

INVESTIGATING THE STRUCTURAL IMPACT OF DEEP TIE BEAM ON THE PERFORMANCE OF DOMESTIC BUILDINGS

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Tie beams are structural members commonly used to connect isolated or strip footings at the foundation level in domestic buildings. Their primary function is to reduce differential settlement between footings and enhance the overall stiffness of the foundation system. Additionally, tie beams can support non-load-bearing ground floor partitions and distribute loads more uniformly, especially in irregular or weak soil conditions. Despite their widespread use globally, the analysis and design of tie beams often lack standardized closed-form solutions, leading to empirical or experience-based design practices. Therefore, understanding the structural impact of tie beams is crucial for improving the long-term performance of domestic buildings, particularly where soil variability poses a challenge.

In Sri Lanka, rubble foundations with tie beams are commonly used in low-rise houses. While rubble foundations carry ground-floor wall loads, poor soil conditions often cause settlement cracks. Adding deep tie beams helps redistribute loads and minimise differential settlement. When these beams share wall loads, their depth, reinforcement, and placement become critical. Selecting a foundation system without considering its structural adequacy and soil conditions can lead to settlement, poor load transfer, and structural cracks. This study examines how different tie beam configurations affect the structural performance of domestic buildings under weak soil conditions.

A case study two-story reinforced concrete (RC) building with plan dimensions of 4.5 m × 4.5 m and a floor height of 3 m was considered in the analysis. This research examines two commonly used construction practices: (1) RC footings with rubble foundations and shallow tie beams, and (2) RC footings with deep tie beams. The depth of the shallow tie beam was taken as 225 mm, while the depth of the deep tie beam was taken as 350 mm. The soil bearing capacity was varying varied from 50–200 kPa, representing weak and firm soil conditions.

Numerical models were developed using ETABS software to simulate the structural performance of both foundation systems. The simulations analysed axial force distribution, settlement patterns, and their resulting effect on bending moments and shear forces in the superstructure, particularly at the junctions between upper-floor beams and foundations. The study provides a comprehensive framework to evaluate and compare the effectiveness of each foundation technique under different soil conditions.

This research clearly demonstrates the structural advantages of incorporating tie beams in domestic building foundations in Sri Lanka. Numerical analysis results indicate that deep tie beams significantly reduce settlement and axial forces, particularly in weak soils, thereby enhancing load distribution and overall foundation stability. Although increased stiffness leads to higher bending moments and shear forces, the inclusion of deep tie beams is crucial in low-bearing-capacity soils to ensure improved long-term performance and structural integrity of buildings.

Keywords: Domestic buildings, Soil bearing capacity, Rubble foundations, Deep tie beams

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