BEHAVIOUR OF ROCK SOCKETED PILE GROUPS

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Rock socketed pile groups are extensively employed in the construction industry due to their effectiveness in maximizing space utilization while supporting substantial structural loads, thereby enabling efficient vertical construction. This technique is particularly relevant in Sri Lanka, where bedrock is frequently encountered at shallow depths. However, despite the widespread use of rock socketed pile groups, the accurate determination of their bearing capacity remains insufficiently explored in existing literature. The conventional method, which involves simply aggregating the bearing capacities of individual piles, often lacks precision and necessitates further investigation.

This study seeks to characterize the behaviour of rock socketed pile groups by estimating their bearing capacity, taking into account key parameters of pile groups such as pile spacing, socket length, and bedrock properties, as well as evaluating the overall efficiency of these pile groups. This study aims to achieve objectives through a thorough three-dimensional finite element (FE) analysis. This analysis involves developing a detailed model to assess the impact of key parameters of the pile group on both the bearing capacity and efficiency.

This study seeks to confirm the accuracy and relevance of the finite element analysis results by cross-referencing them with experimental data from local sources. The study employs instrumental pile load test (IPT) data from a 1200 mm diameter, 10 m long test pile, implemented in the Port Access Elevated Highway project in Sri Lanka, to validate the FE model. The initial elastic modulus achieved 67% accuracy, which improved to 70% when doubled, and reached a peak of 75% with a tripled elastic modulus. Following model validation, a comprehensive FE analysis was conducted, adjusting bedrock properties and pile group parameters such as spacing and socket length to assess bearing capacity and group efficiency. The study focused on 2x2 pile groups, each with a 1200 mm diameter, assessing group efficiency by comparing individual pile performance to behaviour of the entire group.

Increasing the spacing between piles does not affect the settlement for pile groups embedded in very strong bedrock. Similarly, extending the socket length for pile groups in very strong bedrock also does not alter settlement. In such cases, group efficiency remains constant regardless of changes in pile spacing or socket length, and the efficiency typically exceeds 1. In contrast, for pile groups installed in weak bedrock, increasing the spacing between piles leads to greater settlement, while extending the socket length results in reduced settlement. For these weaker bedrock conditions, group efficiency improves with increased socket length but declines with greater pile spacing. Despite these variations, group efficiency remains below unity for weak bedrock, though it approaches unity as socket length increases. The study shows that current practice method is effective for pile groups in strong bedrock but less reliable in weak bedrock. It emphasizes the need to account for group parameters and bedrock conditions when selecting rock socketed pile groups for effective structural load support.

Keywords: Bearing Capacity, Finite Element Analysis, Group Efficiency, Pile Groups, Rock Socket

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Behaviour of Rock Socketed Pile Groups

Background of the study

In Sri Lanka, the behavior of rock socketed pile groups regarding bearing capacity and group efficiency is underexplored.

Aim

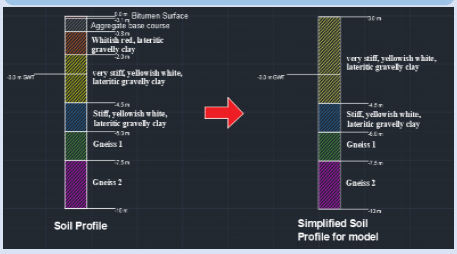
Characterize the behaviour of rock socketed pile groups

Objectives

Investigate the effect of the pile spacing, Socket Length and Bed Rock

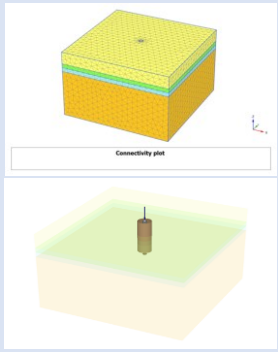
Methodology

Data collection



Bore hole data & Instrumental pile load test (IPT) results of test pile at the Port Access Elevated Highway project in Sri Lanka

Model Development



Material properties

Soils — Pile — Bed rock

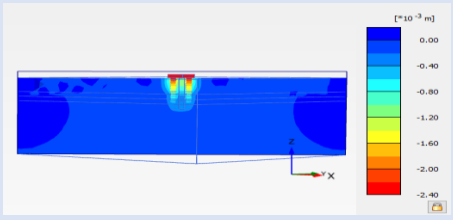
Parameters of pile

Length – 10 m

Material models

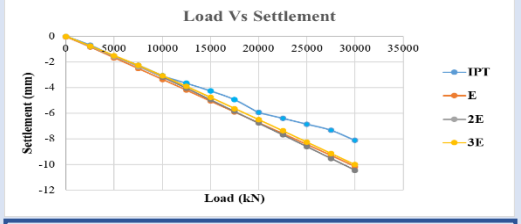
Mohr-coulomb
Linear elastic

FE Analysis & Results



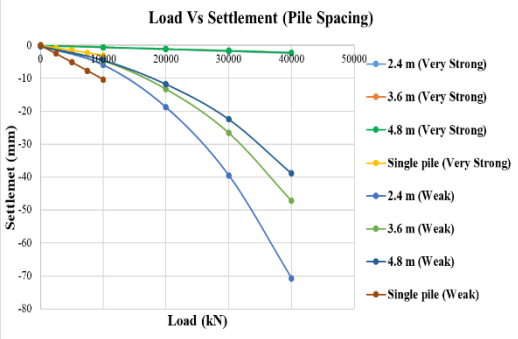
FE analysis with varying pile spacing, socket

Model Validation

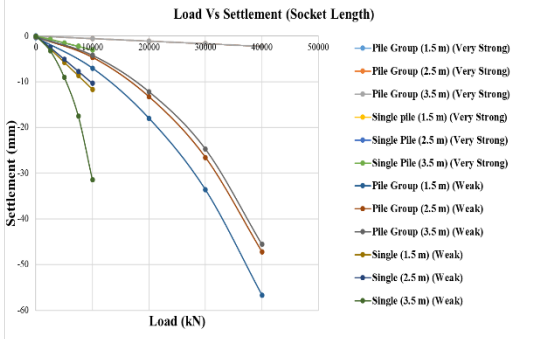


75% accuracy of FEM with IPT when Elastic modulus

Results



- Group Efficiency $_{\text{(very strong bed rock)}} > 1$



- Group Efficiency $_{\text{(Weak bed rock)}} < 1$