CHAPTER II

LITERATURE REVIEW

2.1. Deep Foundation

Deep foundation are employed principally when weak or otherwise unsuitable soil exists near the ground surface and vertical loads must be carried to strong soils at depth. Deep foundations have a number of other uses, such as to resist scour; to sustain axial loading by side resistance in strata of granular soil competent clay; to allow above-water construction when piles are driven through the legs of a template to support an offshore platform; to serve as breasting and mooring dolphins; to improve the stability of slopes; and for a number of other special purposes. The principal deep foundations are driven piles and drilled shafts. (Reese, Lymon C., 2006)

2.2. Pile Foundation System

Piles are structural of timber concrete, and/or steel, used to transmit surface loads to lower levels in the soil mass. This may be by vertical distribution of the load along the pile shaft or a direct application of load to a lower stratum through the pile point. A vertical distribution of the load is made using a friction, or “floating”, pile and a direct load application is made by a point, or “end bearing”, pile. This distinction of piles purely one of convenience since all piles function as a combination of side resistance and point bearing except when the pile penetrates an extremely soft soil to a solid base.

Piles are commonly used for:

1. To carry the superstructure loads into or through a soil stratum. Both vertical and lateral loads may be involved
2. To resist uplift, or overturning, forces as for basement mats below the water table or to support tower legs subjected to overturning
3. To compact loose, cohesion-less deposits through a combination of pile volume displacement and driving vibrations. These piles may be later pulled.
4. To control settlements when spread footings or a mat is on a marginal soil or is underlain by a highly compressible stratum.
5. To stiffen the soil beneath machine foundations to control both amplitudes of vibration and the natural frequency of the system.
6. As an additional safety factor beneath bridge abutments and/or piers, particularly if scour is a potential problem.
7. In offshore construction to transmit loads above the water surface through the water into the underlying soil. This is a case of partially embedded piling subjected to vertical (and buckling) as well as lateral loads.

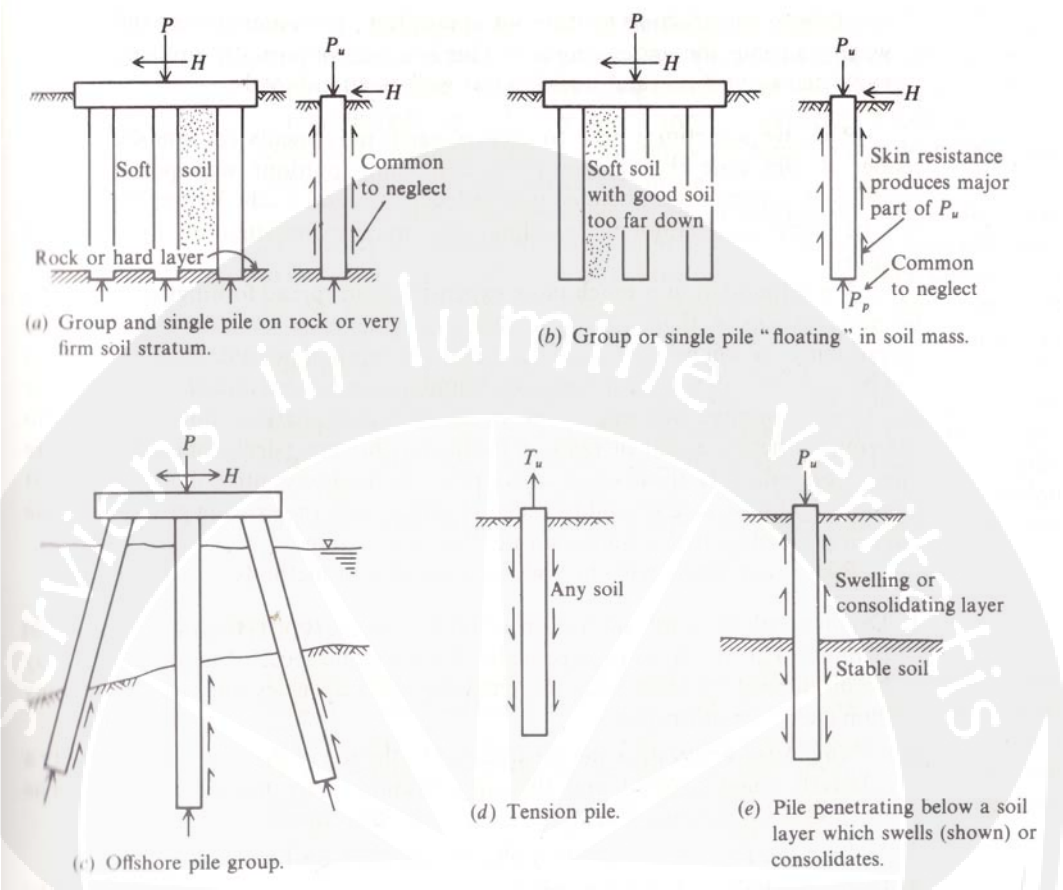

Figure 2.1 Typical Pile Configurations

A pile foundation is much more expensive than spread footings and likely to be more expensive than a mat. In any case great care should be exercised in determining the soil properties at the site for the depth of possible interest so that it can be accurately determined that a pile foundation is needed and, if so, that neither an excessive number nor lengths are specified. A cost analysis should be made to determine whether a mat or piles, in particular the type (steel, concrete, etc), are more economical. In those cases where piles are used to control the settlement at marginal soil sites, care should be taken to utilize both the existing ground and the piles in parallel so that a minimum number are required.

Piles are inserted into the soil via a number of methods:

1. Driving with a steady succession of blows on the top of the pile using a pile hammer. This produces both considerable noise and local vibrations which may be disallowed by local codes or environmental agencies and, of course, may damage adjacent property.
2. Driving using a vibratory device attached to the top of the pile. This is usually a relatively quiet method and driving vibrations may not be excessive. The method is more applicable in deposits with little cohesion.
3. Jacking the pile. This is more applicable for short stiff members.
4. Drilling a hole and either inserting a pile into it or, more common, filling the cavity with the concrete which produces pile upon hardening.

(Bowles, J. E. 1988)

2.3. Related Research

Some researches about the analysis of axially loaded single pile had been done in some country. Rodrigo Salgado and Junhwan Lee (1999) in their research titled *Pile Design Based on Cone Penetration Test Results* had a inspirational summary. They said that since the CPT methods available for pile design were developed under different conditions, the selection of the method should take into account the differences and recommendation of the methods.

Static cone penetration is better related to the pile loading process than the SPT. The test is performed quasi-statically and resembles a scaled-down pile load test. In the present study, in order to take advantage of the CPT for pile design, load settlement curves of axially loaded single piles bearing in sand were developed in terms of normalized base resistance (q_b/q_c) versus relative settlement (s/B).

For more general use of CPT-based pile design method, a correlation between SPT blow count N and the cone resistance q_c can be used. Field SPT and CPT test data for an Evansville sandy soil site suggests the correlation between q_c and N proposed by Robertson and Campanella (1983) is likely applicable to Indiana sandy deposits.

Other research had been done also by Murad Y. Abu-Farsakh and Hani H. Titi (2004) titled *Assessment of Direct Cone Penetration Test Methods for Predicting the Ultimate Capacity if Friction Driven Piles*. Their study presented an assessment of eight direct CPT methods to estimate the ultimate load capacity of square PPC friction piles driven into Louisiana soils. Analysis was conducted on 35 friction piles loaded to failure with CPT's conducted adjacent to each test pile. The measured ultimate load capacity for each pile was determined from the load settlement curve using the Butler-Hoy method (1977). The ultimate load capacity of each pile was also determined using the CPT methods, and the static α and β methods.

Their study showed that the ultimate pile capacity can be determined using the CPT data with the acceptable accuracy. The performance of the CPT methods may vary according to the performance used to determine the ultimate pile load capacity from the load test. The results are also influenced by the characteristics of the soil at the site. The conclusions of this study are based on the ultimate pile capacity interpreted from the load test using the Butler-Hoy method (1977).

Andras Mahler (2004) had been done research also titled *Use of Cone Penetration Test in Pile Design*. Four pile capacity methods were evaluated using CPT data for thirteen full scale axial pile load tests. The test piles were CFA piles with various geometry and were measured in various soil conditions. DIN 4014, LCPC, EUROCODE 7-3, and ERTC 3 methods were used for pile capacity predictions. To decide whether it is caused by the differing soil conditions or by differences in the pile installation process requires further studies. Nevertheless is is clear that those methods represent a useful tool in geotechnical design.