CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Soil nailing is the passive reinforcement of existing ground by installing closely spaced steel bars (nails) that are encased in grout. As construction proceeds from the top to bottom, shotcrete or concrete is also applied on the excavation face to provide continuity. Soil nailing is typically used to stabilize slopes or excavations where top-to-bottom construction is advantageous compared to other retaining wall systems.

The technique of soil nailing has been increasing in popularity because it offers cost-effective retaining system for a variety of ground conditions such as the side slopes of canals, temporary vertical cuts for constructing basements, and permanent excavation near roads. This technique has been used extensively in Europe for the last 45 years. In the Unites States, the past 25 years have seen a continued interest in its applications. In Egypt, this technique has been widely used in the last few years, and has been adopted in several projects such as City Stars in Cairo, Pump Station in Toshka project, and in stabilizing the slopes of canals.

The design of soil nailed wall is based on two main methods. The first is the limit equilibrium method, and the second method is by using finite element analysis. Both methods give good results in design of soil nailed wall.

1.2 RESEARCH OBJECTIVES

There were several objectives for this research. First was to determine the best way to simulate the soil nailed wall using finite element software known as PLAXIS®. Secondly, to carry out a parametric study to determine the effect of each parameter on global factor of safety and horizontal displacement at the top of the soil nailed wall in the final construction stage. The main objective of the research was to develop charts for the preliminary design of soil nailed wall based on factor of safety and displacement. These design charts provide evaluation of the global factor of safety and the anticipated horizontal displacement at the top of the soil nailed wall.

1.3 METHODOLOGY AND APPROACH

The objectives of the research were achieved through three stages. In the first stage, a finite element model was performed using PLAXIS® to simulate a selected section in the location of City Stars project using three different nail models. Comparing the results of the three nail models with field data, then the best model could be deduced; also a comparison was made between the values of factor of safety that deduced from finite element model and that deduced from Egyptian code procedure. In the second stage, the best nail model deduced from the first stage was used to create several runs in order to study the effect of each parameter on the final construction stage global factor of safety and horizontal displacement at the top of the wall. In the third and last stage, a parametric study of the second stage was performed to create design charts that give the ability to determine preliminary global factor of safety and horizontal displacement at the top of soil nailed wall and at the end of construction.

1.4 SCOPE

Chapter 2 presented a literature review contains a historical background of the use of soil nailed walls and describes the soil nailed wall main components, construction sequences, main factors affect soil nailed wall, deformation of the soil nailed wall and the different methods used to design of soil nailed walls. In Chapter 3, a simulation by three different nail models of a section on City Star project using PLAXIS® was conducted, and the results from the finite element model were verified with field data, also a comparison made between the finite element model and the procedure discussed by the Egyptian Code. A Parametric study that includes a series of 270 runs were developed in Chapter 4 using the best model determined in chapter 3 to find out the effect of different parameters on global factor of safety and horizontal displacement at the top of the soil nailed wall. In addition, relations were predicted showing the most effective parameters on the global factor of safety and horizontal displacement at the top of the wall and at the final construction stage. In Chapter 5, design charts based on factors of safety and displacements were developed depending on the results of the parametric study performed in chapter 4. These design charts were corrected for global factor of safety and horizontal displacement at the top of the wall, if the values of friction angle, deformation modulus or wall height are different from values that used in the design charts. A summary of the overall findings and conclusions, as well as recommendations for future studies were presented in the last chapter of the thesis.