Highlights of Research

(1) Efficiency of Leachate Recirculation Systems in ELR Landfill in Denton, TX (PI: MD Sahadat Hossain)

Currently I am working with the City of Denton to study the efficiency of leachate recirculation system in the Enhanced Leachate Recirculation (ELR) landfill. The objective of the proposed research is to help the City of Denton with the implementation of Enhanced Leachate Recirculation (ELR) cell at Denton Landfill. Accurate and verifiable measured data of inputs and outputs to the landfill system will be crucial in determining the tangible benefits of Enhanced Leachate Recirculation. The main objectives of the proposed research are to:

- Demonstrate the benefits of operating landfills as Enhanced Leachate Recirculation (ELR).
- Demonstrate the ability to operate wet cell without adverse impact on the environment.
- Monitor the effectiveness of designed ELR components at Denton landfill

This will be the first project of this kind in Texas. The research results will other cities and TCEQ to implement ELR or bioreactor landfill technology effectively through out TEXAS. The study will develop a guideline for developers, engineers, and city planners for bioreactor landfill design and operation practices in Texas.

(2) Bioreactor Landfill Technology (PI: MD. Sahadat Hossain)

My research and scholarship are well recognized internationally. I have worked extensively on the design of waste containment and bioreactor landfill technology. During my Ph.D. at NCSU, I have successfully completed a research project on leachate circulation in municipal solid waste landfills to further our understanding of the design of bioreactor landfills. The completed project was sponsored by Environmental Protection Agency (EPA). My research work was focused on "Mechanics of Compressibility and Strength of Solid Waste in Bioreactor Landfills." My research work linked the gap between geotechnical and environmental aspects of bioreactor landfills and provided a correlation between the geotechnical engineering properties as a function of waste decomposition and biological degradation. This has been a major advance to the field of landfill technology and geoenvironmental engineering. Bioreactor landfill technologies are becoming more and more popular as a waste disposal technique. I have continued to develop as one of the leading researchers areas related to the mechanics of solid waste in landfills.

At present, I am working on changes in dynamic characteristics of MSW in bioreactor landfills with time and decomposition. The effects of accelerated decomposition on permeability of MSW in a bioreactor landfill are investigated. Municipal solid waste (MSW) samples were collected from a transfer station in Burlington, Texas, were used to built two sets of bioreactor cells.

Figure 1 Simulation of Bioreactor Landfill in the Laboratory

Each set of reactor consists of four 16-gallon reactors to prepare samples at different stages of decomposition. The first sets of reactors were set up without soil, and the second sets with soil to simulate the intermediate covers.

Some of the research publications from the projects are listed here:

1. **Hossain, M.S.**, Haque, M.A., Qasim, S. and Hoyos, L. (2007). "Dynamic Characteristic of Municipal Solid Waste with Degradation in Bioreactor Landfills", 4th International Conference on **Earthquake Geotechnical Engineering**, June 25-28, 2007, **Thessaloniki**, **Greece.**
2. **Hossain, M.S.**, Haque, M.A., Qasim, S. and Hoyos, L. (2007). "Seismic Stability of Bioreactor Landfill with Decomposition - A Numerical Modeling", 4th International Conference on **Earthquake Geotechnical Engineering**, June 25-28, 2007, **Thessaloniki, Greece.**
3. **Hossain, M.S.**, Hoyos, L.R. and Penmethsa, K. (2007), "Permeability of Municipal Solid Waste in Bioreactor Landfill with Degradation**"** Accepted for Presentation and Publication to Geotechnical Special Conference, **GeoCongress 2008**, to be held on March 9 – 12, 2008, New Orleand, Louisiana

(3) Geophysical Investigations (PI: MD. Sahadat Hossain, Co-PI: Mohammed Najafi)

I have acquired High Resolution Resistivity (HRR) equipment to conduct geophysical study of existing subsurface conditions. The use of geophysical methods for the evaluations geohazrads potential of a site is increasingly becoming popular all over the world. During failure analyses, several parameters are investigated by geologists and geotechnical engineers. However, they can only obtain information at certain points, not a general "view" of site conditions. Geophysical methods have the possibility to give an "image" of the subsurface. Also, with the development of new software for the interpretation of resistivity measurements, 2D and 3D "resistivity imaging" or "resistivity tomography" is extensively used today in shallow geophysical investigation and especially for geohazard study. HRR is used for enhanced mapping of lateral and vertical variations in subsurface moisture content, environmental

contamination, and near surface geology. HRR can accurately map ground water flow within earthen embankments and dams. It provides finer details and greater depths (up to 50 meters or more) of investigation than traditional Electromagnetic Induction (EMI) method. A typical HRR survey utilizes a multi-channel, multi- electrode automatic sequencing data acquisition system. I am working with Dr. Najafi on determining voids around underground pipes using resistivity imaging. Examples of the equipment capabilities are presented here:

Figure 1 Super Sting R18P Imaging System

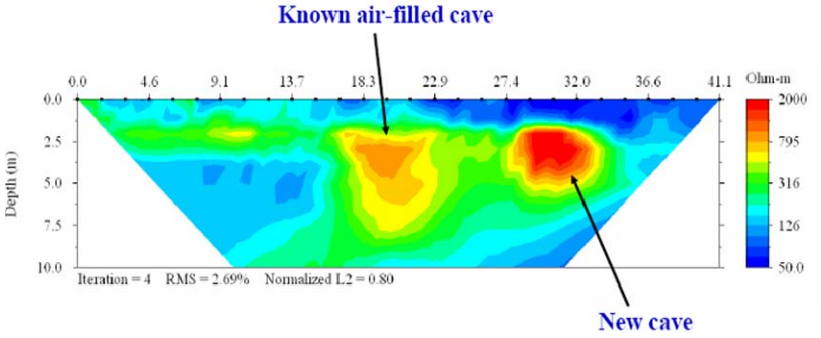


Figure 2 Detection of Voids using HRR

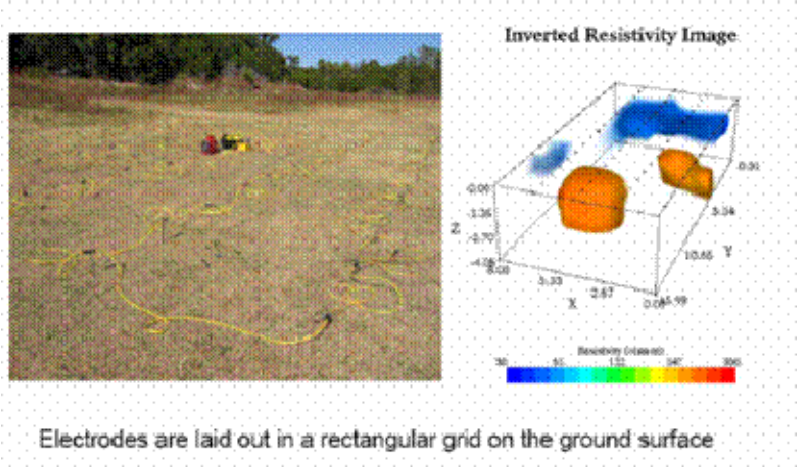


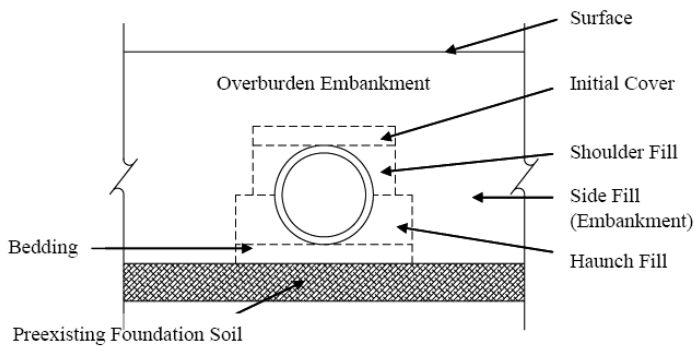
Figure 3 Detection of underground contaminants using HRR

(4) Numerical Modeling

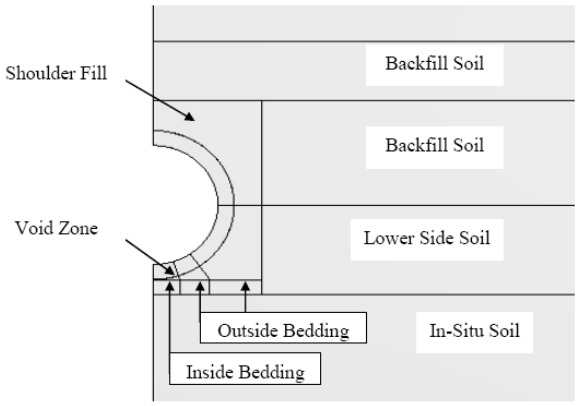
a) Finite Element-Based Investigations of the Effects of Bedding Thickness and Bedding Irregularities on the Underground Pipes".**(PI: Ali Abolmaali, Co-PI: MD Sahadat Hossain)**

I have worked with Prof. Ali Abolmaali to study the effects of bedding thickness and irregularities on underground pipes. The pipe-soil interaction was studied by using the finite element software, ABAQUS/CAE Version 6.5-1 as a symmetric model of embankment installation. A three-dimensional finite element model (FEM) of the concrete pipe and surrounding soil was developed. The FEM is capable of simulating material, geometric, and contact nonlinearities which employs a nonlinear incremental solution algorithm.

To study the effect of bedding thickness on the pipe wall, due to the increment of backfill soil depth, contact elements were employed in the interface between each two regions. The lateral boundaries and model length were also studied for the converged solution. A parametric study was conducted to study the effects of bedding thicknesses 3 in (7.5 cm), 5 in (12.5 cm), 7 in (17.5 cm), and 9 in (22.5 cm) with backfill heights 20 ft (6 m), 40 ft (12 m), 60 ft (18 m), 80 ft (24 m), and 100 ft (30 m).

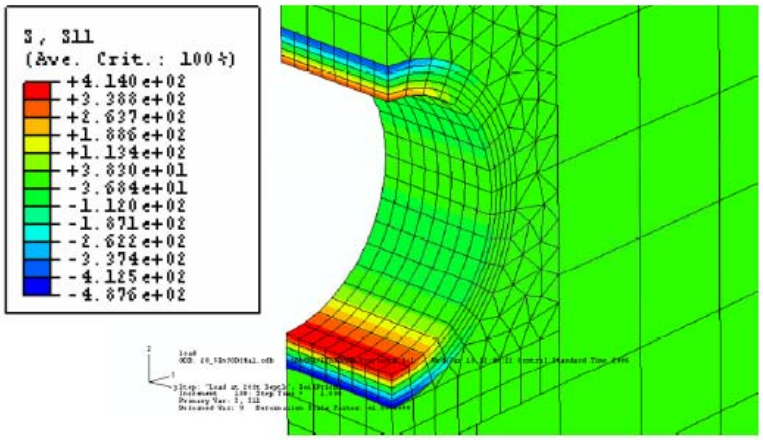


(a)

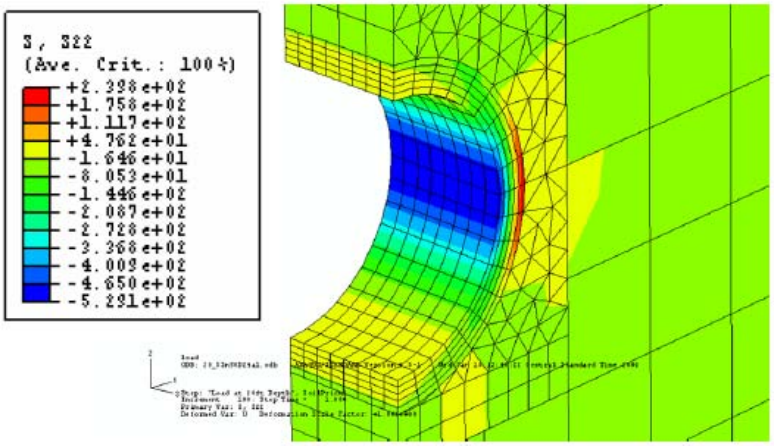


(b)

Figure 1 Embankment Installation (Positive Projection); (a) Typical details and (b) Soil zones used in the symmetric FEM model



(a)



(b)

Figure 2 Typical stress contour in the pipe wall; (a) Hoop stresses at invert and crown and (b) Hoop stresses at springline

(b) Pile Supported Embankment on Soft Ground (PI: MD. Sahadat Hossain)

I have worked on Cheimco-pile supported embankment on soft Bangkok clay for his Masters Thesis in Asian Institute of Technology (AIT), Bangkok, Thailand. Both full scale field study and numerical modeling were completed for the chemico-pile supported embankment. The Finite Element Program PLAXIS was utilized for numerical modeling purpose. The comparisons between numerical modeling and field data are made for pore water pressure, vertical settlements, and lateral movements. I have continued on pile supported embankment research. Recently I have completed a project on identifying and investigating different types of pile-supported embankments, and their improvement effects on the embankment. The research results were published in the Journal of TRB in 2006. The paper presents the

improved effect of chemico pile on soft clay, observed improved embankment behavior based on the field data, and comparison of field data with numerical modeling results.

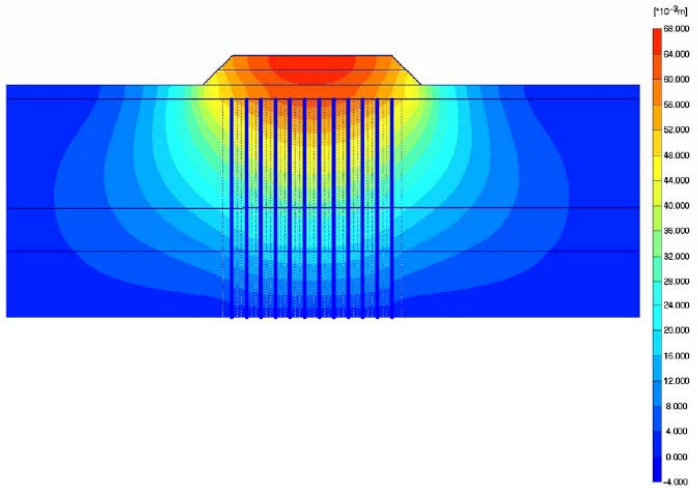


Figure 1 Total Displacement Contour of the Improved Embankment

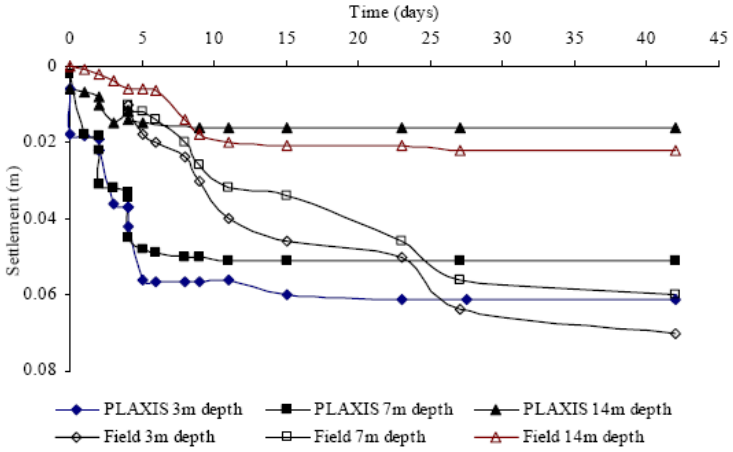


Figure 2 Comparison of Predicted and Measured Subsurface Settlement

(5) Brownfields (PI: MD Sahadat Hossain)

Since its inception in 1995, EPA's Brownfields Program has grown into a proven, results-oriented program that has changed the way contaminated property is perceived, addressed, and managed. EPA's Brownfields Program is designed to empower states, communities, and other stakeholders in economic redevelopment to work together in a timely manner to prevent, assess, safely clean up, and sustainable reuse Brownfields. A Brownfields is a property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. It is estimated that there are more than 450,000 Brownfields in the U.S. Cleaning up and reinvesting in these properties increases local tax bases, facilitates job growth, utilizes existing infrastructure, takes

development pressures off of undeveloped, open land, and both improves and protects the environment. Initially, EPA provided small amounts of seed money to local governments that launched hundreds of two-year brownfields "pilot" projects. Through passage of the Small Business Liability Relief and Brownfields Revitalization Act, effective polices that EPA had developed over the years were passed into law. The Brownfields Law expanded EPA's assistance by providing new tools for the public and private sectors to promote sustainable brownfields cleanup and reuse.