EFFECT OF TIE BEAMS ON THE BEHAVIOR OF ISOLATED FOUNDATION SYSTEMS

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The stability of isolated foundation systems is crucial to the structural integrity and safety of buildings, especially in regions with varying load conditions. Tie beams, widely used to connect isolated footings, play an integral role in this process. However, their impact on bearing capacity and settlement characteristics is often overlooked in standard analyses. This research primarily aimed to explore the influence of tie beams on the settlement characteristics and overall performance of isolated foundation systems. A comprehensive methodology combining both model experiments and finite element analysis (FEA) was employed to achieve these objectives.

Initially, two model experiments were conducted using small-scale prototype structures: one with a single isolated footing and another with two footings connected by a tie beam. These experiments aimed to validate the FEA results by comparing the experimental settlement data with the simulated outcomes.

Two distinct models of the foundation system were developed, each based on a typical three-story building with 16 isolated footings. This setup was designed to simulate a realistic structural scenario and evaluate the impact of tie beams under varying loading conditions. The footings were loaded with varied loadings in the range of 350 kN to 1300 kN to simulate real-world scenarios. One model included tie beams connecting the footings, while the other omitted them, allowing for a comparative analysis of their effects on settlement and structural integrity.

The findings reveal that incorporating tie beams significantly reduces the maximum individual settlement, with a decrease of up to 22 mm (43%). Furthermore, the inclusion of tie beams narrowed the variation in settlement across individual footings, resulting in a more uniform distribution of settlements. Differential settlements were notably reduced, with all values staying under 2 mm, reflecting a 92% reduction compared to the model without tie beams.

In conclusion, the inclusion of tie beams significantly reduces both settlements and differential settlements, contributing to a more uniform distribution of loads across isolated foundation systems. While positioning tie beams at the footing level may further reduce settlements, it also increases the forces acting on the tie beams, necessitating higher reinforcement and potentially leading to increased construction costs. The research recommends maintaining tie beams at ground level in general construction practices, except in scenarios where minimizing settlements is critically important. This study underscores the significance of tie beams in enhancing the performance and stability of isolated foundation systems, highlighting their essential role in mitigating settlement-related issues.

Keywords: Pad footings, Finite element analysis, Shallow foundations, Differential settlement, Model experiment

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Model Experiment

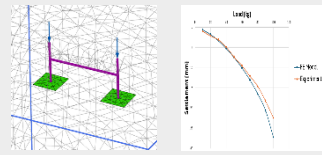
Apparatus

Two prototype footings

Experiment Procedure

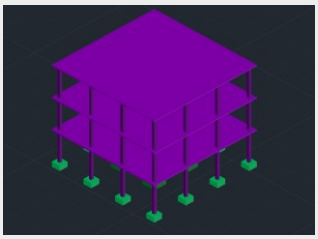
The experimental setup was loaded, and settlements were measured

FEM Validation

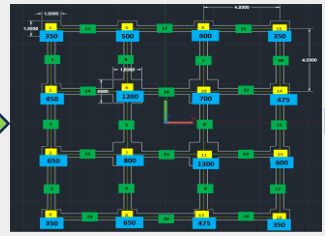


Experiment modeled with FE Software for both setups, and results were compared

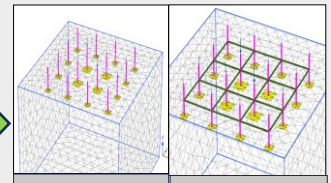
Finite Element Model



Considered building with isolated foundation system



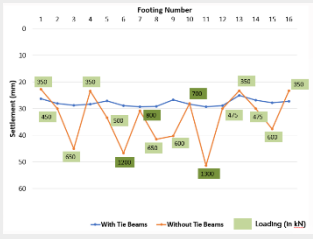
Foundation system with varying loadings (350 kN - 1500 kN)



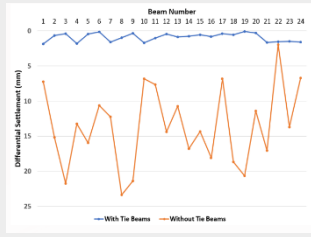
Without Tie Beams | **With** Tie Beams

FEM for two foundation systems

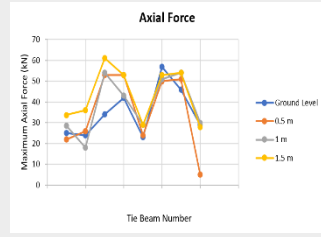
Results and Conclusion



Variation of verticle settlement



Variation of differential settlement between adjacent footings



Variation of axial load with tie beam location

- Incorporating tie beams significantly reduces the maximum individual settlement, with a decrease of up to 22 mm (43%)
- Differential settlements were notably reduced, with all values staying under 2 mm, reflecting a 92% reduction compared to the model without tie beams
- Positioning tie beams at the footing level may further reduce settlements, it also increases the forces acting on the tie beams