Experimental Study for Load Transfer Characteristics of Reinforcing Piles

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Contents

1. Introduction
2. Experimental scheme
3. $Q_{\text{all}}$- Single pile
4. $Q_{\text{all}}$- Multiple pile
5. Stiffness K of reinforcing pile
6. Load distribution ratio
7. Conclusion
Introduction

Existing Condo.

Add. floor

$P_1 + P_2$ exceed the design bearing capacity of existing piles $\rightarrow$ Need additional piles

Increased load

Existing load

$P_1 + P_2$
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

\[ \frac{P_1 + P_2}{n_1 + s_2} \]

- \( P_2 \): Additional load
- \( P_1 \): Existing load
- \( n_1 \): Existing pile
- \( s_1 \): Reinforcing pile

Construction staged analysis

\[ \frac{P_1}{n_1} + \frac{P_2}{n_1 + s_2} \]

\( n_1 \)

\( n_1 + s_2 \)
What is my experimental scheme?

P₁ causes Δ₁ and P₂ causes Δ₂
Settlement(Existing Piles) : Δ₁+Δ₂
Settlement(Added Pile) : Δ₂
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
Dr=40%, USCS: SP
γ\text{max} 1.66 g/cm³, γ\text{min} 1.33 g/cm³

*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

- \( Q_{ult} = 4.2 \text{ kgf} \)
- \( Q_{all} = 2.1 \text{ kgf} \) (F.S. = 2)

\[ \times \text{ Model single pile} \]
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**

<table>
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<th>Load Stage</th>
<th>Load applied piles</th>
<th>( \Delta P )</th>
<th>Total load</th>
<th>Indv. load</th>
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</table>

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: $14.3\text{kgf/mm} \rightarrow 0.9\text{kgf/mm}$

K values of reinforcing pile: $2.7\text{kgf/mm} \rightarrow 0.8\text{kgf/mm}$

Reinforcing pile behavior is located beyond ultimate state.
Load Distribution Ratio (LDR)

Stage 4: $Q_{all} \ E$

LDR : Existing pile $\rightarrow$ 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 \( 25\% \rightarrow 20\% \) when settlement developed.
   The LDR of an additional pile increased from \( 0\% \rightarrow 20\% \) 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