INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Engineered multi-layered cover system (MLCS) are constructed over near surface waste disposal facilities (NSDF) after the operational closure for minimizing rain water ingress into the underlying wastes. There are different types of MLCS, which are applicable for a given climatic condition. The relevant literature advocates clay based hydraulic barrier as the MLCS for high humid high intensity rainfall regions like Indian subcontinent. There are not many studies that evaluate the hydraulic performance of MLCS relevant to the tropical climate of India. The main objective of this study is to investigate the hydraulic performance efficiency of the MLCS for the tropical Indian climate. This was accomplished by conducting controlled laboratory percolation study under constant ponding depth for different configurations of MLCS for a duration of 900 days. The role of inclusion of geosynthetic clay liner (GCL) and fly ash in the MLCS was studied based on the laboratory results. A field MLCS was constructed for studying the percolation characteristics under realistic soil-atmosphere boundary condition for a period of 800 days. The laboratory and field MLCS were simulated numerically using HYDRUS 2D finite element code for identifying the appropriate hydraulic characteristic input and boundary conditions. Based on this, the climate change impact on MLCS was investigated with and without considering material performance deterioration for a duration of 87 years.

The numerical simulation of laboratory MLCS column matched well with wetting water retention characteristics as compared to drying and predicted results. The numerical analysis of field MLCS indicated the appropriateness of drying water retention characteristic input for simulating the alternate wetting and drying conditions. The MLCS with GCL resulted in 36 % cost benefit and performed efficiently despite using relatively permeable fly ash in the surface layer. In the absence of GCL, MLCS underperformed when fly ash was added to the surface layer. The field study of MLCS revealed that the input atmospheric boundary condition based on Penman-Monteith evapotranspiration model gave comparable numerical and measured results. The effect of 800 days of weather variation was found to be significant for surface layer (SL), and marginal for both drainage and barrier layers (DL and BL). Vegetation growth and desiccation cracks on the SL hardly affected the moisture dynamics in the BL for this duration. The numerical simulation of long-term climate change impact of 87 years exhibited high sensitivity of SL to the atmospheric variants by undergoing cyclic wetting and drying. The simulation results indicated that the provision of MLCS without GCL restrict water interaction with the waste by 13 and 18 years with and without considering material deterioration, respectively. The provision of GCL in the MLCS delayed the water interaction with the waste by 25 and 42 years with and without considering material deterioration, respectively.