CHAPTER II

LITERATURE REVIEWS

A variety of analytical and numerical approaches have been applied to analyze vertically loaded pile group in the past. Among others, the integral equation method is the most employed scheme. Poulos (1986) and Butterfield and Banerjee (1971), both employed Mindlin's solution for a point load in homogeneous elastic soil to study the interaction between two piles. In those papers, the increase in settlement of each pile is represented by an interaction factor. This approach was subsequently extended to handle soil nonhomogeneity and nonlinearity.

Randolph and Wroth (1979) proposed an approximate method for a pile group in soil with uniform stiffness and with stiffness increasing linearly with depth. The solution procedure is rigorous for rigid piles, but for compressible piles, semi-empirical equations relating the shaft settlement to the settlement of the pile top and pile tip have to be introduce to enable the numerical evaluation. In addition, this approach is restricted to linear elastic soil behavior.

Chow (1986) presented a hybrid method in which theoretical load-transfer curves was employed to describe soil response. Later he presented a numerical method based on elasticity theory for the case of nonhomogeneous soil (Chow 1987). The load-deformation relationship of the soil was determined by using the flexibility approach. In addition, a consistent set of elastic soil parameters was applied to model the soil response to each individual pile as well as the pile-soil-pile interaction.

Chin, et al. (1990) presented a numerical method based on a simplified elastic continuum Boundary Element method. The soil flexibility coefficients were evaluated by using the analytical solutions for a layered elastic half-space.

Guo and Randolph (1999) presented solutions for estimating the settlement of pile group in non-homogenous soil, using a load transfer approach derived from elastic continuum theory. Interaction factors between each pair of pile group and overall settlement ratio of various geometries were evaluated from the solutions.

Shen, et al. (1997) proposed a variational approach to determine the deformation of piles. A variational solution for the analysis of pile group in soil was modeled by the theoretical load-transfer curves. Later, Shen, et al. (1999) used the same approach for the analysis of pile group in an elastic half-space. Mindlin's solution was applied to simulate the response of the half-space. The deformations of pile group and its shear stresses were represented by a finite series with a set of unknown constants. The principle of minimum potential energy was used to determine these constants. Both the soil and piles were assumed to be linear isotropic elastic and the soil stiffness can either be constant or linearly increasing with depth.

All studies mentioned above considered the half-space as an elastic solid. In the context of poroelasticity, Niumpradit and Karasudhi (1981) presented the first theoretical study of quasi-static response of an axially loaded elastic bar in a homogeneous poroelastic half-space. They formulated the interaction problem in the Laplace transform space by using Muki and Sternberg's integral equation approach and Biot's theory for poroelastic materials. Senjuntichai and Rajapakse (1995) developed a computationally efficient and numerically stable exact stiffness matrix scheme to evaluate quasi-static response of a multi-layered poroelastic medium with compressible constituents. In their approach, the Laplace-Hankel transforms of displacements and pore pressure at layer interfaces are considered as the basic unknowns and the general solutions are used to explicitly derive the stiffness matrix which describes the relationship between the generalized displacement and force vectors of a layer. The global stiffness matrix of the multi-layered half-space is then assembled by considering the equilibrium of tractions and continuity of fluid flow at the interfaces between the adjacent layers.

Recently, Senjuntichai et al. (2002) studied an axial load transfer problem of a single pile in a multi-layered poroelastic medium by using the variational approach (Selvadurai and Rajapakse 1990) and an exact stiffness matrix scheme (Senjuntichai and Rajapakse 1995). A review of literature indicates that an axially loaded pile group embedded in a multi-layered poroelastic medium has never been investigated in the past.