INVESTIGATE THE STRUCTURAL PERFORMANCE OF PAD FOOTINGS WITH DIFFERENT GROUND IMPROVEMENTS

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When the footings are constructed on weaker soils, several structural enhancement techniques such as use of larger footings, micro piles, or different ground improvement techniques such as use of concrete cylinders and use of filling materials or low-grade concrete are being used in practice. However, there is a limited understanding of the effectiveness of these different techniques. The aim of this research is to provide a design guideline/ framework for design engineers when constructing column footings in domestic buildings on weaker soils. This study pursue the following objectives: Identifying current design practices used by the engineers when constructing domestic buildings on weaker soils, Developing comprehensive Finite Element (FE) models using MIDAS software to investigate the behaviour of column footings with the varying embedment depths, Conducting a parametric study to investigate the behaviour of column footings with the implementation of identified strength enhancement techniques, and comparison of the results to identify feasibility of identified strength enhancement techniques.

This research investigates the structural adequacy of the above techniques by using the MIDAS GTS-NX FE analysis software. Footing and soil were modelled two dimensionally and three dimensionally in drained conditions incorporating soft clay soils and dense sand. Validation process was carried out comparing theoretical settlements and settlements from the FE model. Mesh sensitivity analysis was carried out to optimise the computational process. A comprehensive study was carried out with developed models to investigate the effect of embedment depth of the footing, effect of use of concrete cylinders, influence of soil replacement with quarry dust and impact of low-grade concrete layers below the footing. The comprehensive modelling techniques developed in this research could be used for further studies in different ground improvement techniques and will provide an idea about the feasibility of enhancement techniques to make necessary structural enhancements and ground improvements when constructing domestic buildings on weaker soils, thus reducing the costs.

This study concluded that for a typical footing stress range of 150-175 kN/m^2, optimum embedment depth lies within the range of 0.6 m to 1 m. Within this range, the load versus settlement curve demonstrates a desirable linearity, suggesting that the footing can accommodate the expected stresses while minimising excessive settlement, and increasing the depth of the cylinder has a noticeable effect on reducing settlement by 16% -17% but beyond approximately 1.2 m in height, there is no noticeable impact on the settlement. This study also concluded that use of quarry dust replacement can reduce overall settlements in drained conditions by 50% - 60% while bearing capacity can be increased by 45% to 55%. Optimum depth of soil replacement can be taken as between 1 m – 1.2 m for the embedment depth of 0.8 m. and use of Grade 15 concrete layer below the footing can reduce the settlements and enhance the bearing capacity. Implementation of 150 mm – 250 mm thick M15 concrete layer underneath the footing can reduce settlements by 55% - 60% for 210 kPa of pressure.

Keywords: Pad Footing, Settlements, Bearing Capacity, Ground Improvement, Concrete Cylinders, Finite Element Analysis

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Background

Ground Improvement Techniques

- use of larger footings
- use of concrete cylinders
- use of filling materials or low-grade concrete

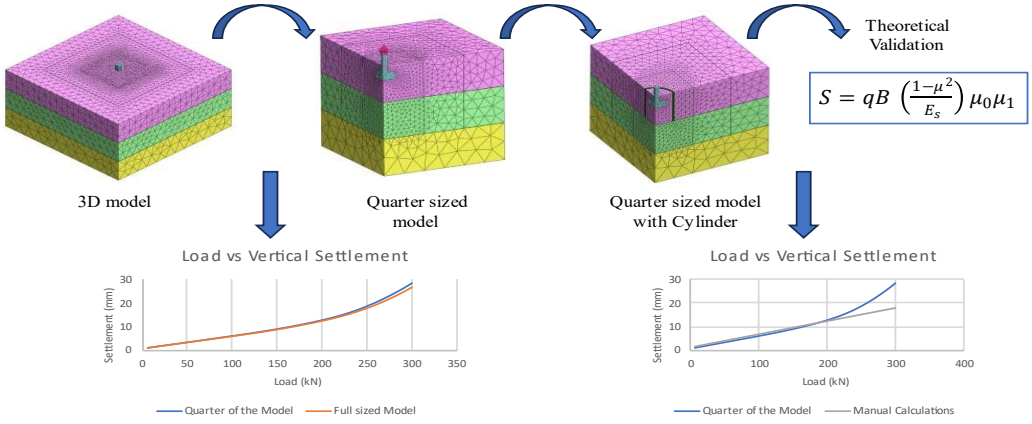
Aim – To provide a design guideline/ framework for design engineers when constructing column footings in domestic buildings on weaker soils.

Individual Pad Footing

Objectives

- Identify current design practices used by the engineers when constructing domestic buildings on weaker soils.
- Develop comprehensive FE models using MIDAS software to investigate the behavior of column footings with the varying embedment depth
- Conduct a parametric study to investigate the behavior of column footings with the implementation of identified strength enhancement techniques.
- Compare the results to identify feasibility of identified strength enhancement techniques.

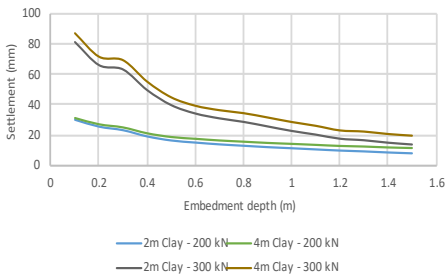
Methodology



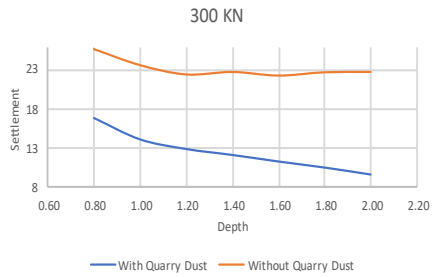
Load vs settlement curves for both full and quarter models

Load vs vertical settlement graphs obtained from theoretical calculations and finite element model

Results



Settlement vs Embedment depth curves for 2m and 4m thick clay layers



Settlement vs Replacementheight of Quarry dust