ABSTRACT

This paper is on 3-D analysis of piled raft foundations on sand. The numerical analysis was carried out with three typical load intensities of the serviceability load. Further, extensive parametric studies were carried out with the variables pile spacing, number of piles, pile diameter, raft dimension ratio, and raft thickness. The maximum settlement of the piled rafts depends on the pile spacing and the number of piles; while the raft thickness does not have a significant effect. In all cases, the normalized settlement recorded is mostly less than 2% of the raft width and the maximum value was noted for the 8x27m piled raft. The increase in raft thickness reduces the differential settlement in the foundations. The raft-soil stiffness \( (K_{so}) \) is shown to influence the differential settlement and has the largest influence. The performance of piled raft in sandy soil condition is assessed and general conclusions are also made.

KEY WORDS: Numerical Analysis, Piled Raft Foundation, Sand

INTRODUCTION

This paper is on a detail 3-D analysis of piled raft foundations using the PLAXIS 3-D software. A six-layer soil model is adopted which is commonly encountered in Surfers Paradise of Gold Coast. The numerical work is carried out on 3-D PLAXIS analysis. Extensive parametric studies were carried out with the variables pile spacing, number of piles, pile diameter, raft dimension ratio, and raft thickness.

Historically, the pile raft analysis has its origin to the pile group analysis. The early work of Skempton (1953) and Meyerhof (1959) were empirical in nature and relates to the settlements of pile groups. The important work of Fraser and Wardle (1975), Poulos and Davis (1980), Randolph (2003), and Poulos (2006) are reviewed in relation to the pile group analysis, load transfer mechanism and other pertinent aspects related to the fundamentals of pile group analysis. The contributions from Tomlinson (1986), Coduto (1996), Poulos (1993) and Van Impe (1991) are also studied in relation to the equivalent raft methods of analysis. The contributions from Poulos (1993), and Clancy and Randolph (1993) are reviewed in relation to the equivalent pier methods of analysis in piled raft foundations. The rapid developments in the numerical analysis of pile behaviour and piled raft foundations saw numerous. The more rigorous methods of piled raft analysis began with the contributions of Kuwabara (1989), and extended by Poulos (1993) with further contributions from Ta and Small (1996), Zhang and Small (2000), and Mendoca and Paiva (2003). Notably, Prakoso and Kulhawy (2001) used the PLAXIS software in the 2-D analysis of piled raft foundations.

This paper will illustrate the practical applications of the piled raft foundation using PLAXIS 3-D software.

SOIL MODEL

General stratigraphy of Surfers Paradise subsoil is described in this section. On the surface, there is a thin layer of fill material. The next layer of medium dense sand varied in thickness from 5 to 9.5m. The medium dense sand is underlain by a layer of very dense sand with thickness varying from 14 to 22m. Within the very dense sand layer, an organic peat strip is found. Although, the thickness of this peat layer is not much (about 1 to 3m), it has adverse effects on the settlement of foundations especially for raft foundations. Under the very dense sand layer, stiff clays are encountered with the thickness of about 8 to 10m. The last layer above the high stiffness weathered rock is clayey sand or a mixture of sand, gravels and clays. The clayey sand layer is about 3m thick. The weathered rock is found at the level of 30m. The static water level is about 3.5m to 4m below the surface. Generally, the soil has high bearing capacity at the surface so it is quite favourable for raft foundations. However, the highly compressive peat can cause excessive settlements for buildings founded above it. Thus, deep foundations such as piled foundation and piled raft foundation should be used. The simplified soil profile at the Surfers Paradise and the summary of the soil properties used in the numerical analysis are shown in Fig. 1. The stratigraphy of the soil layers are given below.

- Layer 1: Loose to medium dense sand 5m thick with SPT in the range of 5 to 20, with static water table 3.5m below ground surface.
- Layer 2: Dense sand 8m thick and SPT values over 50.
- Layer 3: Organic peat and silty clays with average thickness 3m.
- Layer 4: Very dense sand with thickness varying from depth of 16 to 22m and SPT values over 50.
- Layer 5: Mainly stiff clay inter-bedded with sand strips, but idealized as homogeneous stiff clay 8m thick with SPT values of about 30.