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Case study on deep excavation works by soil nailing on adjacent building

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ABSTRACT: It was done the introduction that it was easy for an on-site example and the Korean ground where deep excavation was carried out in the place that was near to a building in Korea. And, it introduced the pre-soil nailing method executed to control the deformation of the retaining wall. Deformation control of the retaining wall of this pre-soil nailing method was able to be confirmed. The forecast of the wall deformation by the back-analysis method of using the measurement is executed by using FEM and while excavation. As a result, the prediction method was very effective.

1 INTRODUCTIONS

Soil nailing is a typical in-situ reinforcement method used for a wide variety of construction applications, such as, stabilization of cut slopes and excavation retaining walls(Juran & Elias 1991, Hanna, Juran, Levy & Benslimane 1998). By the way, in major big cities of the world, many kinds of infrastructures have been highly developed. Therefore, it is very important to predict the deformation behavior of ground due to the excavation work and to estimate the effect of ground deformation on the neighboring structures. Therefore, this paper tries to introduce the example of constructing about 35㎙ in underground excavation depth by using soil nailing and the ground anchor in Seoul Korea. Digging up 35 m in the underground is that a lot of the construction cases are rare in Seoul Korea by using soil nailing either. Various earth retaining wall methods were applied in this construction and there was a building that was very adjacent and, on the other hand, a variety of reinforcement methods were executed. The steel pipe grouting is executed from the center of the earth retaining wall by the industrial method to reinforce the lower side of an existing building and the ground has been improved. The pre-nailing method was executed, and moreover, the deformation of the earth retaining wall was controlled, and, as a result, the pre-nailing method that controlled the settlement of an existing building was executed. And, because the back analysis is executed when under construction and the forecast in the future was executed compared with the measurement result, it tries to introduce this. Finally, it tries to introduce the risk management method that executes it from the first stage of construction. This risk management method is a new risk management technology while using it making it in Samsung Corporation.

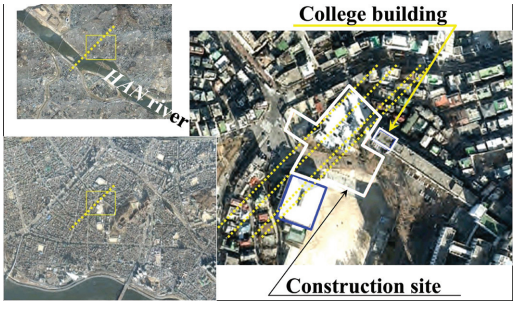

Photo 1. Aerial photograph of site.

2 OUTLINE OF CONSTRUCTION

2.1 *Outline of site*

This site is situated in South Korea Seoul, and an architectural scale is the 16th floor on the ground, and the sixth floor in the underground. And the excavation area is about 94,508 m^2, and the maximum underground excavation depth is about GL-34 m. A building and a gymnasium and a private house approach the excavation site circumference. Figure 1 shows a site circumference.

The constitution of the ground is 0～3 m fill, 3～12 m residual soil, 12～19 m weathered rock, 19～20 m weak rock, 20～35 m hard rock. The initial water level is under the ground in the weathered rock neighborhood.

In addition, a CIP+E/A method is applied to the method of the retaining wall. However, a strut method was applied for the section (college building south side section) that difficulty was expected for execution by interference when that executed the work in E/A. In addition, a S/N method of construction was applied for

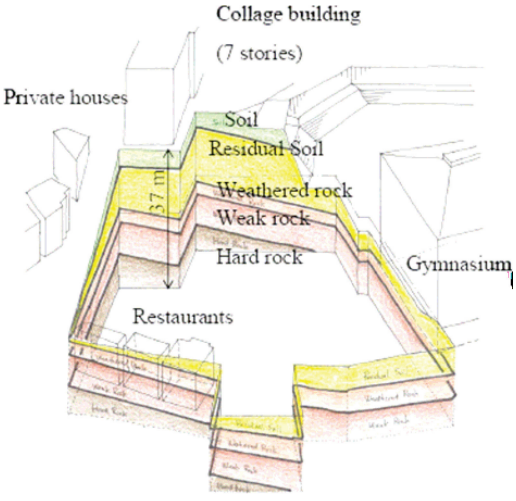

Figure 1. Excavation area and Geological profile.

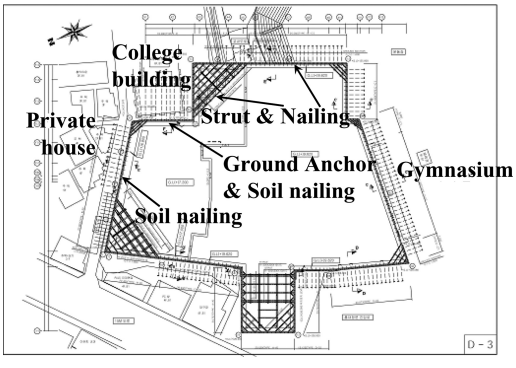

Figure 2. Support method of the excavation plane.

the part section (residential area part section) that was not able to obtain the outskirts's consent in E/A execution. CIP was carried out for weathered soil section. It was applied H-pile + shotcrete for the bedrock section. Figure 2 shows the support method of the excavation plane.

2.2 *Outline of measurement*

The setting position of the measure was shown in figure 3. In this site, a excavation section is very complicated. In addition, this site where excavation depth is very deep, and an adjacent building approaches it, and it is executed the work very hard. Therefore, it was judged deformation measurement of the back ground and that the deformation measurement of the adjacent structure was very important. Inclinometer, piezometer, tiltmeter, crack gage, settlement gage is installed around an adjacent building. In addition, multi-cell liquid settlement systems was installed for the

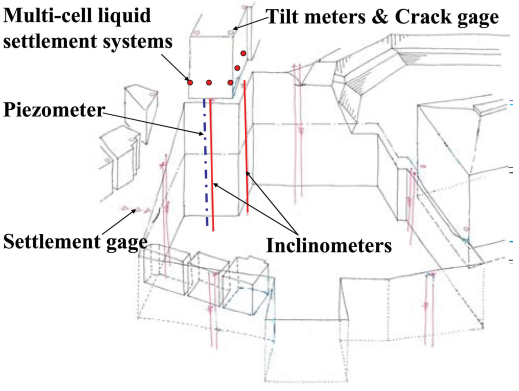

Figure 3. Setting position of the measure.

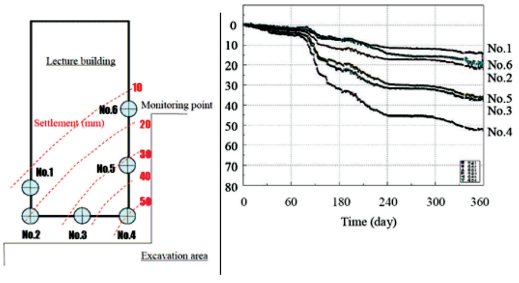

Figure 4. Measurement position and actual settlement.

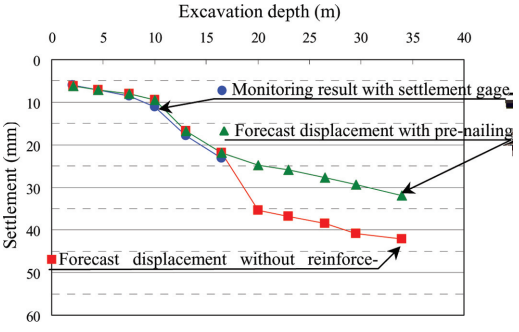

Figure 5. Expected settlement of the building.

college building and precision was high and measured the settlement of the building.

2.3 *Result of monitoring*

Figure 4 show the actual settlement at the collage building in Figure 1 during deep excavation.

Figure 5 showed relations between excavation depth and the settlement of the college building.

Figure 5 estimated quantity of settlement of the college building occurred by the deformation of the retaining wall by the back analysis method. An analysis

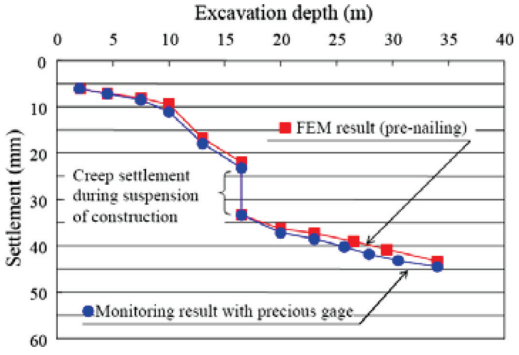

Figure 6. Calculated settlement and actual settlement.

result, it was estimated that quantity of settlement of a building exceeded about 40 mm to last excavation. Deformation when it applied pre-soil nailing to restrain settlement of the building was estimated together. As a result, when it applied a pre-soil nailing method of construction, quantity of expected settlement was estimated by it being occurred to about around 10 mm small. Therefore, it was applied a pre-soil nailing method of construction.

Figure 6 shows volume of deformation and the relations of the real volume of deformation predicted during excavation. Quantity of expected settlement accords with quantity of real occurred settlement well. Therefore, expectation by the back analysis mothod that used volume of deformation occurred during excavation is very effective.

3 CONSTRUCTION METHOD

3.1 *Pre-soil nailing method*

As a result of having expected the displacement of the wall, because the inequality settlement of the college building exceeded a creterion, it was judged that excavation was performed by an existing method, and a pre-soil nailing method was applied. The concept of pre-soil nailing showed in figures 7 and 8. A Pre-soil nailing method is a method to minimize liberation from stress by the excavation. It is a method to minimize the deformation of the wall body by it leave soil before excavation and restrain the deformation of the wall by the liberation from stress, and executing the work in nailing.

Photo 2 shows the construction of pre-soil nailing in site.

3.2 *Steel pipe reinforcement*

Photo 3 is a scene reinforcing the building retainer by a steel pipe grouting method of construction from the wall for the settlement restraint of the building.

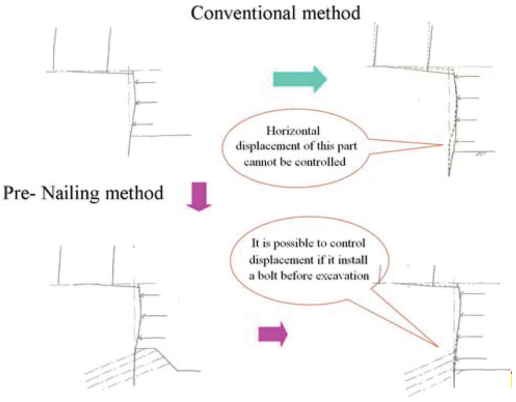

Figure 7. Conventional method and pre-soil nailing.

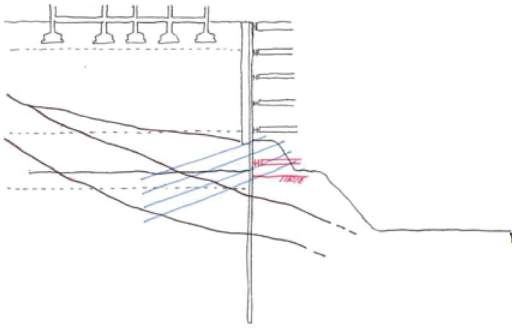

Figure 8. Concept of pre-soil nailing.

Photo 2. Construction of pre-soil nailing.

As for the grouting, the deformation of the wall body and the possibility that the deformation that it cannot expect occurred of the building is expected and reinforced it with minimum pressure and quantity of injection. Therefore, it managed 5 kg/cm^2 with

Photo 3. Reinforcement of building foundation.

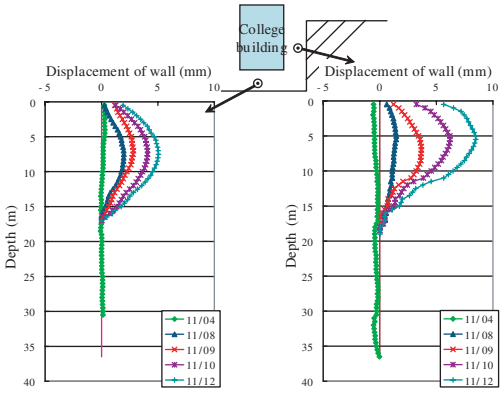

Figure 9. Wall displacement during steel pipe grouting.

injection pressure and volume of injection with 3% of ground.

Figure 9 shows the displacement of the retaining wall at steel pipe grouting. Wall body displacement of about 5 ~ 8 mm occurred by pressure at the time of the grouting additionally around a grouting position. In addition, it was shown because the displacement that almost resembled the displacement that was expected before steel pipe grouting reinforced it according to upper figure 6 occurred. Therefore, as for steel pipe reinforcement to restrain the settlement of the existing building which there was on the back of the wall, the deformation of the wall body was increased with outbreak of the creep deformation by the perforation of the structure lower part, and effect of the reinforcement was confirmed in the thing that was not so big.

4 CONCLUSION

This article analyzed the excavation method that was appropriate in excavation through in-situ measurement and numerical analysis in an object in the site that did a building and very neighboring excavation, a reinforcement method. When it arranges the result, it seems to be next.

(1) It introduced the ground in South Korea with the case with the site where it touched the building in South Korea and a deep excavation had been executed.
(2) The FEM analysis that used a measurement result to predict the deformation of the retaining wall was carried out. The predicted value by the back analysis method that used measurement data was able to confirm that it was effective in reliability improvement.
(3) Steel pipe reinforcement was carried out to restrain the settlement of the back existing structure of the retaining wall. However, the deformation of the wall was increased with outbreak of the creep deformation by the perforation of the lower part of the structure. Therefore, the effect of the reinforcement was confirmed in the thing that was not so big.
(4) Pre-nailing method of construction was carried out to decrease the displacement of the retaining wall and displacement of the back ground by it in digging as much as possible. As a result, a pre-nailing method of construction was able to confirm that a displacement restraint effect was good.

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