CELLULAR PILE RAFT FOUNDATIONS FOR LIGHTWEIGHT MULTI-STOREY BUILDINGS

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The global demand for housing and urban land scarcity has driven the need for multistorey buildings. The substructure design plays a crucial role in ensuring the stability of these structures, as traditional foundation methods, like piled or piled raft foundations, are essential for distributing the substantial loads. However, the high costs associated with these systems have prompted the exploration of alternative foundation designs. This study's approach seeks to optimize foundation construction by reducing costs without compromising structural integrity, making it a viable solution for sustainable urban development.

This study investigates the feasibility of employing a raft foundation, particularly a weight-compensated cellular raft design for multistorey buildings exceeding 10 floors which typically require costly pile foundations. Unlike traditional piles, Backhoe loaders are proposed for constructing piles filled with Aggregate Base Course (ABC) with cement and inserting reinforced columns for anchoring the cellular raft. The strategy involves settling the building slightly to mobilize the soil capacity, particularly for sandy clay soil conditions. Furthermore, the study explores the potential of lightweight superstructures to significantly reduce construction costs by optimizing structural weight and eliminating the need for pile foundations. Specifically, it explores the utilization of Expanded Polystyrene (EPS) based lightweight panels and precast prestressed concrete beam systems with precast prestressed concrete slabs. Investigating a 10-story reinforced concrete moment resisting frame (MRF) supported by a cellular piled raft foundation, the research employs a direct approach considering soil-structure (SSI) interaction effects. Through construction stage analysis using finite element software (Midas GEN, Midas GTS NX), the study determines optimal gap sizes for the cellular raft and assesses the maximum number of storeys feasible without pile foundations. Overall, this study suggests that on sandy clay soil, constructing taller buildings with a maximum of 14 floors, in addition to the cellular basement, is feasible using lightweight superstructures in conjunction with cellular rafts.

Moreover, the research recommends increasing pile spacing beyond the current 5m x 5m grid configuration to fully mobilize soil capacity. Future studies should also investigate the effectiveness of these foundation systems across various soil types, including silty clay, loamy soil, and sandy loam, to further validate the design's applicability in different geological conditions.

Keywords: EPS light-weight wall panels, Finite element method, Soil–structure interaction, Sustainable construction, Weight compensated foundation

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Cellular Pile Raft Foundations for Lightweight Multi-Storey Buildings

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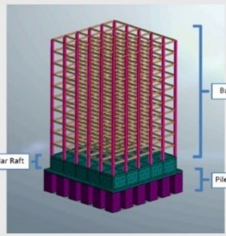
Introduction

Tall buildings exceeding 10 floors typically rely on costly pile foundations, highlighting the need for alternative, cost-effective solutions.
This study delves into the feasibility of raft foundations, particularly weight-compensated designs with cellular rafts, as a viable alternative.Backhoe loaders are proposed for constructing piles filled with Aggregate Base Course (ABC) with cement and inserting reinforced columns for anchoring the cellular raft.

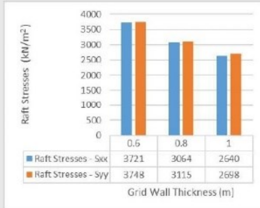
Methods

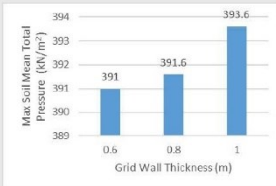
- A Three-Dimensional Finite Element Model of the proposed structural system was developed with commercially available computer software MIDAS GEN for the superstructure and Midas GTS NX was used for substructure integration.
- Construction stage analysis was carried out for the foundation analysis.

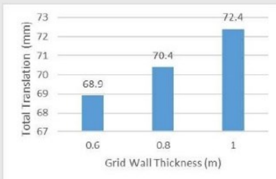


Results

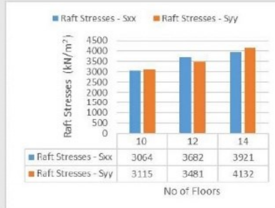
Variation with cellular grid wall thickness

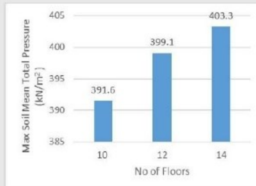


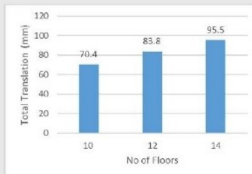




Variation with incremental floor addition

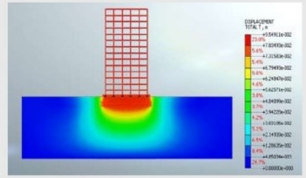






Conclusion

With the settlement for 14 floors reaching 95.5 millimeters, it was determined that further floor additions beyond this point are not feasible due to excessive settlement and limitations in the soil's bearing capacity.



Recommendations

It was observed that the current pile grid configuration of 5m x 5m is insufficient for fully mobilizing soil capacity, it's advised to increase pile spacing.
Moreover, investigating the effectiveness of these foundations across diverse soil types.

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