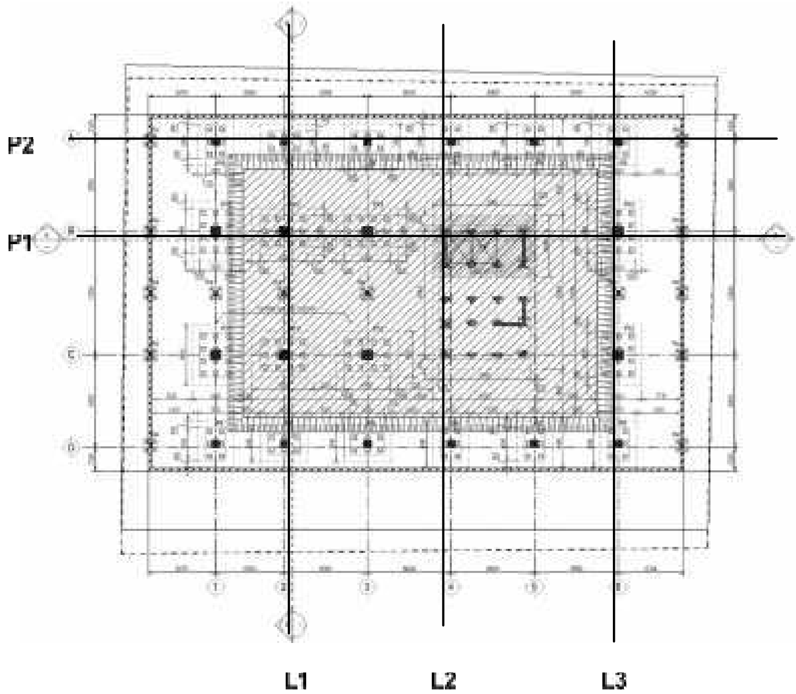

Fig. 3 Excavation layout and the cross section lines

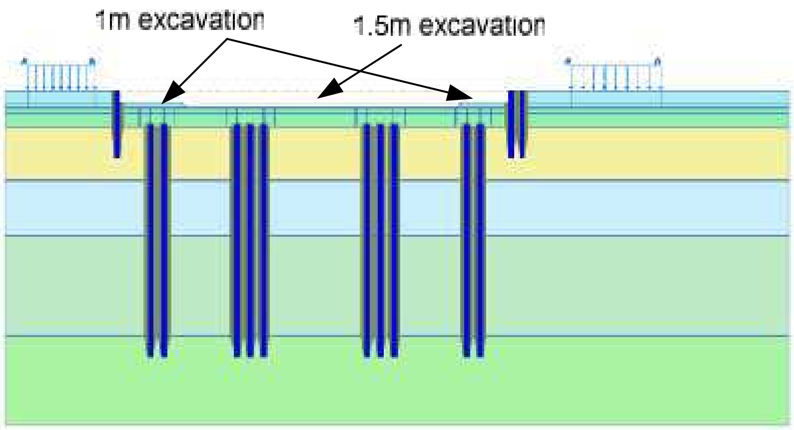

Fig. 4 Illustration of the excavation stages

SIMULATION RESULTS

Cross section P1

The cross section P1 passed 4 pile caps and the lift (Fig. 5). The lift was excavated to 4.65 m depth. Braced supports were installed at soldier piles, the edge cap and lift excavation. The critical exaction was the lift one. 2 braced supports were required to stabilize the excavation. The maximum displacement induced was 6.7 mm occurred on the top of the lift excavation (Fig. 7). The safety factor during excavation was 2.7 (Fig. 6). Interesting result is shown in Fig. 8. It shows that displacement occurred both in the excavation wall and floor. The sheet pile wall should be long enough to reduce the displacement below the bottom of the excavation. The main result associated to the building near the excavation was the deformation of the building. It was about 3.5 mm for the 3 stories building.

Fig. 5 The geometry model of cross section P1

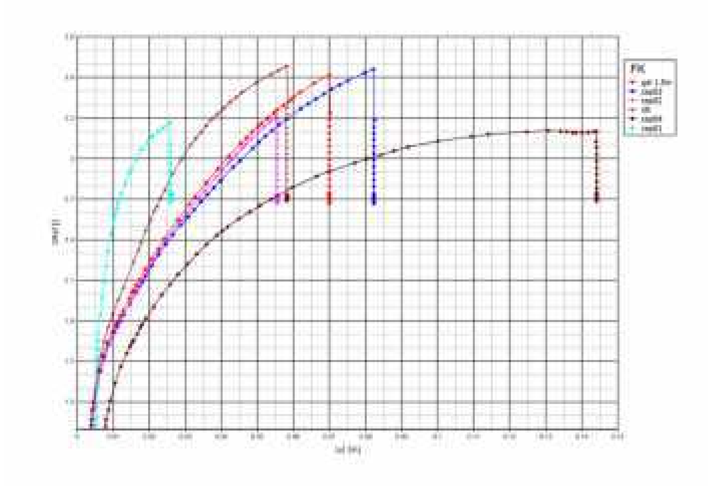

Fig. 6 Safety factor for each excavation stage

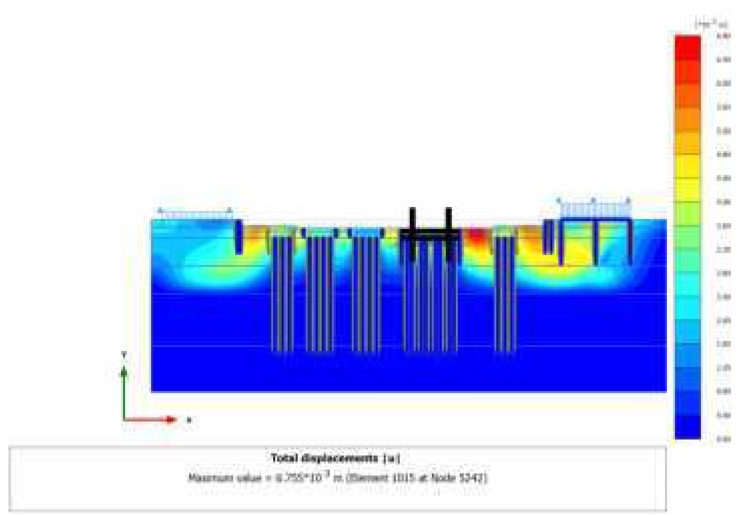

Fig. 7 Displacement distribution for lift excavation

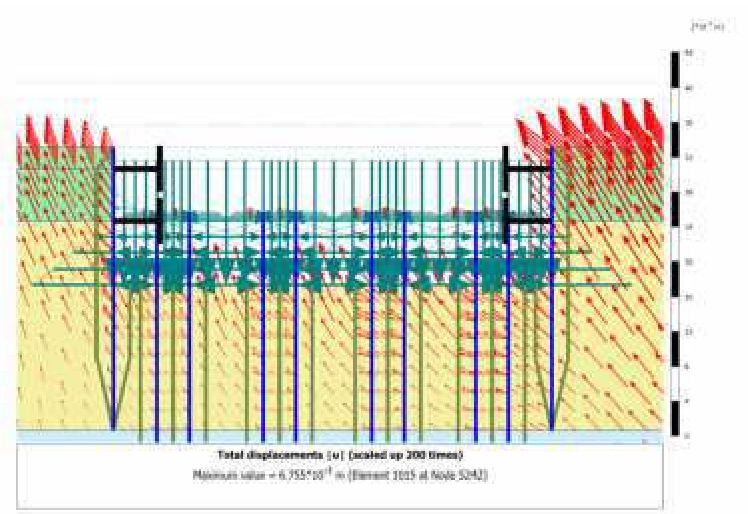

Fig. 8 displacement direction around the lift excation

Cross Section P2

Cross section P2 was important since it was a 2 stories surgery room of the hospital next to the project. Small deformation only should be tolerated during the excavation. The safety factor reached during excavation was 2.4 (Fig. 10). Meanwhile the maximum deformation occurred at the hospital was 2.4 mm (Fig. 9). The results were tolerable to keep the hospital building stable.

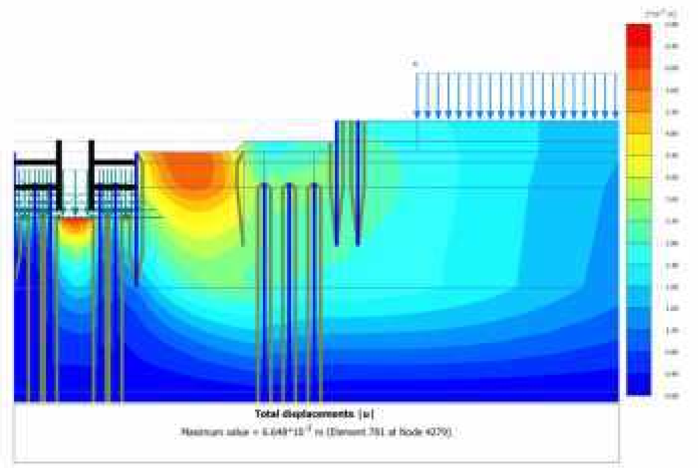

Fig. 9 Geometry model of cross section L2

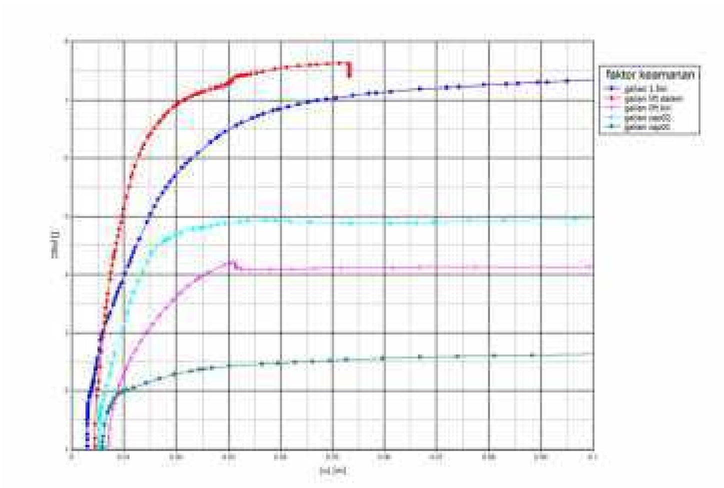

Fig. 10 Safety factors for each excavation stage of P2

CONCLUSION

An evaluation of excavation next to the existing building was conducted. The numerical simulation showed that local excavation stage yield small deformation to the neighborhood building. The deformation occurred at adjacent building was less than 5 mm.

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