

## Numerical Study of Piled Raft Foundation Under Vertical Static and Seismic Loads

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**Abstract :** Piled raft foundation (PRF) is a union of pile and raft working together through the interaction of soil-pile, pile-raft, soil-raft and pile-pile to provide adequate bearing capacity and controlled settlement. A uniform pile positioning is used in PRF; however, there is a wide room for optimization through parametric study under vertical load to result in a safer and economical foundation. Addis Ababa is found in seismic zone 3 with a peak ground acceleration (PGA) above the threshold of damage, which makes investigating the performance of PRF under seismic load considering the dynamic kinematic soil structure interaction (SSI) vital. The study area is located in Addis Ababa around Mexico (commercial bank) and Kirkos (Nib, Zemen and United Bank) in which input parameters (pile length, pile diameter, pile spacing, raft area, raft thickness and load) are taken. A finite difference-based numerical software, FLAC3D V6, was used for the analysis. The Kobe (1995) and Northridge (1994) earthquakes were selected, and deconvolution analysis was done. A close load sharing between pile and raft was achieved at a spacing of 7D with different pile lengths and diameters. The maximum settlement reduction achieved is 9% for a pile of 2m diameter by increasing length from 10m to 20m, which shows pile length is not effective in reducing settlement. The installation of piles results in an increase in the negative bending moment of the raft compared with an unpiled raft. Hence, the optimized design depends on pile spacing and the raft edge length, while pile length and diameter are not significant parameters. An optimized piled raft configuration ( $\frac{L}{D} = 0.25$  at the center and piles provided around the edge) has reduced pile number by 40% and differential settlement by 95%. The dynamic analysis shows acceleration plot at the top of the piled raft has PGA of  $0.25 \frac{m}{s^2}$  and  $0.63 \frac{m}{s^2}$  for Northridge (1994) and Kobe (1995) earthquakes, respectively, due to attenuation of seismic waves. Pile head displacement (maximum is 2mm, and it is under the allowable limit) is affected by the PGA rather than the duration of an earthquake. End bearing and friction PRF performed similarly under two different earthquakes except for their vertical settlement considering SSI. Hence, PRF has shown adequate resistance to seismic loads.

**Keywords :** FLAC3D V6, earthquake, optimized piled raft foundation, pile head department

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