CHAPTER I

INTRODUCTION

1.1 Introduction

The movement of the contaminant in the environment is caused by many factors. These factors are governed by the process of the advection, dispersion, adsorption, and degradation among the others. The first three of these processes are affected by soil charateristics, particularly the grain-size distribution, aggregation of particles, mineral composition, ionic strength and soil concentration. For the adsorption and degradation, the processes depend on properties of the polluting compound as well as the character of mineral surfaces and possibly on soil organic matter. A typical soil deposit, having layers of differing characteristics, provides a very complex medium for the transport of pollutants. Prediction or evaluation of the movement of pollutants in such soils requires consideration of the described processes.

An area of interest within the field of subsurface transport and fate processes that is receiving much recently attention is the area of modeling. Groundwater contamination is an issue of a major concern in residential areas in the vicinity of landfills and waste disposal repositories. It has become apparent that there is a lack of physical observations of pollutant behavior in soils. This information is vital to evaluate existing theoretical models and develop improved conceptual models of transport processes. The economics, large time scales and lack of control over the boundary conditions have prevented the development of field scale experiments. Column tests are limited in use and difficult to apply to full scale problems. Thus, researchers have come to recognize that a geotechnical centrifuge can provide a powerful testing tool for modeling the transport of contaminants in subsurface (Arulanandan et al., 1988; Hensley 1989; Cooke and Mitchell, 1991; Hensley and Savvidou, 1993 and Hellawell et al, 1993).

However, the cost and land requirements to construct a geotechnical centrifuge are typically prohibitive.

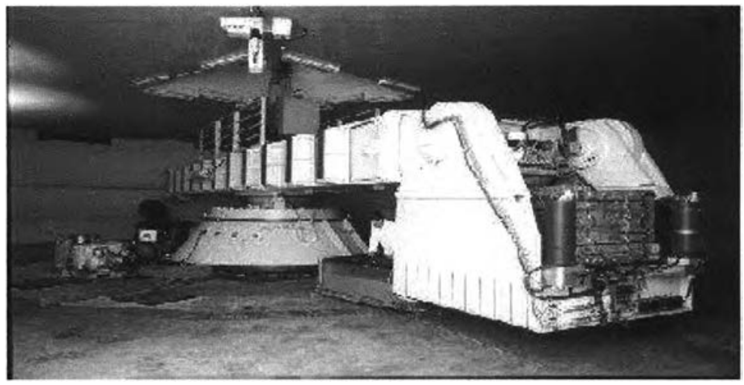

Figure 1.1 9-m Radius Centrifuge at the University of California, Davis

1.2 Objectives

The modular finite-difference groundwater flow model well known as MODFLOW (McDonald and Harbaugh, 1988 and Harbaugh and McDonald, 1996a and b) has been developed for simulating confined, unconfined, and saturated flow in one, two or three dimensions. The program allows both steady-state and transient simulations. Geotechnical centrifuge can provide a powerful testing tool for modeling the transport of contaminants in subsurface soils (Arulanandan et al., 1988; Hensley 1989; Cooke and Mitchell 1991; Hensley and Savvidou 1993 and Hellawell et al, 1993). The main objective of this thesis is to validate MODFLOW by using the result from the centrifuge model tests. In addition validity of centrifuge scaling laws is investigated using MODFLOW.

The main objective is achieved by:

1. Studying the scaling laws and modeling subsurface transport and fate processes.
2. Studying the MODFLOW program and simulate the program correctly.
3. Validating the contaminant transport processes using MODFLOW and centrifuge model test results.

1.3 Hypothesis

The Geotechnical Centrifuge, a powerful testing tool for modeling the transport of contaminants in soils, can be used to validate the computer groundwater flow computer such as “MODFLOW”.

1.4 Scope of the study

1. Two cases of centrifuge model are simulated by Visual MODFLOW version 3.0.
   - First case is a scale model test using several types of soils in idealized models of one-dimensional flow situations (Arulanandan et al., 1988).
   - Second case is an experiment performed on the Cambridge Geotechnical Centrifuge investigating the migration of a contaminant plume under the influence of density gradients (Hellawell and Savvidou, 1994).
2. Using the parameters from the case results and simulate the program to prove the scaling law.
3. The MODFLOW program is validated by comparing the predictions against centrifuge model test result on contaminant transport.

Table 1.1 The detailed of the case studies

First Case	Second Case
1. The change of concentration to initial concentration at Middepth of each type of soils 2. One dimensional flow situation 3. Different scale model tests are used in these cases 4. Types of media are Silica Flour, Snowcal 50 and Monterey 0/30 sand	1. The migration of a contaminant plume under the influence of density gradients 2. Two dimensional flow situation 3. 100-g scale model test is used in this case 4. The prototype is a landfill leaking a non-sorbing dense pollutant into a homogeneous silt layer. The soil type is Silica Flour. The pollutant is sodium chloride

In this work, an attempt is made to enhance the capabilities of the MODFLOW program. The main focus is to validate the MODFLOW program for applications in environment problems by simulating the contaminant transport and use as the tools before construct a geotechnical centrifuge model. In Chapter II, the review of MODFLOW development, geotechnical centrifuge and scaling law are presented. The detailed of MODFLOW and the validation procedure are given in Chapter III. In Chapter IV, validation results are discussed. The validation is divided into two sections, a scaling law study and comparisons with experimental results. The conclusion and recommendations for further study are given in Chapter V.