Problem Statement

I. Problem Title

Setup and Relaxation Effects on Load Carrying Capacity of Driven Piles

II. Problem Statement

Field observations have demonstrated the existence of increase in the load carrying capacity of piles driven in saturated clays and silts (e.g., Seed and Reese 1955, Yang 1956, Housel 1958, McCammon and Golder 1970, Flaate 1972, Thorburn and Rigden 1980, Konrad and Roy 1987, McManis et al. 1988, Skov and Denver 1988, Fellenius et al. 1989, Coop and Wroth 1989, Bogard and Matlock 1990). The increase over time of the load carrying capacity after installing driven piles is called pile setup (or freeze). This phenomenon is often associated with piles driven into saturated clays and silts. Pile setup in saturated clays is mainly attributed to soil consolidation around driven piles (e.g., Soderberg 1962, Randolph et al. 1979, Whittle 1993, York et al. 1994, Titi 1996). When a pile is driven into saturated NC clays, it disturbs and remolds the surrounding soil generating excess pore pressures. Thereafter, the excess pore water pressures dissipate by flowing away from the pile resulting in soil consolidation, which leads to the increase of the pile load carrying capacity over time (pile setup).

On the other hand, an opposite phenomenon called pile relaxation has been observed (e.g., Yang 1970, Cox and Kraft 1979, Fellenius et al. 1989, Jardine and Bond, 1989, Bond and Jardine 1991, York et al. 1994) in which the load carrying capacity of the pile decreases with time after installation. Pile relaxation can be encountered in dense fine sand, inorganic silt, or stiff fissured clay.

Pile setup and pile relaxation are complex phenomena, which directly related the behavior of the pile during: (a) pile installation, (b) simultaneous changes in the stresses and pore water pressures in the surrounding soil, (c) equalization of the excess pore water pressures and stresses in the soil, and (d) pile loading.

In engineering practice, design and analysis of friction piles is carried out based on empirical formulas and depends to a large extent on personal experience and judgment of the engineer. Because of many uncertainties associated with pile foundation analysis and design, full-scale pile load tests are usually carried out at the site for important projects. It is customary to do these tests 2 to 3 weeks after driving. The purpose of a pile load test is mainly to assist the design engineer and to provide actual evaluation of the pile response under loading. Nevertheless, pile load tests cannot substitute for the engineering analysis of the pile behavior. Pile installation causes changes to the pile load carrying capacity over time. In engineering practice, the change in the load carrying capacity (pile setup or pile relaxation) that develops after performing the load test is commonly ignored. This might result in failure if pile relaxation occurs or conservative design in the case of pile setup. Piles are expensive and critical structural members, and pile projects are always costly. Therefore, there is a need for pile design based on a rational method that accounts

for the time effect on the load carrying capacity of driven piles, which will assure stability of foundations and will reduce the cost of piling.

III. Objectives of Research

The objectives of this study are to:

1. Investigate the factors associated with pile setup and relaxation
2. Develop methodology to predict/estimate pile setup and relaxation associated with driven piles
3. Verify the methodology based on pile performance in field by conducting field and laboratory experiments

IV. Urgency

Piles are commonly used in transportation projects. Most state DOTs around the country spend millions of dollars each year on piling. Development of pile design that accounts for pile setup and relaxation is urgent as it leads to cost savings in piling projects with maintaining the required of level of safety/stability of pile supported structures.

V. Estimated Cost and Time Required

It is estimated that this research will take three years and will cost approximately $450,000.