Experimental Study for Load Transfer Characteristics of Reinforcing Piles

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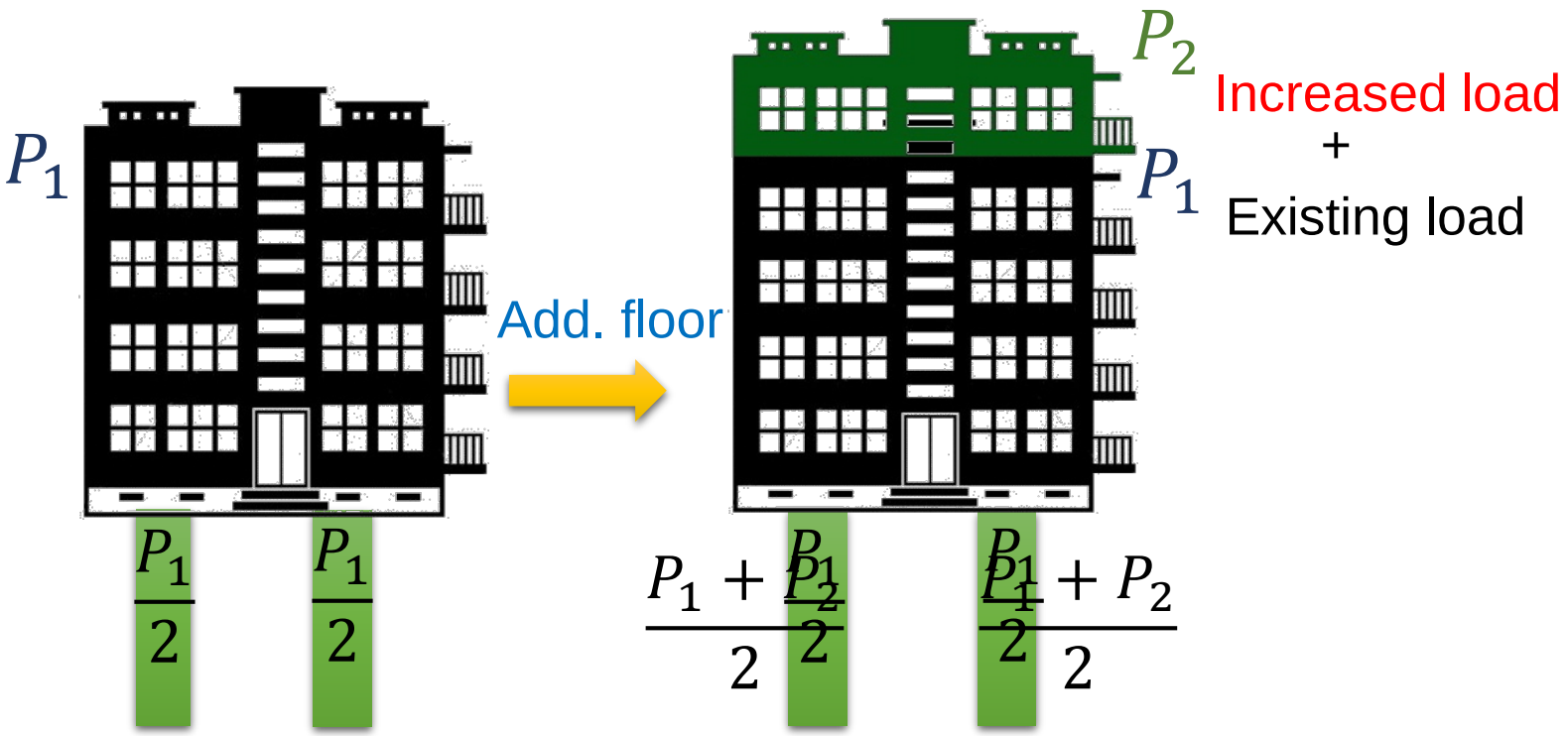
Introduction

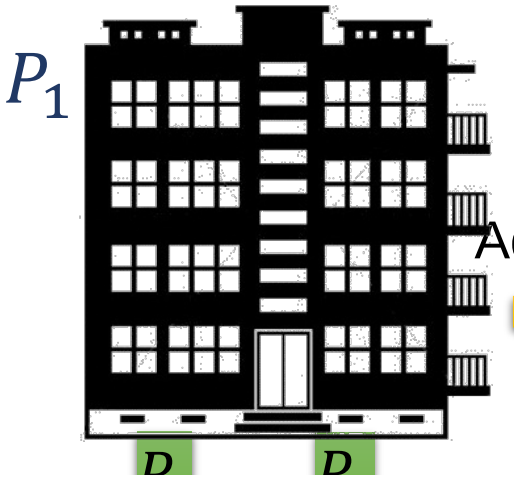
Existing Condo.



P_1+P_2 exceed the design bearing capacity of existing piles → Need additional piles

Introduction

Existing Condo.



Add. floor

Increased load
+
Existing load

Construction staged anaysis → $\frac{P_1}{2}+\frac{P_2}{3}$ $\frac{P_2}{3}$ or $\frac{P_1}{2}+\frac{P_2}{3}$

Conventional anaysis → $\frac{P_1+P_2}{3}$ $\frac{P_1+P_2}{3}$ $\frac{P_1+P_2}{3}$

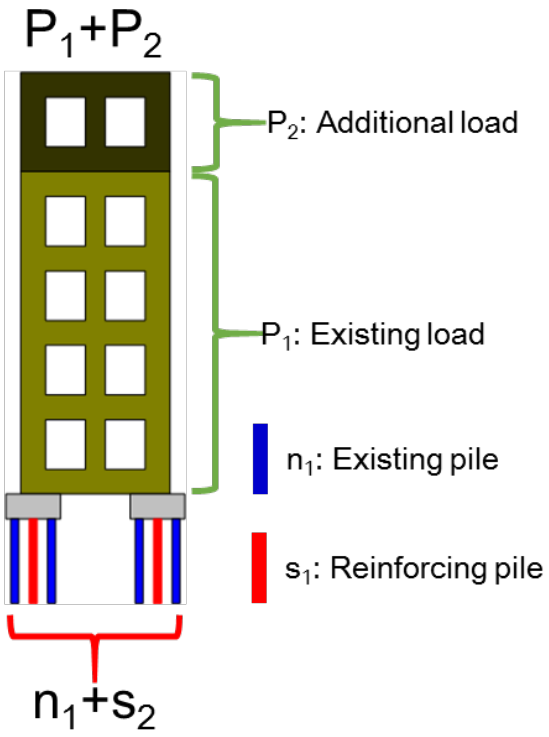
Load for existing piles might exceed their design bearing capacity with an amount of $P_2/3$.

Added pile can take the load of $P_2/3$???

Introduction

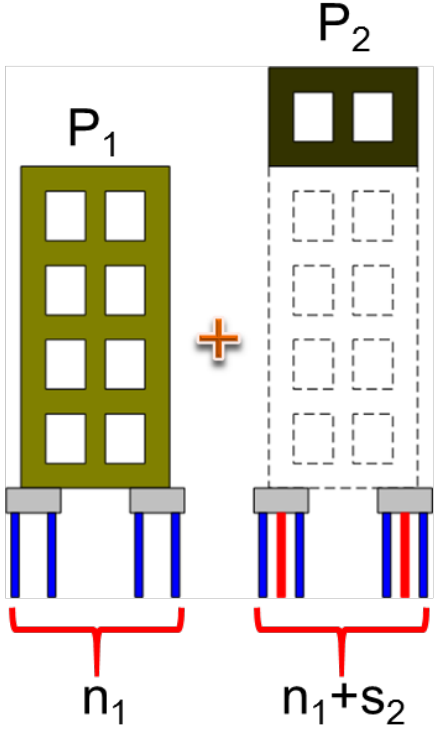
Conventional analysis

$$\frac{P_1+P_2}{n_1+s_2}$$

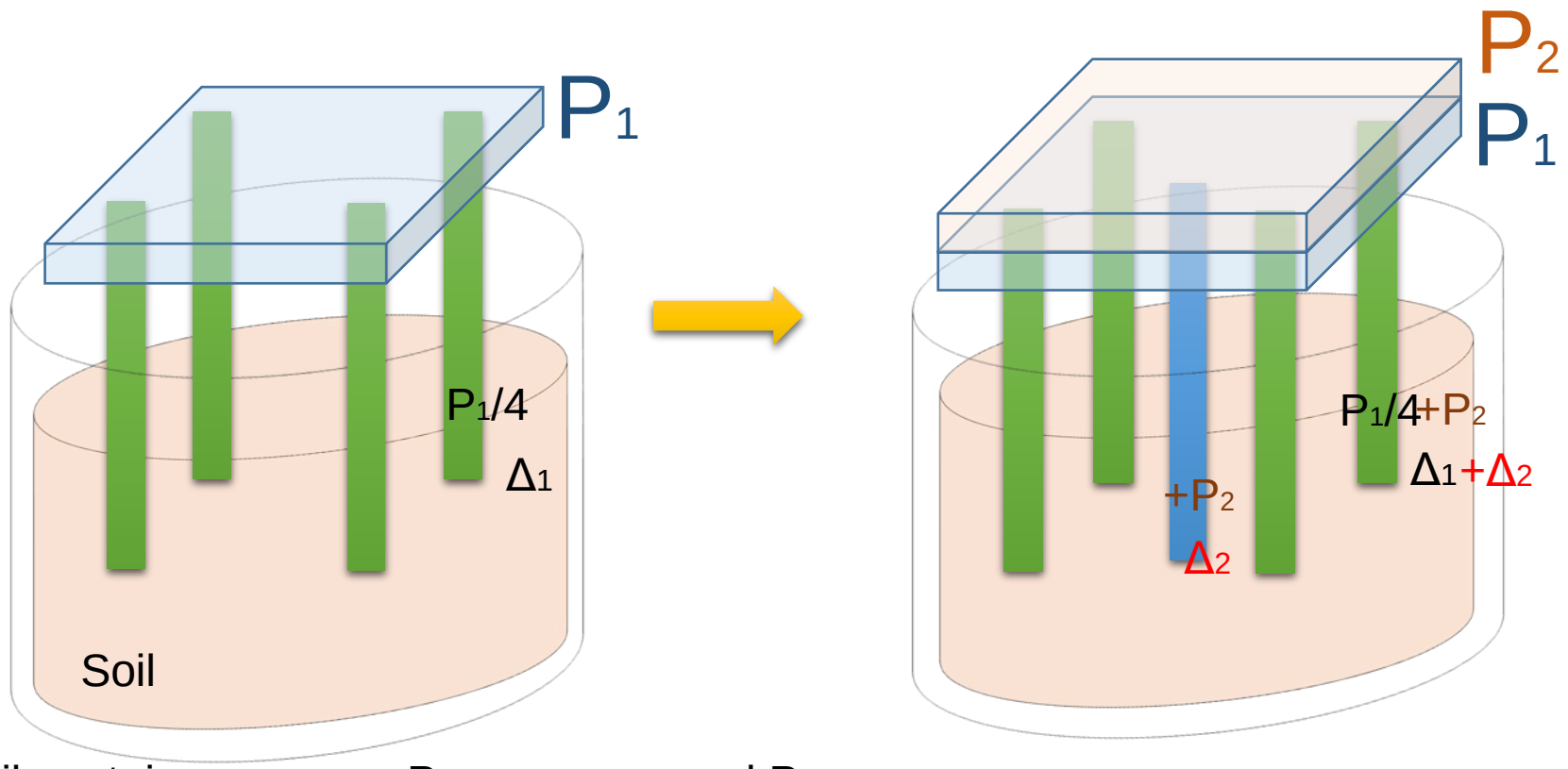


Construction staged analysis

$$\frac{P_1}{n_1}+\frac{P_2}{n_1+s_2}$$



What is my experimental scheme?



Soil container

P_1 causes Δ_1 and P_2 causes Δ_2

Settlement(Existing Piles) : $\Delta_1+\Delta_2$

Settlement(Added Pile) : Δ_2

Single pile experiment

-Setting the single pile

-Prepare soil specimen with air pluviation

-Install the foundation slab

-Install the pile cap

-Apply load with incremental vertical displacement.

-Rotation of the wrench has the pile to move vertical direction.

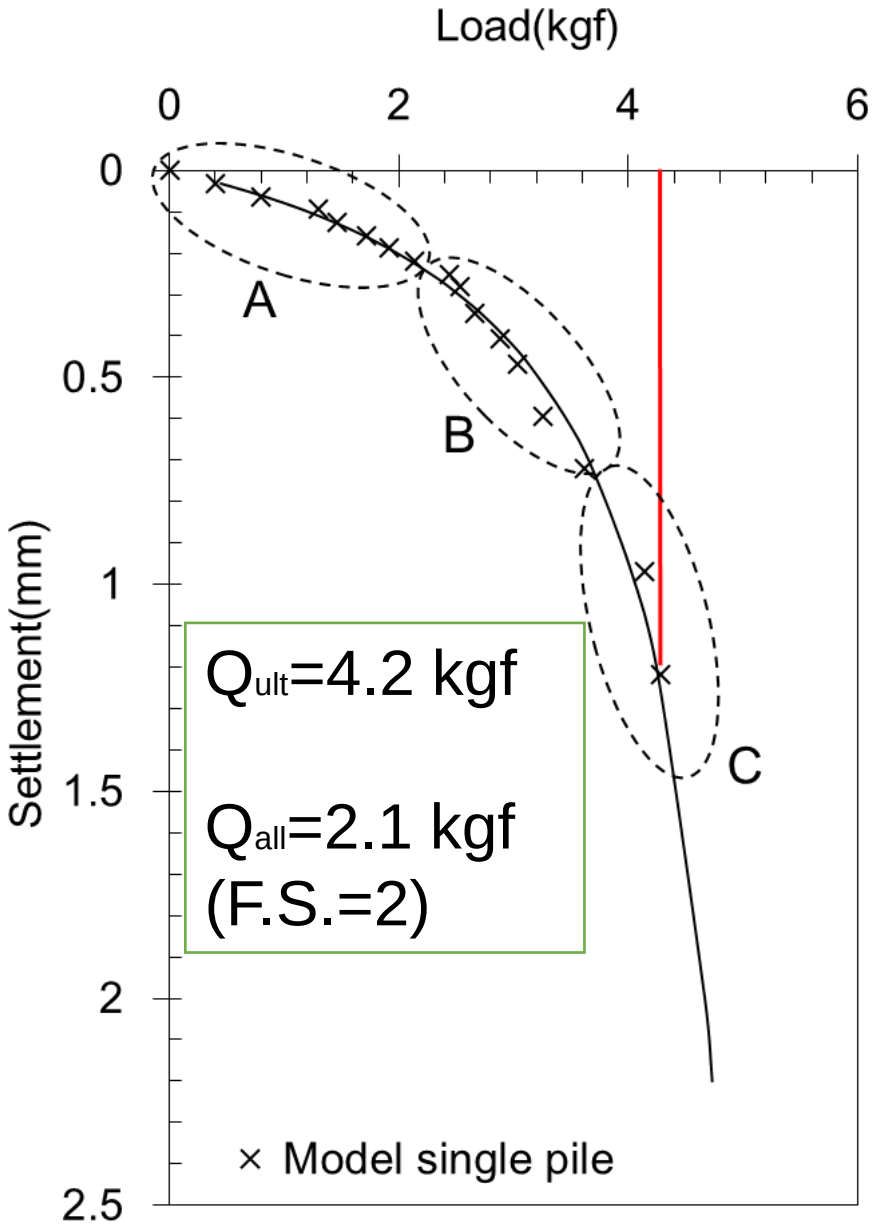
-The incremental vertical displacements are 1/32mm, 1/16mm, 1/8mm depending on load stage.

*Soil Box
Material: Acrylic
L=400mm
Φ=380mm

*Soil
Joomoonjin Sand
D_r=40%, USCS: SP
γ_{max} 1.66 g/㎤, γ_{min} 1.33 g/㎤

*Pile
Material: Al
L=300mm, Φ=20mm
From the bottom of 60mm (3D)

Q_{all} - Single pile



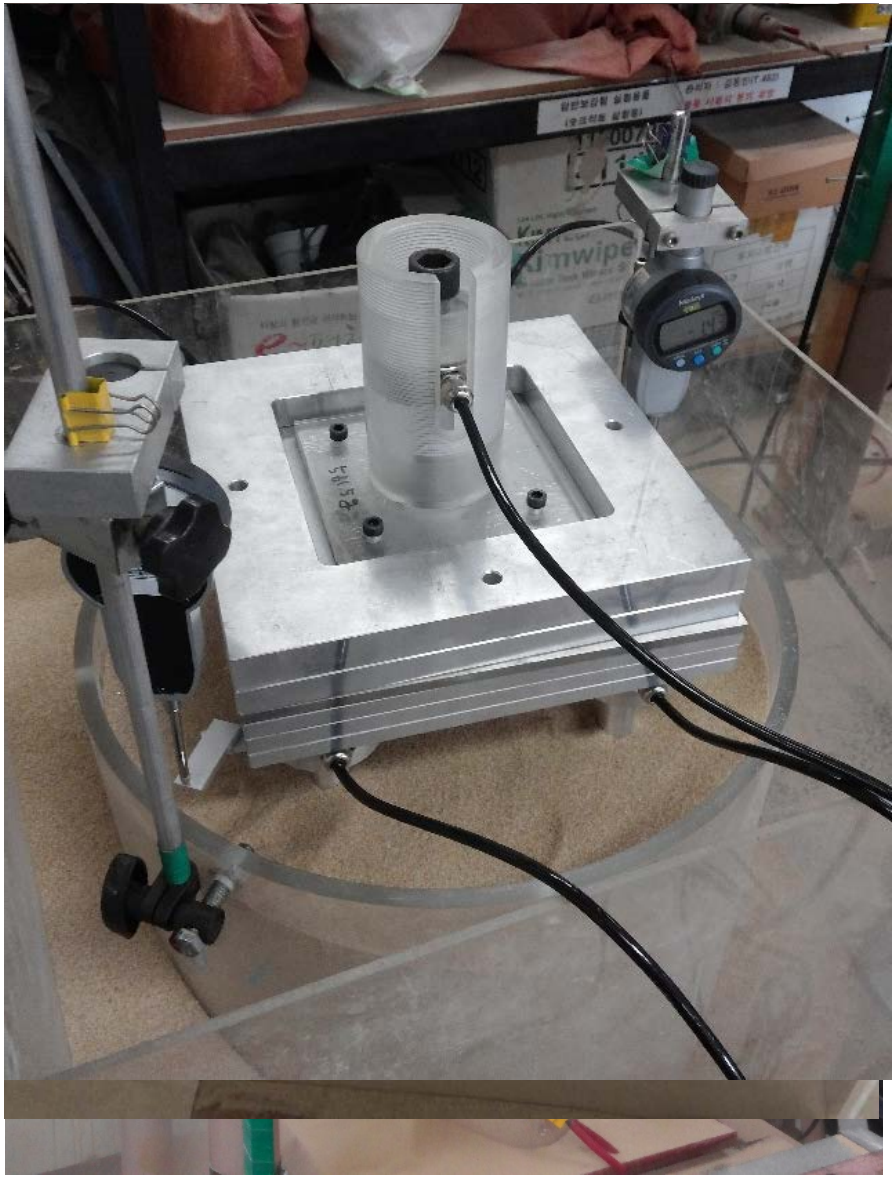
A : Elastic zone
→ Small settlement with load increase

B: Settlement changes rapidly

C: Ultimate state

Theoretical bearing capacity(ISO): 4.2 kgf

Multiple pile experiments



Step

1. Setting the piles (Existing piles and added one)

2. Prepare soil specimen with air pluviation

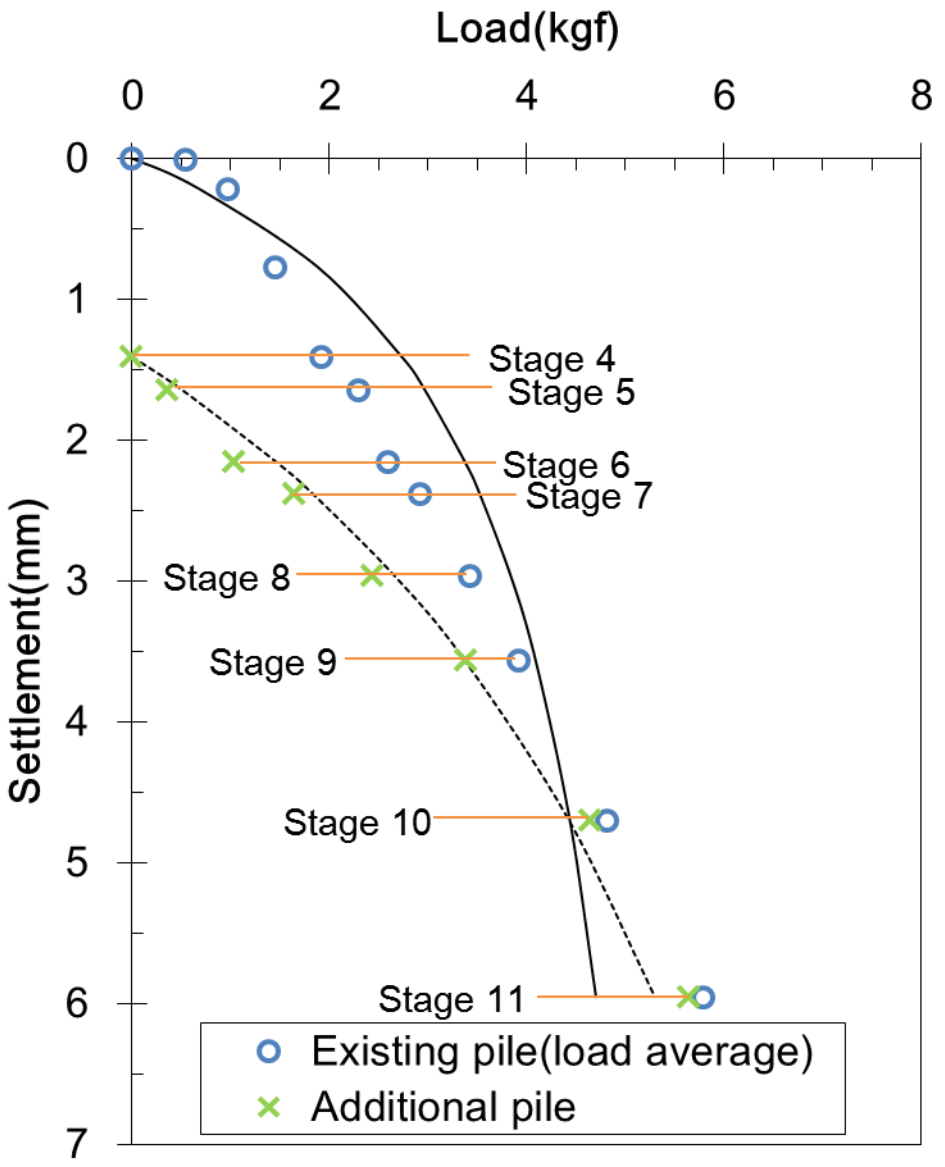
3. Setting the dial gauge

4. Apply load(P_1=Q_{all}) to existing piles

5. Install a load-applicable device for added pile

6. Apply load(P_2>Q_{ult}) to all piles

Q_{all} – Multiple piles

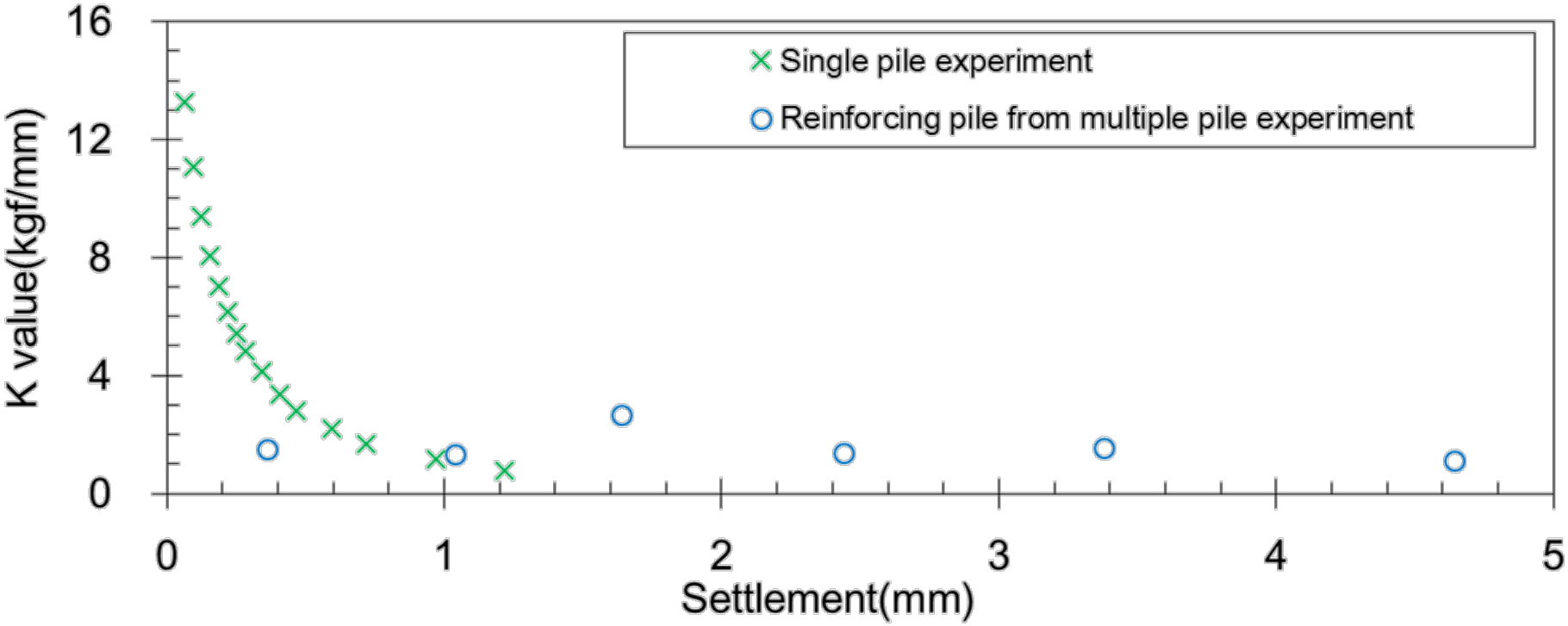


(kgf)

Load Stage	Load applied piles	ΔP	Total load	Indv. load E	Load on A
0	E	0	0	0	-
1	E	2.5	2.5	0.6	-
2	E	1.9	4.4	1.1	-
3	E	2.0	6.4	1.6	-
4	E	2.4	8.7	1.9	0
5	E+A	2.0	10.7	2.3	0.4
6	E+A	2.0	12.6	2.6	1.0
7	E+A	2.0	14.6	2.9	1.6
8	E+A	3.0	17.5	3.4	2.4
9	E+A	3.0	20.5	3.9	3.4
10	E+A	5.0	25.4	4.8	4.6
11	E+A	5.0	30.3	5.8	5.6

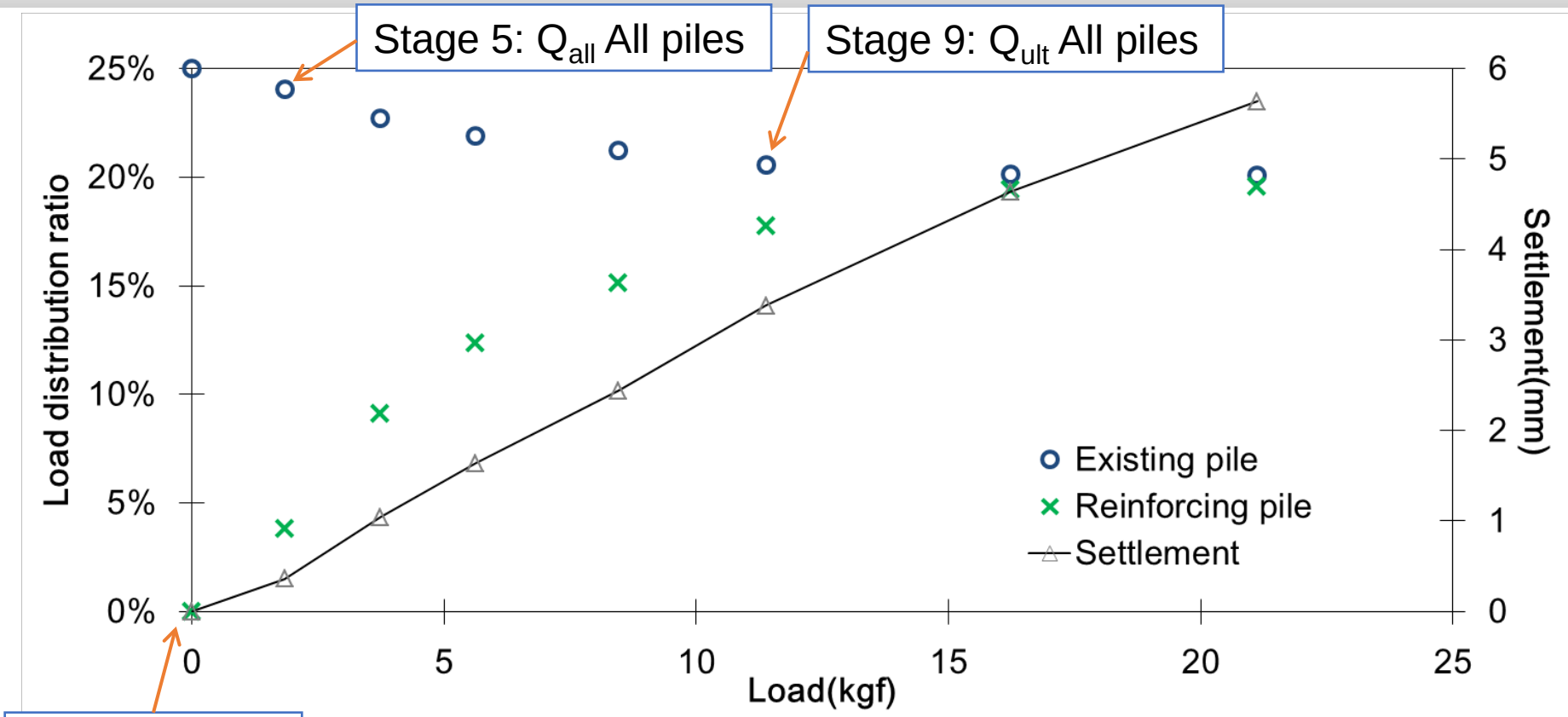
Stage 4: Q_{all} E
Stage 5: Q_{all} All piles
Stage 9: Q_{ult} All piles

Stiffness K of reinforcing pile



K values of single pile : 14.3kgf/mm → 0.9kgf/mm
K values of reinforcing pile : 2.7kgf/mm → 0.8kgf/mm
Reinforcing pile behavior is located beyond ultimate state

Load Distribution Ratio(LDR)



LDR : Existing pile 25%→20%

LDR : Reinforcing pile 0% →20%

LDR approaches to 20% as settlement develops

Conclusion

1. Multiple pile experiment was performed.
   First, allowable load (P_1) applied to four existing piles.
   Additional load (P_2) was applied to four existing and one additional pile.

2. Individual piles support almost equal load (25%) when P_1 is applied.
   The existing pile's LDR decreased 25% → 20% when settlement developed.
   The LDR of an additional pile increased from 0% → 20% as load increased.
   At this moment, the foundation system behaves as a unified entity.

3. The K-values of an additional pile were relatively lower than the single pile test.
   The additional pile behaves as though it is ultimate state throughout the loading history.

4. Upon foundation retrofitting design, a precise analysis for load distribution between existing and additional piles has to be performed according to the above experimental study.

Question?

Thank You