

Abstract

The design and construction of foundations are critical for supporting structures amidst urbanization's demands. The conventional approach of utilizing individual piles as the primary load-bearing elements in foundation design has persisted for decades. Nevertheless, the limitations of this approach have become increasingly evident in the face of intricate soil conditions, fluctuating structural loads, and the requirement for heightened stability. This has prompted a shift towards exploring alternative foundation systems that can address these challenges more effectively. In response to this challenge, the piled raft foundation has emerged as an innovative solution, offering enhanced load-bearing capacity and settlement control. Piled raft foundation combines the benefits of pile and raft through its unique load-sharing mechanism.

This research, titled 'Numerical and Experimental Analysis of Load-Sharing Behaviour in Piled-Raft Foundations', delves into the complex mechanics of piled raft foundations. It seeks to comprehensively grasp load distribution mechanisms through numerical simulations and experimental investigations. The primary objective is to comprehend interaction factors and develop settlement-based predictive models, with a focus on load distribution mechanisms. Through exhaustive literature reviews and comprehensive investigations, it addresses diverse design methodologies, situating the research within broader foundation engineering contexts and paving the way for advancements in geotechnical methodologies. This study explores the domain of numerical modelling concerning piled raft foundations, utilizing the ABAQUS software for its robust capabilities in simulating complex structural interactions and soil-structure behaviours in piled-raft foundations, facilitating a comprehensive investigation. To validate the approach, an established numerical model, previously documented in the literature and developed using

ABAQUS, was reconfigured. However, the existing study focused predominantly on a linear elastic model during this reconfiguration. Recognizing the significance of addressing non-linearity in analysis, the current investigation extensively employed the Mohr-Coulomb model to replicate soil continuum behaviour. This model choice is driven by its inherent simplicity, proven adaptability across diverse scenarios, its ability to replicate soil continuum behaviour effectively. At the core of our research lies the parametric analysis, which includes varying geometric parameters such as raft thickness, pile length, and number of piles. Furthermore, variations in soil characteristics, including the modulus of elasticity, Poisson's ratio, and angle of internal friction was examined. Notably, the sensitivity assessment and analysis step time increment were meticulously executed during the preliminary phase of the study. This cautious approach ensures comprehensive definition and optimization of foundational aspects before progressing to subsequent analysis stages, thereby enhancing accuracy and efficiency in the subsequent stages of the research project.

The experimental investigation undertaken in this study involved conducting small-scale model tests to explore parametric analysis and consequently, comprehend the complexities of load-sharing mechanisms within piled-raft foundations. The study encompassed both sandy and clayey soil types, acknowledging the diverse geotechnical characteristics that can influence load distribution mechanisms. The model tests examined variations in pile length and numbers to analyse load sharing in piled rafts over sand and clay. The behaviour was assessed using the load improvement ratio and load-sharing ratio, indicating the effectiveness of piled-raft foundations in enhancing load-bearing capacity and redistributing loads efficiently.

Sandy soils typically exhibit different behaviour compared to clayey soils due to variations in their composition, density, and shear strength properties. By testing in both soil types, the study aimed to capture a broader spectrum of geological conditions. Moreover, the comparative analysis between traditional pile foundations, raft and piled raft foundations demonstrated that the ultimate bearing capacity of piled raft foundations surpassed the sum of traditional raft and pile foundations,

emphasizing the significant role of interaction effects.

Specific interaction factors, including pile-pile interaction, raft-pile interaction, and pile-raft interaction factors, quantify these interactions. The assessment of these interaction factors employed a settlement-based approach. Predictive models for these interaction factors have been developed through the application of the multiple regression analysis technique. This approach was guided by experimental insights, with regression analyses carried out using the ORIGIN software. Leveraging such analysis, interaction factors were developed for both sand and clay soil conditions.

In a nutshell, the aim of this endeavour is not only to contribute to the pursuit of civil engineering knowledge but also to serve as inspiration for fellow researchers and practitioners, encouraging them to push the boundaries of innovation in foundation design and construction.