IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project title: Hydro-Mechanical Behaviour of Geosynthetic Clay Liners in Landfill Capping Systems

Project number: IMURA0064

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Research Academy theme

Infrastructure engineering
Water

The research problem

Waste containment facilities (i.e. municipal solid waste/hazardous waste landfills, etc.) form part of critical infrastructure that provides essential community services. In most cases, they are designed to ensure negligible long-term environmental and human health impact. To achieve these aims, construction is required of barrier systems which effectively separate the waste and the associated leachate and biogas from the groundwater system and the atmosphere, respectively. One conventional approach to barrier systems has been to construct a “resistive barrier” composed of a capping liner that reduces water ingress into the landfill and controls biogas escape into the atmosphere, as well as base liner having a low saturated permeability which minimises leachate migration out of the landfill. Over the past decade, geosynthetic clay liners (GCLs) have become one of the dominant construction materials in landfills and have gained widespread acceptance for use in capping systems. GCLs are typically comprised of a thin layer of bentonite sandwiched between two layers of geotextile with the components being held together by needle-punching or stitch bonding. Once on-site, the GCL is unrolled in strips (panels), the panels overlapped without mechanical welding and self-seal at the overlaps when the bentonite hydrates. Due to biodegradation of waste, capping systems are prone to differential settlements of varying degree of severity. Furthermore, the combined effect of cation exchange and dehydration can adversely affect GCLs to the point where they may no longer be effective as hydraulic or gas barriers. Without a full understanding of the fundamental mechanisms controlling GCL dehydration, and clear understanding of the mechanical behaviour of the GCL under field conditions, unacceptable uncertainty will continue to exist regarding the amount of panel overlap required during installation and the performance of GCLs used in a wide range of applications were the combined effect of differential settlement and dehydration may be problematic

Project aims

The primary objective of this project is to conduct an in-depth study of hydro-mechanical coupling in geosynthetic clay liners under field stress conditions. To achieve this objective, three different tasks will be conducted: (1) laboratory testing involving the use of column tests, (2) centrifuge testing, and (3) numerical modelling.

Expected outcomes

The major outcome will be the development of a methodology to assess the hydro-mechanical behaviour of geosynthetics clay liners in capping systems under field stress conditions.

Which of the above Theme does this project address?

The project will address primarily the Infrastructure Engineering theme. However, it has also ramifications to the water theme since it will contribute to the protection of groundwater resources.

How will the project address the Goals of the above Themes?

The proposed project targets an entirely new and emerging area where very limited research has been carried out. This project is of considerable relevance to India since colossal amounts of municipal solid waste landfills have accumulated around cities and towns. These sites require closure utilizing properly designed capping systems to safe-guard the environment and to look for other redevelopment avenues such as reusing of large hectares of area occupied by closed landfills in the future. The problem is all the more acute in and around mega cities. Interestingly, scarcity of suitable earthen materials in urban areas necessitates looking for alternative barriers such as geosynthetic clay liners GCLs. This study will lead to the development of guidelines for appropriate sealing of landfills.

To achieve this goal, advanced and state-of-the-art Monash University equipment will be used to investigate the hydro-mechanical behaviour of GCLs. This will be combined with the large beam centrifuge facility available at IIT Bombay. In addition, existing facilities like differential settlement simulator and in-flight seepage simulator will be directly relevant to this project. The project will also facilitate technology transfer for the development of state-of-the art safe disposal systems for landfills in mega cities in India.