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Dynamic analysis and design of high-risestructure resting on pile raft foundation

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ABSTRACT

Tall building construction usually makes use of pile raft foundations. To minimise differential settling when the soil's bearing capacity is constrained and the loads are heavy, pile raft foundations are used. The concept of employing piles to reduce settlement and the scenarios in which it might be successful are examined in this paper. The assessments of high-rise buildings resting on raft foundations and those resting on pile-raft foundations have been compared. A 15 story RC structure with an SBC of 135 kN/m2 has been taken into consideration for the analysis. STAAD.pro CONNECT Edition V22 and Advance STAAD Foundation were used to model, analyse, and design the building and foundation.On the study and design of the aforementioned high rise structure resting on raft foundation and pile-raft foundation, an attempt has been made to compare various characteristics such as displacement, stresses, moments, etc.

Keywords:- Raft foundation, Piled raft foundation, Displacement,Stresses,Moments.

1. INTRODUCTION

It might be possible to add piles to the raft to improve performance if the design requirement cannot be satisfied by the raft foundation alone. The final carrying capacity of the raft might be increased by using a few strategically positioned piles, which would also enhance settlement and differential settlement performance. The pile raft foundation must be an affordable foundation if the performance of the raft or pile by itself is insufficient to meet the design criteria. The composite structure known as pile raft foundations is made up of the ground, the raft, and the piles. The raft is directly supported by piles and in contact with the earth in this sort of foundation. The majority of the loads in a typical pile foundation are intended to be carried solely by the piles.

In 2015, Chaithra T. P. and Manogna H. N. researched Dynamic Soil-Structure Interaction Analysis for Piled Raft Foundation. They came to the conclusion that a pile raft foundation was preferable to a raft foundation for reducing displacement and settling in soft soil. Nirmal John Joy and Hashifa Hassan examined the settlement characteristics of a combined pile raft foundation built on sand with different arrangements of piles in 2014. They found that the most effective way to considerably lower maximum settlement and differential settlement was to insert high-capacity piles in areas where there was the greatest load concentration and reinforce the rest of the raft with medium capacity piles.

PRESENT WORK

A. Methodology

1. Compilation of specific data regarding raft and piled raft foundation.
2. Make a model of the building using the Staad Pro programme. and model by the response reduction technique.
3. Using the Advance STAAD Foundation, the effects of a 15-story RC building with a raft foundation and a piled raft foundation are examined.
4. A comparison of all software outcomes.

B. Objectives

1. The present work focuses on the analysis of fifteen story RC building for the following cases:

a. With raft foundation. (Shallow foundation)
b. With combined piled raft foundation. (Combination of Shallow and Deep foundation)

2. The comparison of numerous parameters, such as displacement, stresses, and moments, between rafts and piled rafts.

3. Models undergo dynamic analysis using the response reduction method. Numerous studies have been done to determine the structural response for the various input parameters.

3. MODELLING AND ANALYSIS

In the current study, STAAD Pro was used to simulate fifteen RC buildings. utilising the response reduction technique in various situations, including raft foundation and mixed piled raft foundation. Advance STAAD Foundation model and analysis of raft and piling raft foundations.

Cross Sectional and Material Properties

1. Grade of concrete and steel - M30, Fe500
2. Building plan - (45.7 × 63.11) m
3. SBC -135 kN/ m^2
4. Thickness of slab - 0.125 m
5. Each storey height - 3 m
6. Number of storey – 15
7. Total height of building - 49.5 m
8. Seismic zone - zone II
9. External wall thickness - 0.15m
10. Internal wall thickness - 0.1m
11. Thickness of shear wall - 0.23m
12. Sizes of beam - 0.23m x 0.6m , 0.23m x 0.45m
13. Sizes of column - 0.3m x 0.3m& 0.3 m* 1.8 m

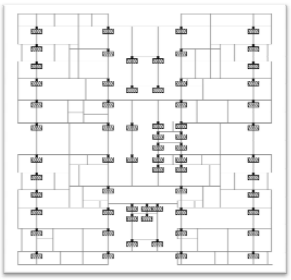

Figure 3.1 : Plan of Building

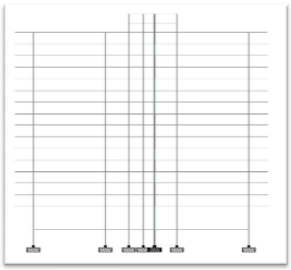

Figure 3.2 : Elevation of Building

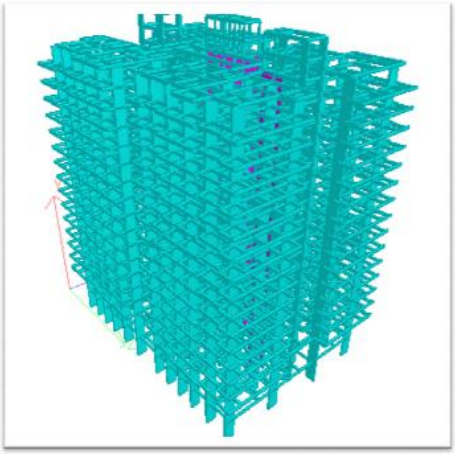

Figure 3.3 : STAAD-PRO model of the building

4. RESULTS AND DISCUSSION

4.1 VARIATION OF MAXIMUM DISPLACEMENT

Table No. 6.1: Variations in Displacements

	Maximum displacement at various Nodes (mm)	
	Building with Raft Foundation	Building with Piled Raft Foundation
Max Dx	60.15	1.11
Max Dy	54.26	0.95
Max Dz	50.38	1.2
Min Dx	48.92	0.023
Min Dy	40.94	0.7
Min Dz	34.96	0.5

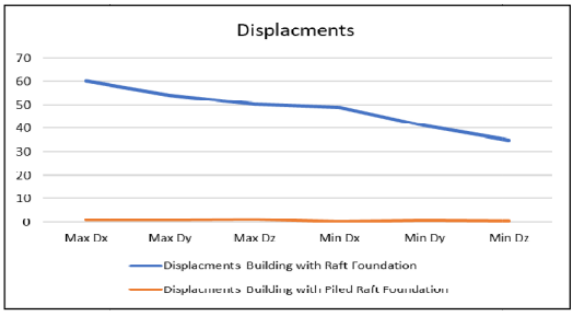

Fig no. 6.1: Maximum displacement at various Nodes (mm)

4.2 VARIATION OF MAXIMUM BASE SHEAR

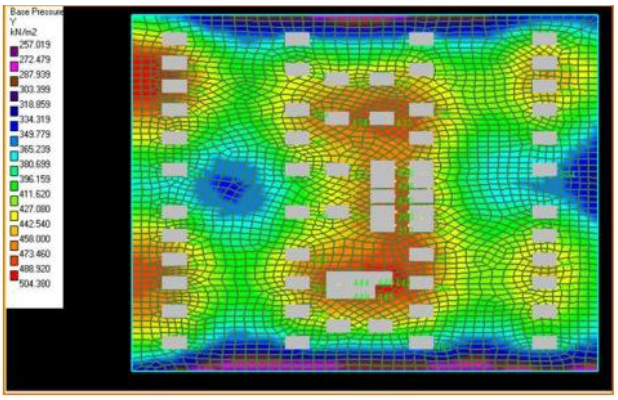

Figure 6.2: Base Pressure in raft foundation

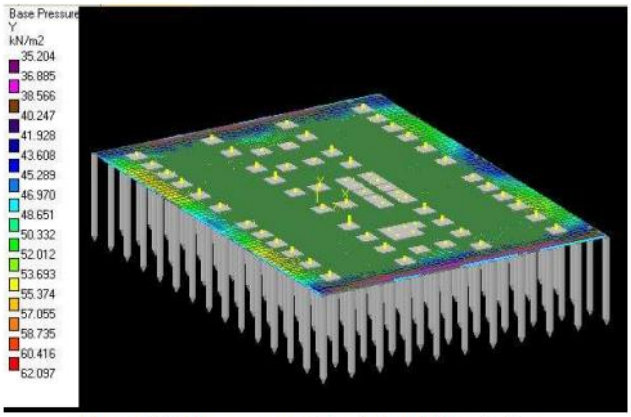

Figure 6.3: Base pressure in piled raft foundation

Table 6.2: Variation of Base Pressure

	Base Pressure (kN/ m²)	
	Raft Foundation	Piled Raft Foundation
Maximum Base Pressure	487.21	62.097
Minimum Base Pressure	283.15	35.204

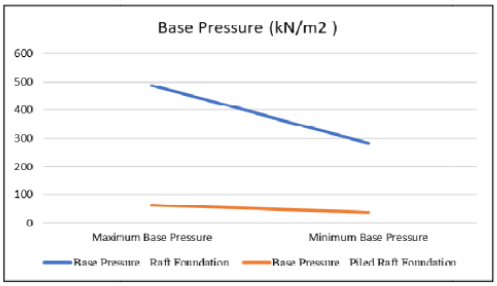

Fig no 6.4. Variation of Base Pressure

4.3 VARIATION OF STRESSES

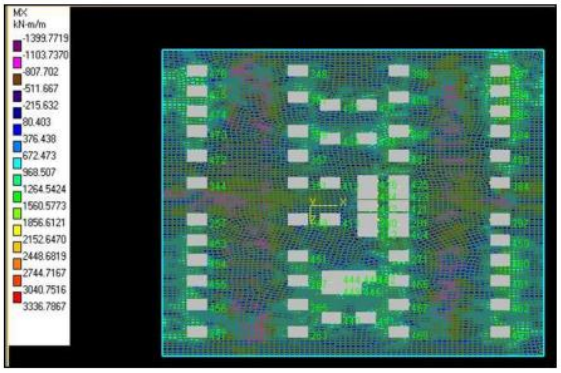

Figure6.5 : Stresses in Mx Direction in Raft Foundation

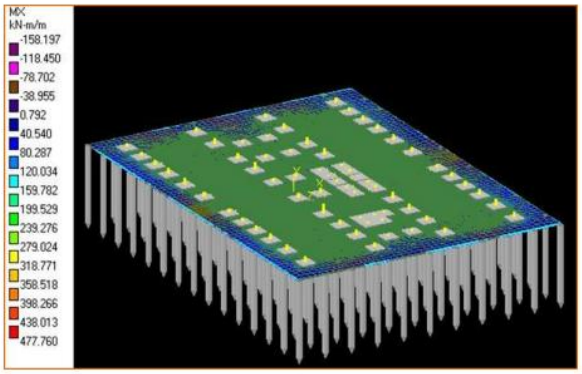

Figure 6.6: Stresses in Mx Direction in piled raft foundation

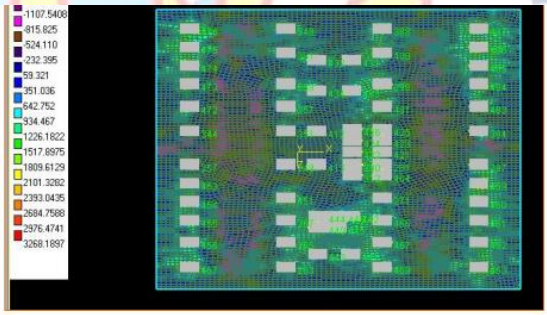

Figure 6.7:Stresses in My Direction in raft foundation

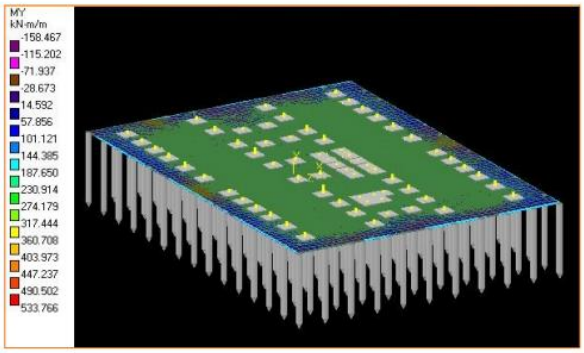

Figure 6.8: Stresses in My Direction in piled raft foundation

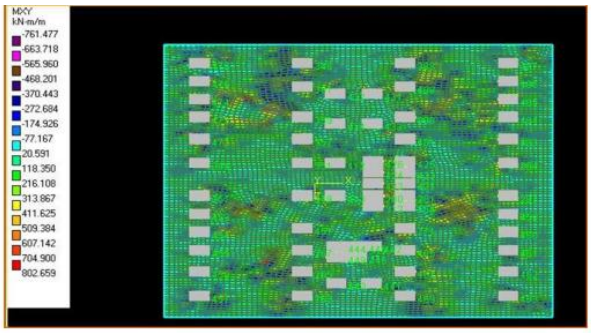

Figure 6.9: Stresses in Mxy Direction in raft foundation

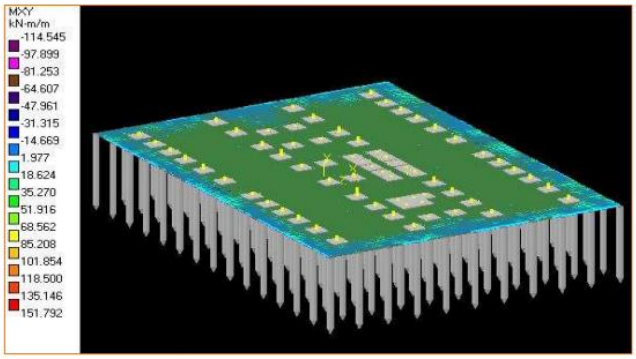

Figure 6.10: Stresses in Mxy Direction in piled raft foundation

Table 6.3: Variation in Stresses

	Raft Foundation			Piled Raft Foundation		
	Mx	My	Mxy	Mx	My	Mxy
Maximum Stresses (kN-m/m)	3306.78	3268.17	802.65	477.76	533.76	151.79
Minimum Stresses (kN-m/m)	1399.77	1399.25	761.47	158.19	158.46	114.54

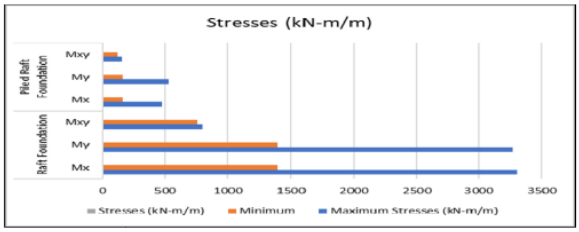

Figure 6.11:Variation in Stresses

4.4 VARIATION OF MAXIMUM MOMENT

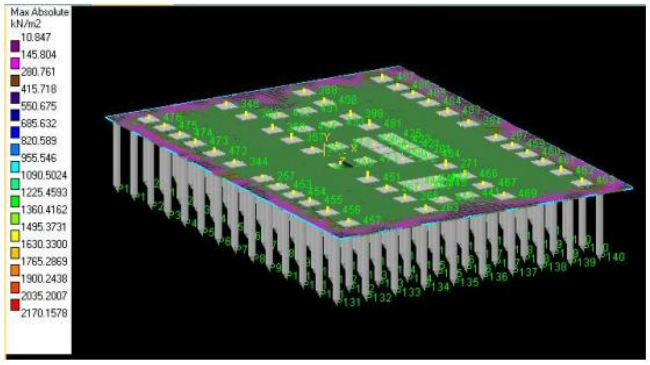

Figure 6.13: Maximum moments on piled raft foundation

Table 6.4: Variation in Moments

	Raft Foundation	Piled Raft Foundation
Maximum moments (kN-m2)	16400	217.1578
Minimummoments (kN-m2)	99.441	10.847

5. CONCLUSION

1. Pile raft foundations instead of raft foundations can greatly reduce displacement.
2. A piled raft foundation can lessen raft settlement, and pile settlement is within acceptable bounds.
3. Raft foundations experience more strains than pile raft foundations.
4. Base pressure is greater in rafts, increasing the likelihood of raft tilting, therefore base pressure can be decreased much more by providing stacked raft foundations than raft foundations.
5. Piled raft foundations have less intense soil pressure than raft foundations.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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