A Case Study of Micropiling in the Urban Environmen

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Jung-Hoon Lee, Ki-Hwan Lee, Hyun Cho(SsangYong Eng. & Const.)
Jaehyeung Jeoung, Changho Choi (KICT)

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Apartment Remodeling Overview

Apartment Remodeling Overview

Overview

- Location : South of Han-River, Seoul, Korea
- Reinforced Concrete Structure
- 3 stand alone buildings
- 12 story buildings
- 27 years old buildings
- 216 housing units in total
- Remodeling work of 18 months

Aeroview of Apartment Complex

Apartment Remodeling Overview

Overview

This site was the first project in South Korea where this type of renovation was permitted by the community and local government.

In this renewed complex, the construction works consisted of

- apartment interior spaces expanded horizontally to provide more residential space -> application 1
- new basement parking lots built below existing gardening areas with elevators linked to them -> application 2
- And, the interior for each unit was modernized. Gardens and the existing building frames were left untouched.

Micropile Design

Micropile Design

Design Guidelines

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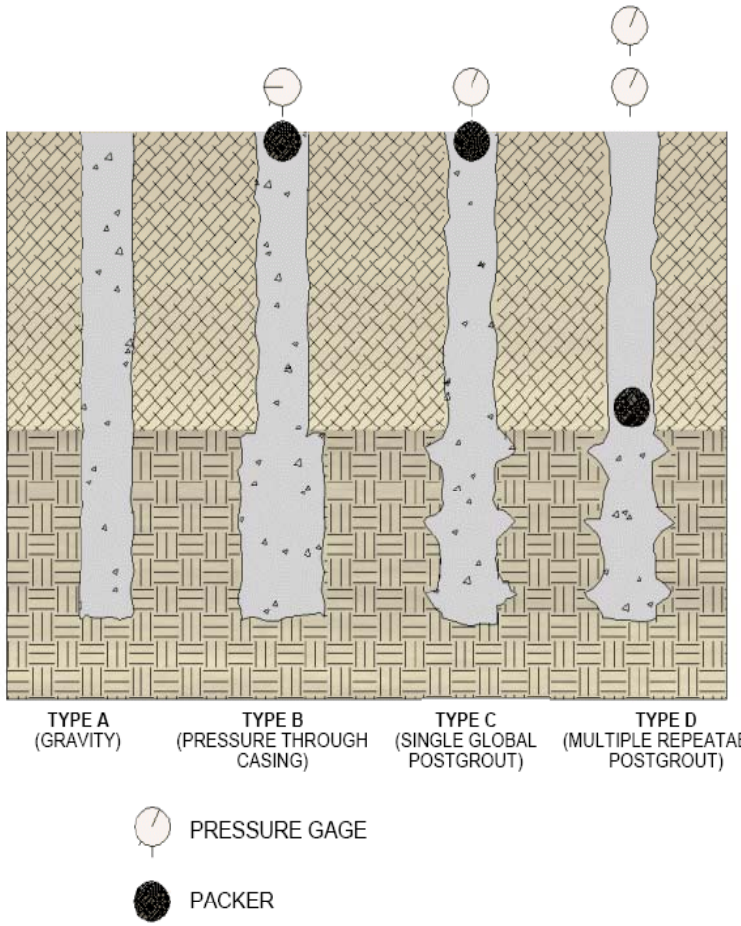
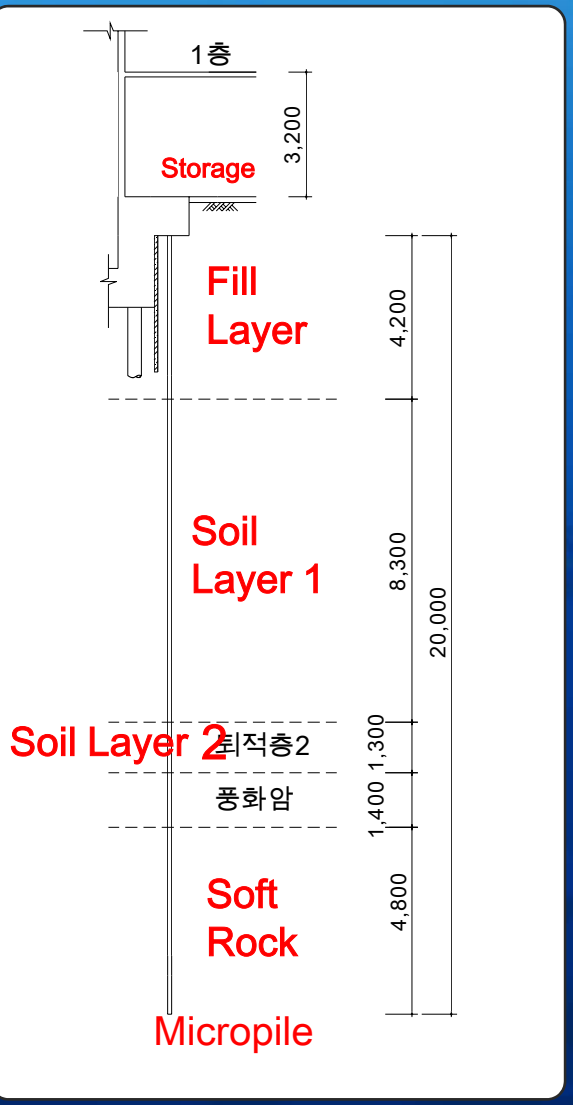


Soil / Rock Description	Typical Range of Grout-to-Ground Bond Nominal Strengths (kPa)			
	Type A	Type B	Type C	Type D
Silt & Clay (some sand) (soft, medium plastic)	35-70	35-95	50-120	50-145
Silt & Clay (some sand) (stiff, dense to very dense)	50-120	70-190	95-190	95-190
Sand (some silt) (fine, loose-medium dense)	70-145	70-190	95-190	95- 240
Sand (some silt, gravel) (fine-coarse, med.-very dense)	95-215	120-360	145-360	145-385
Gravel (some sand) (medium-very dense)	95-265	120-360	145-360	145-385
Glacial Till (silt, sand, gravel) (medium-very dense, cemented)	95-190	95-310	120-310	120-335
Soft Shales (fresh-moderate fracturing, little to no weathering)	205-550	N/A	N/A	N/A
Slates and Hard Shales (fresh-moderate fracturing, little to no weathering)	515-1,380	N/A	N/A	N/A
Limestone (fresh-moderate fracturing, little to no weathering)	1,035-2,070	N/A	N/A	N/A
Sandstone (fresh-moderate fracturing, little to no weathering)	520-1,725	N/A	N/A	N/A
Granite and Basalt (fresh-moderate fracturing, little to no weathering)	1,380-4,200	N/A	N/A	N/A

Type A - Gravity grout only
Type B - Pressure grouted through the casing during casing withdrawal
Type C - Primary grout placed under gravity head, then one phase of secondary "global" pressure grouting
Type D - Primary grout placed under gravity head, then one or more phases of secondary "global" pressure grouting

Micropile Design

Profile



Ground Layers

	N Value	Remarks
Fill Layer	6~7	silty sand with gravel
Soil Layer 1	8~19	silty clay
Soil Layer 2	50	gravel with middle size sand
Weathered Rock	50	piece of rock with sand
Soft Rock		biotite schist

Dimension of Micropile

Dia.	Length	Grout	Thread Bar
ϕ105mm	20.0 m	$f_{c\text{-}grout}$ = 24 MPa	ϕ50mm×1EA $f_{y\text{-}bar}$ = 400 MPa

Design Load and Capacity of Micropile

Allowable compression load for uncased length	Allowable geotechnical bond capacity	Design load
752 kN	636 kN	600 kN

Application 1: Footing Expansion

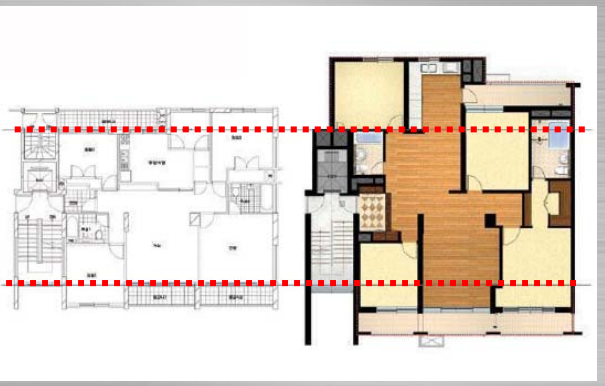
Footing Expansion

Remodeling Work

- new basement parking lots built below existing gardening areas with elevators linked to them
  apartment interior spaces expanded horizontally to provide more residential space
- the interior for each unit was modernized
-

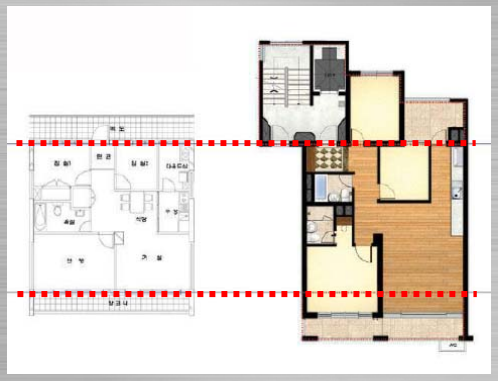
Apartment spaces expanded horizontally

Building 1



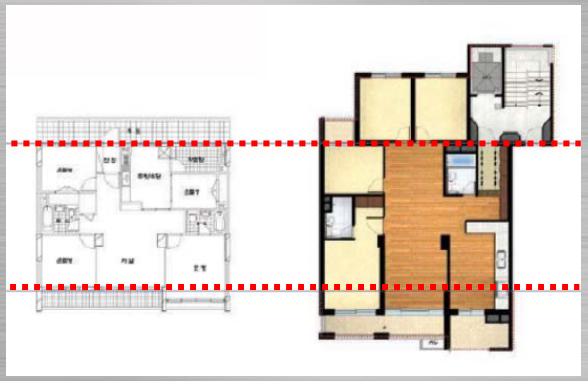
Before (139 m^2) After (175 m^2)

Building 2



Before (93 m^2) After (116 m^2)

Building 3



Before (119 m^2) After (145 m^2)

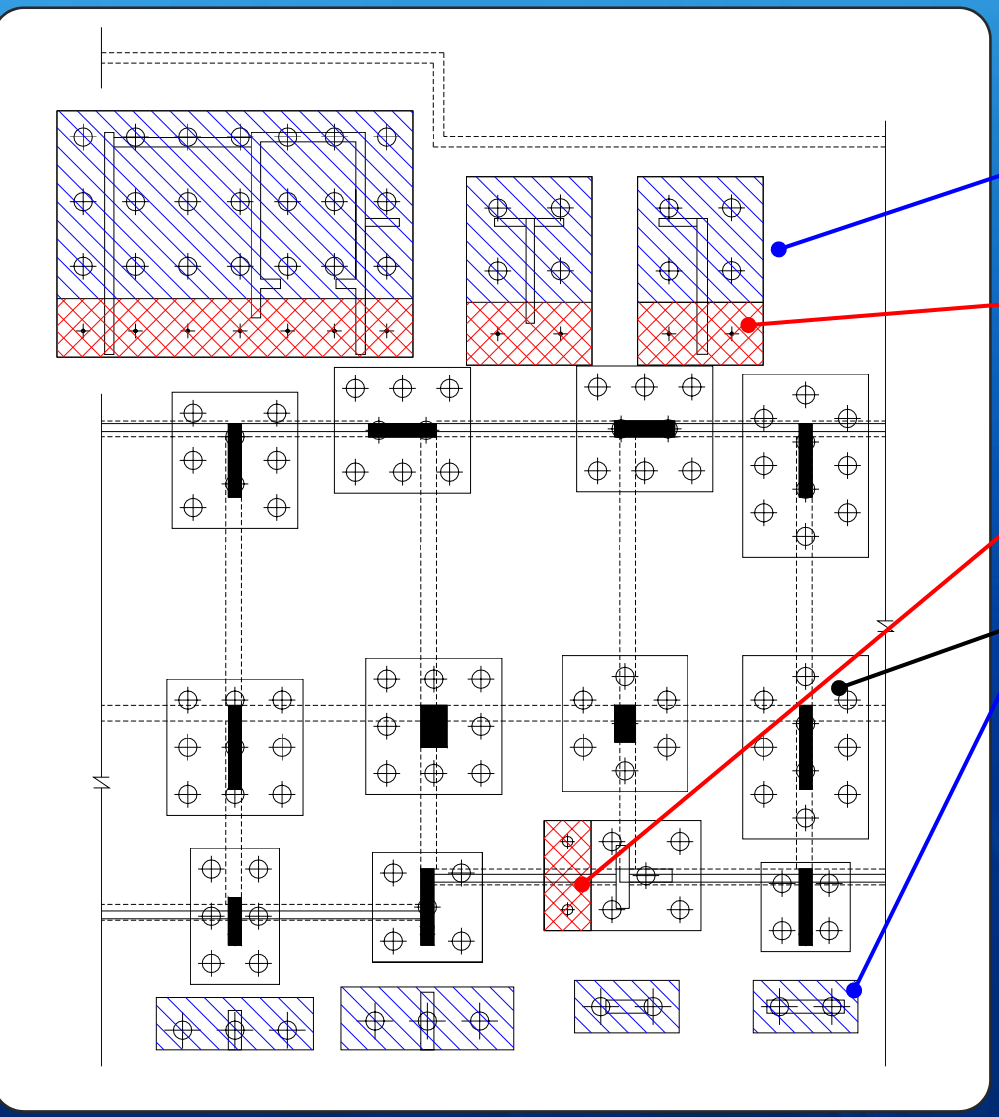
Footing Expansion

Horizontal Expansion of Space

Panoramic View after Remodeling

Footing Expansion

Apartment Unit Foundation Plan (the case of Building 3)



New Foundation
PHC PILE(ϕ400, 700 kN)

New Foundation
(MICROPILE)

Existing Foundation
PC PILE(ϕ350, 400kN)

Where physical and operational imitations did not preclude micropile, PHC piling method was chosen to meet the superstructure loading requirements while limiting the total foundation cost.

Footing Expansion

Apartment Unit Foundation Plan (the case of Building 3)

Application 2: Elevator PIT Extension

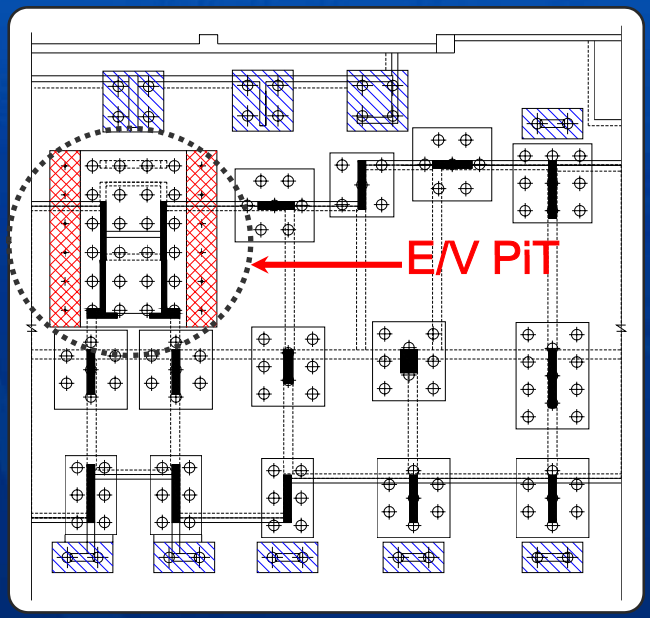
Eelevator PIT Extension

Outlines

- To connect new basement parking area and Building 1, **the elevators were extended downward with** excavation of the bottom of existing foundation.

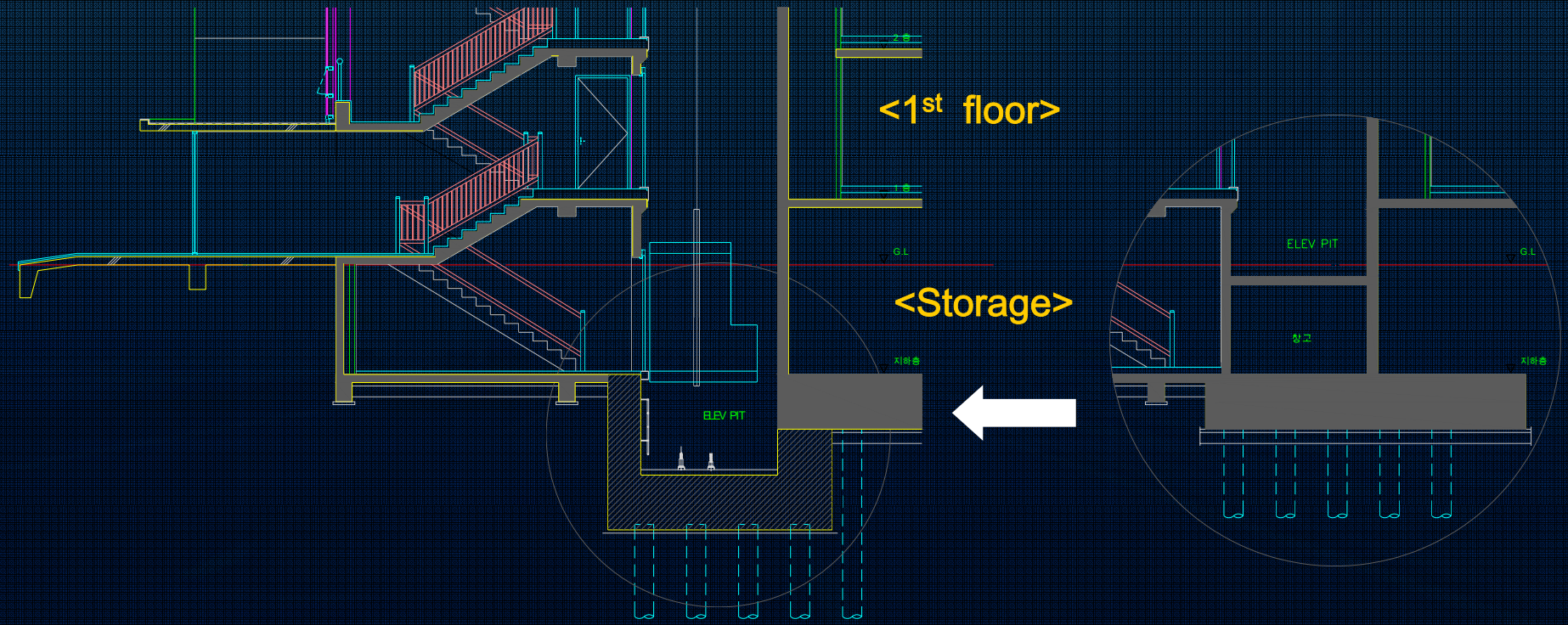
Construction of Basement Parking Area

Plan View (Building 1)



Eelevator PIT Extension

Building 1

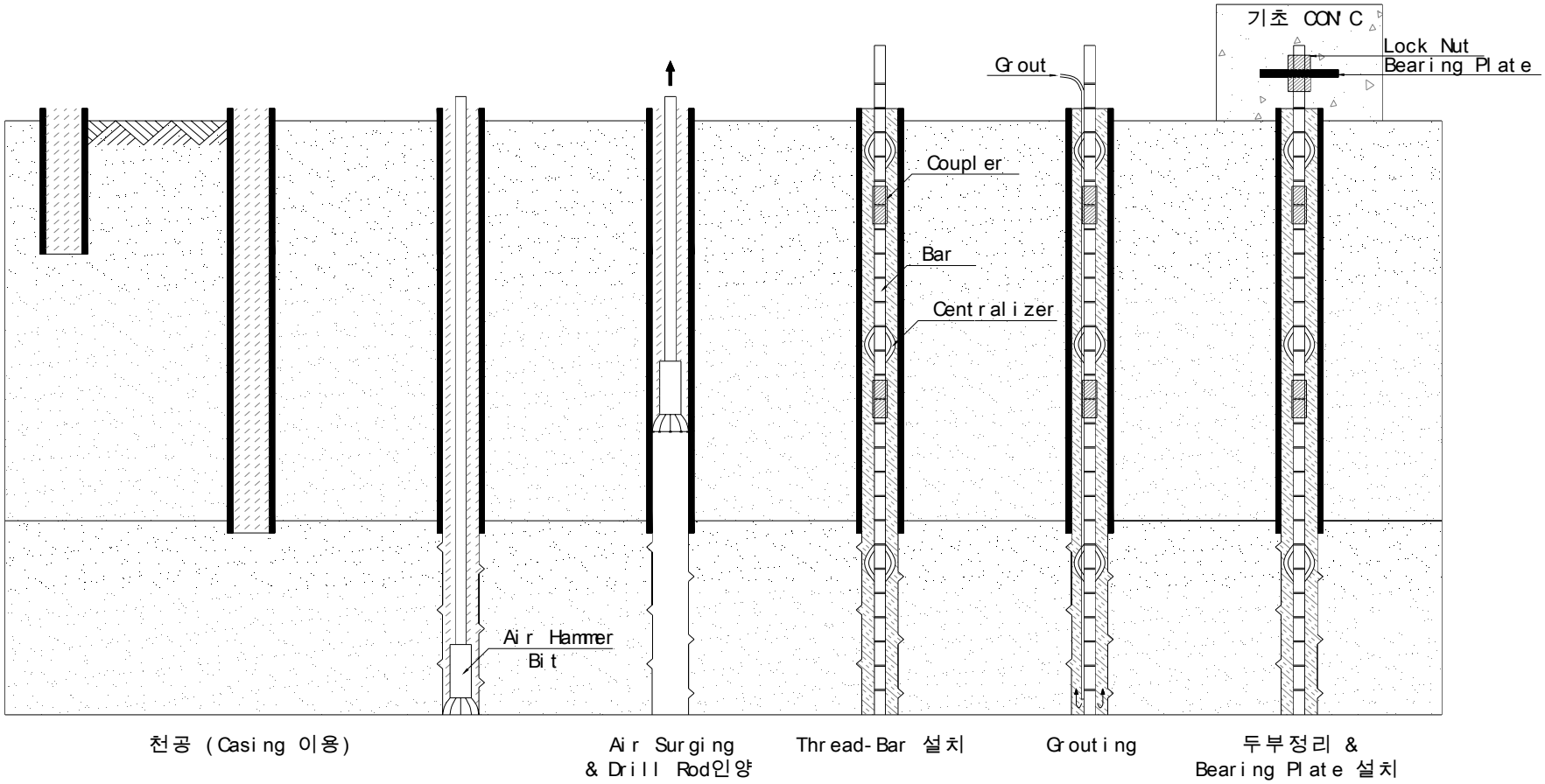


E/V PIT Extension

Before Extension

Construction Sequence of Eelevator PIT Extension

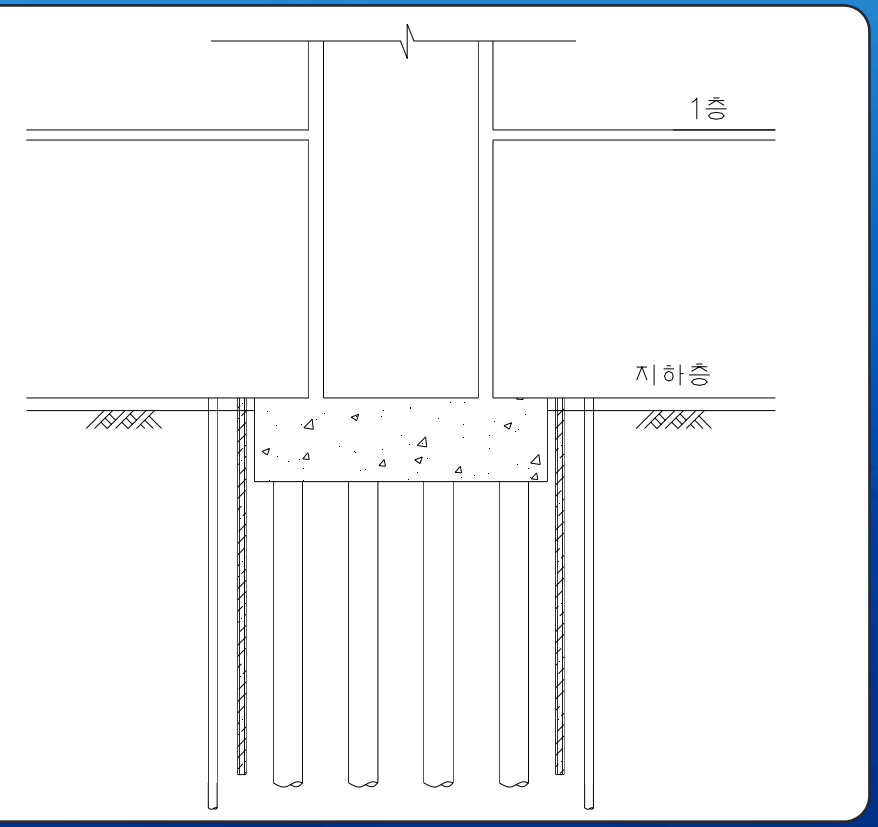
Step 1 : Micropile installation



Micropiles were installed by the side of existing foundation.
The hole was drilled using air hammer bit and air surging.
After installation of thread steel bar, the hole was filled with grout.

Construction Sequence of Eelevator PIT Extension

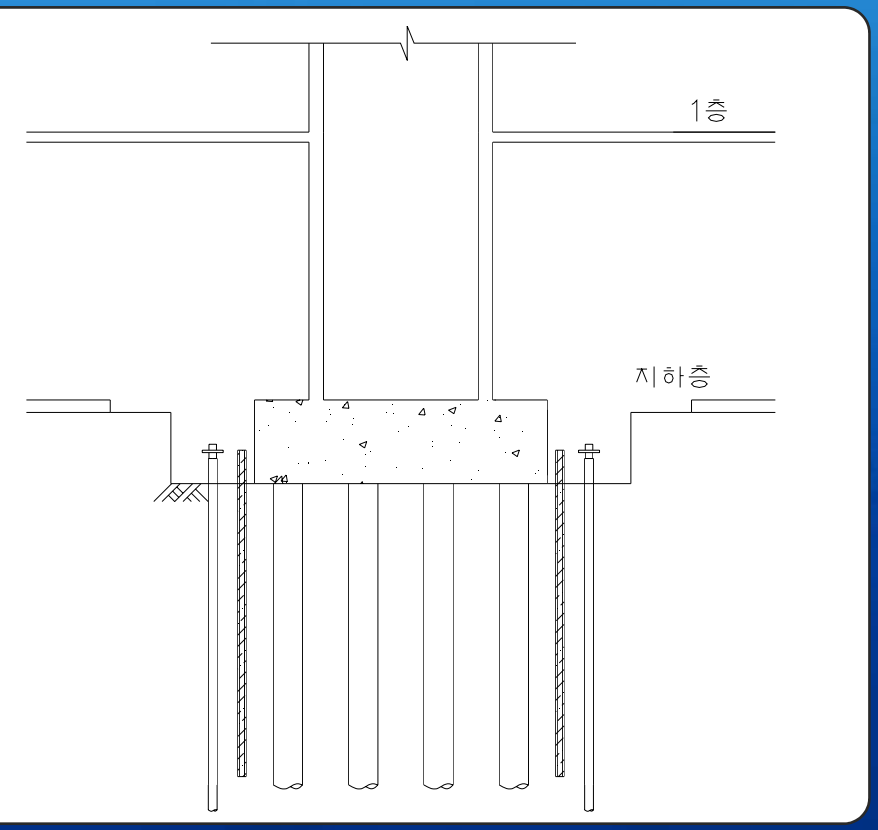
Step 2 : Shoring Installation



Shoring were installed to retain the side earth pressure due to the excavation of existing footing.

Construction Sequence of Eelevator PIT Extension

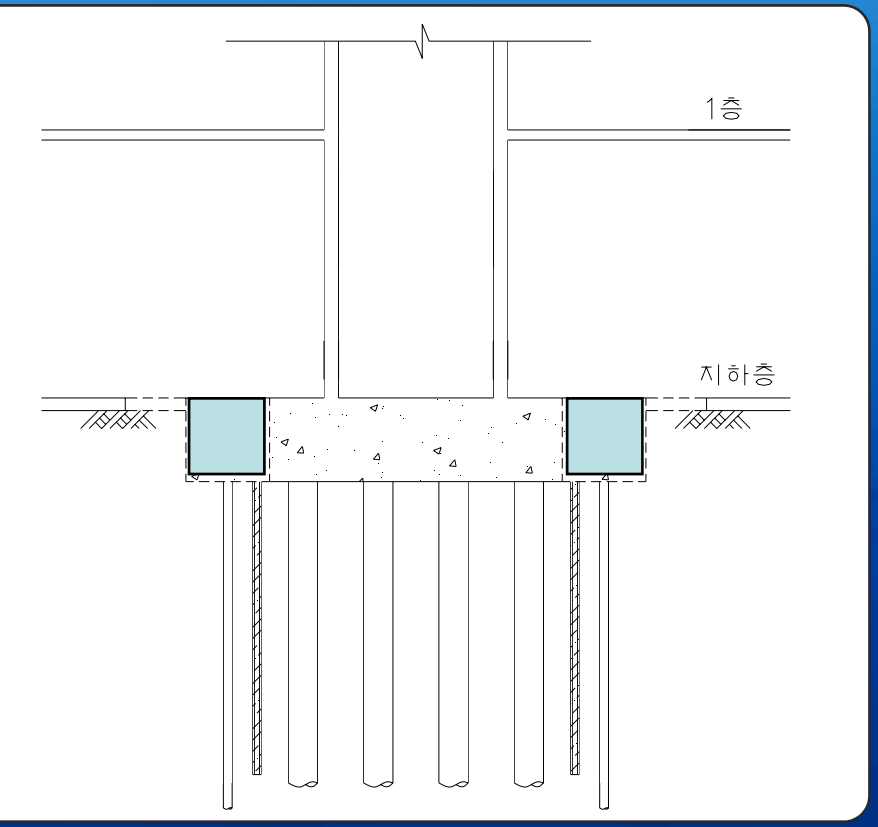
Step 3 : Micropile Bearing Plate Installation



Micropile Bearing Plate was installed for making new foundation.

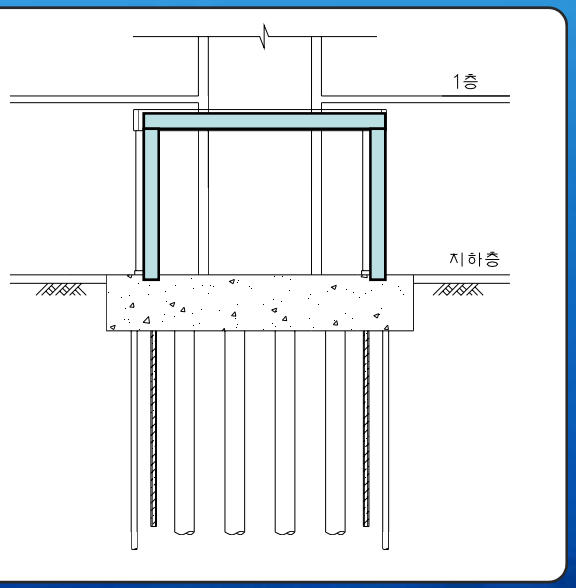
Construction Sequence of Eelevator PIT Extension

Step 4 : Construction of New Footings



Construction Sequence of Eelevator PIT Extension

Step 5 : Temporary Steel Frames were installed using new foundation.

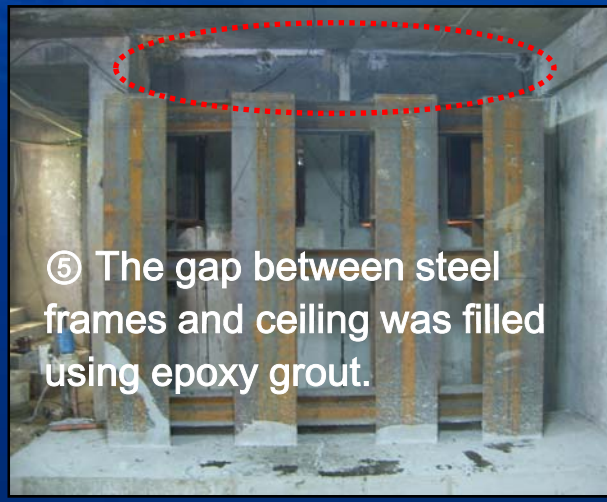



① open the hole for temporary steel frame


② Steel Frame was installed

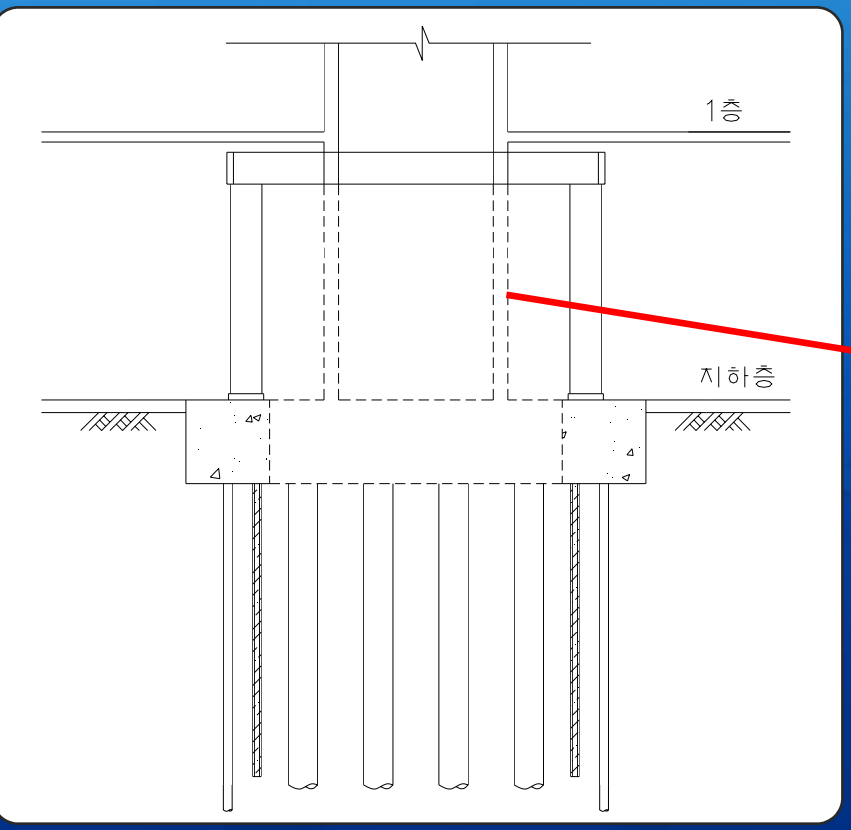

③ Bottom of steel frames was fixed by bolts.

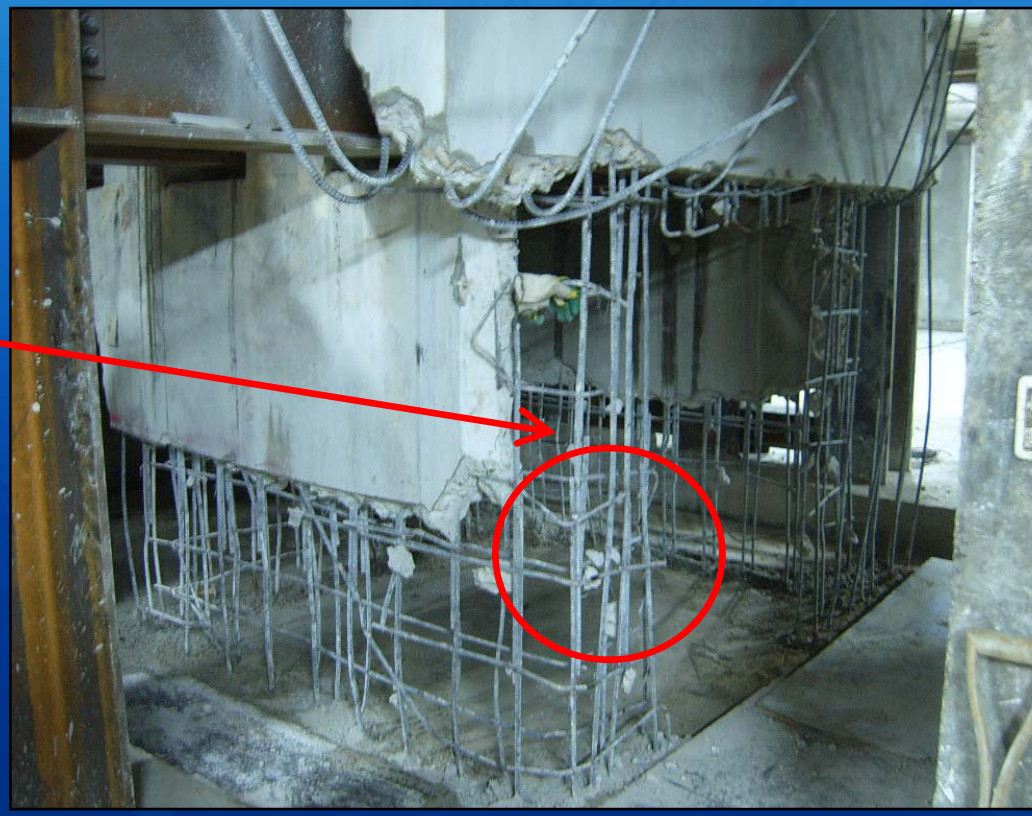

④ Bottom of steel frames was reinforced by concrete.


⑤ The gap between steel frames and ceiling was filled using epoxy grout.

Construction Sequence of Eelevator PIT Extension

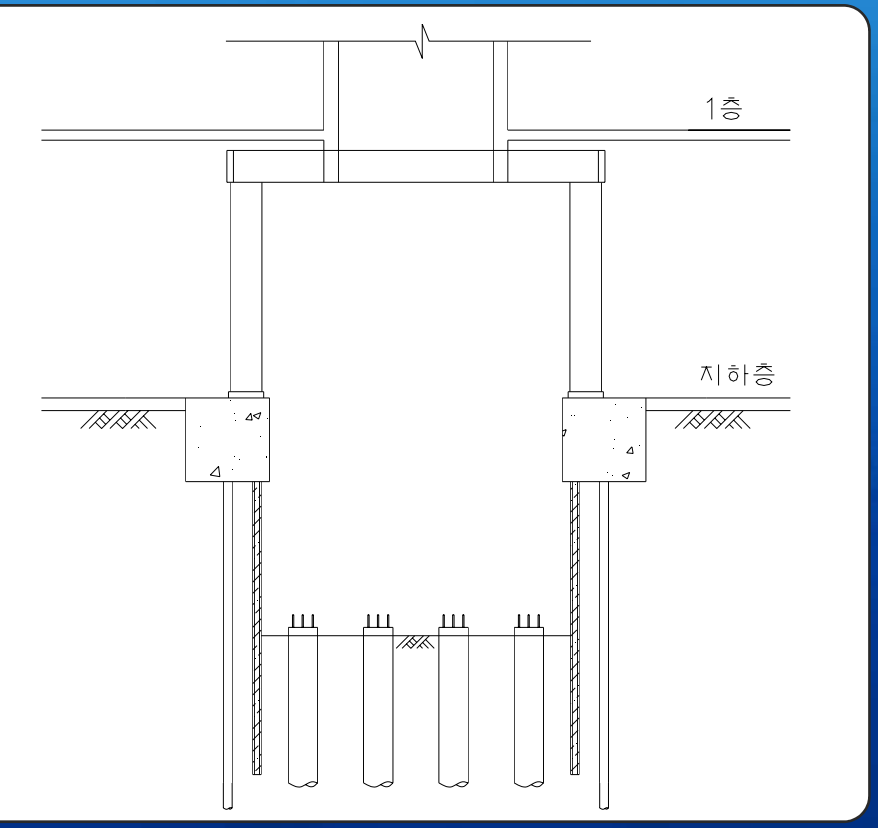
Step 6 : Remove Existing Shaft Walls and Footing





Construction Sequence of Eelevator PIT Extension

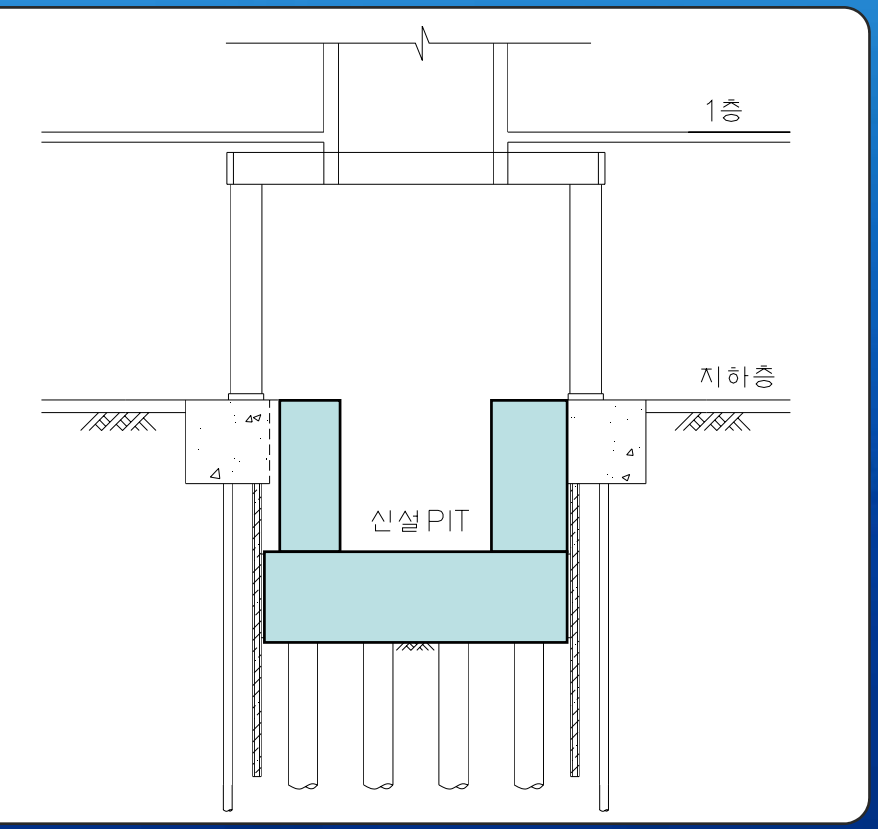
Step 7 : Excavation and Removal of Existing PC pile



Existing PC piles were removed for making the space of elevator PIT.

Construction Sequence of Eelevator PIT Extension

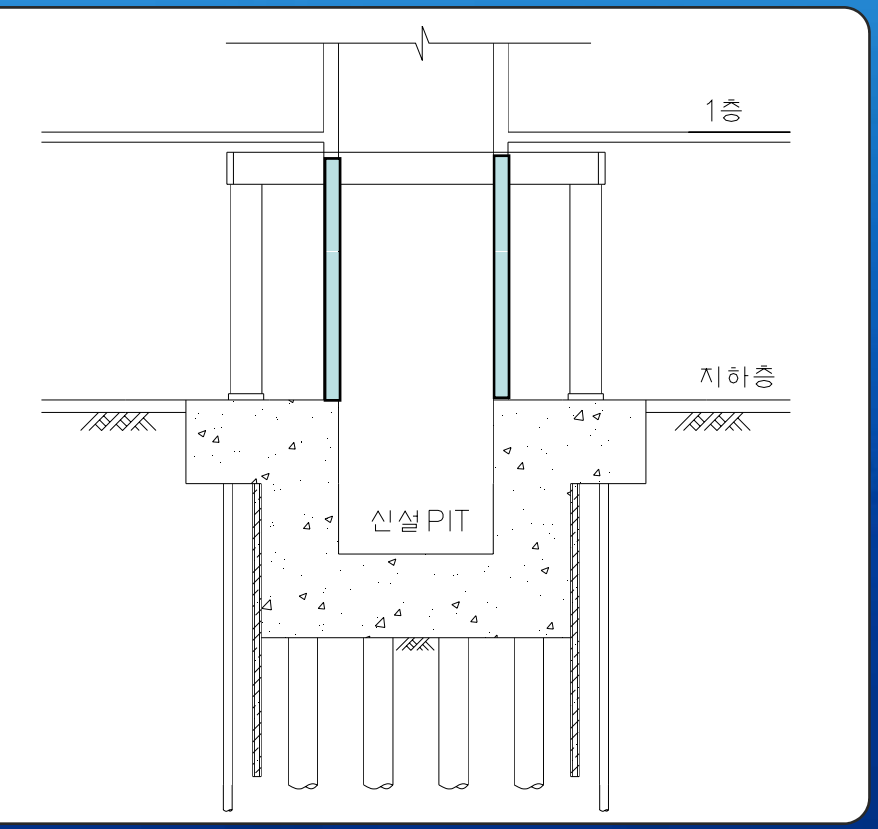
Step 8 : Construction of New PIT Wall



New PIT wall was constructed.

Construction Sequence of Eelevator PIT Extension

Step 9 : Construction of New Shaft Wall



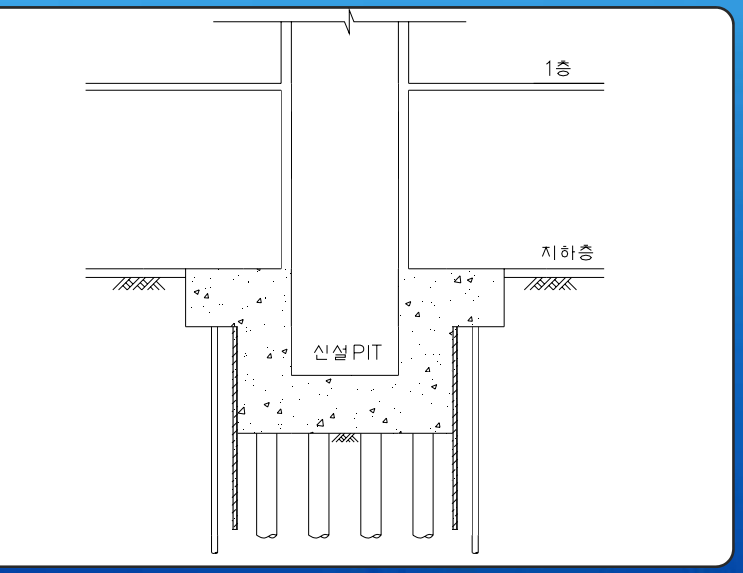
New Shaft wall was constructed by assembling steel mold and filling concrete.

① Assembling Steel Mold

② Filling Concrete

Construction Sequence of Eelevator PIT Extension

Step 10 : Remove Steel Frame



New shaft wall

Conclusions

Concluding Remarks

Site specific technical challenges with related to micropile application were presented in this paper for Bangbae-Gungeon apartment remodeling project. Several concluding remarks are as below.

1) The expansion of residential space and the corresponding increase of house price might provide to a good reason preceding the project.

2) Micropiles provided a constructible technique for retrofitting the existing structures at this site in locations where conventional foundation techniques were not applicable.

3) Micropiles in this application can have a highly beneficial effect on property value.

4) Micropiles enabled the retrofitting of this structure, serving the political interests of the local government and benefiting the local ecology through re-use in place of demolition and reconstruction.

Thank you
for your concentration