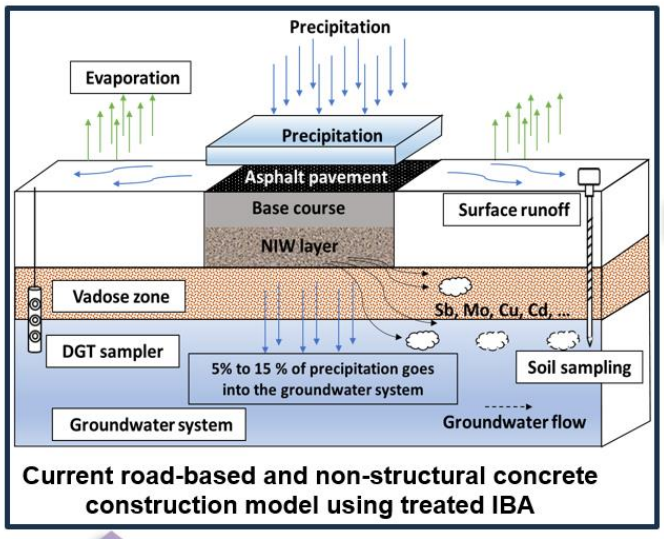
NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE | Nanyang Environment and Water Research Institute

ENVIRONMENTAL STANDARDS & ENGINEERING BEHAVIOURS OF REUSED INCINERATION ASHES FROM MUNICIPAL SOILD WASTE AND SEWAGE SLUDGE

Abstract:

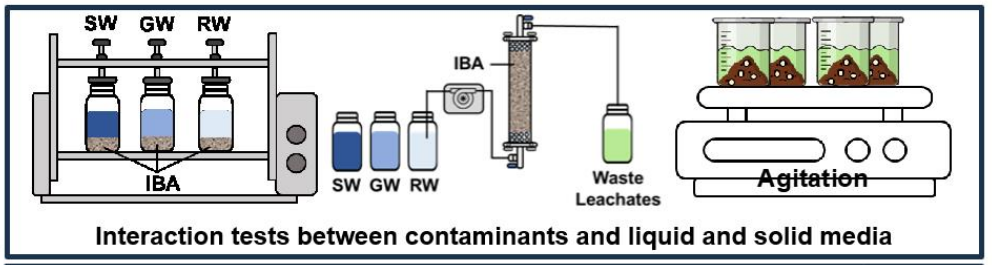
Singapore's only active landfill, Semakau Landfill, is projected to reach full capacity by 2035, highlighting the urgent need for alternative strategies for waste reuse. This study focuses on two major types of waste: incineration bottom ash (IBA) and non-incinerable waste (NIW) - such as wastewater sludge. In Phase 1, a comprehensive field trial at Tanah Merah Coast Road (TMCR) and conceptual site modelling assessed the environmental standards for using IBA in construction. The study investigated leaching characteristics of the treated IBA and its reuse in concrete, vulnerability of local groundwater and soil, and climate change conditions. The Reference Values (RVs) were derived based on conservative modelling assumptions with the intent of allowing widespread adoption of IBA use in Singapore. Phase 2 will review and calibrate the modelling assumptions used in Phase 1 based on 1) more realistic considerations; 2) insights from leaching data of local soil across the proposed test sites; 3) replacement ratios of sand by IBA as subbase material; and 4) endpoint criteria based on the new local soil and groundwater standards to finalise the RVs for road-based and non-structural concrete (NSC) construction applications using treated and untreated IBA. Laboratory tests will assess the environmental and engineering properties, and 15 potential waste reuse sites in Singapore will be studied to map out the local baseline environmental conditions. IBA-embedded concrete's interactions and leaching behaviour at low mixing ratios and various grain sizes, and feasibility of using IBA in structural concrete and coastal protection applications will also be studied.

NIW is the second largest group of waste residues disposed at Semakau Landfill (SL). R&D initiatives have been undertaken to treat NIW for construction applications, more notably the development of light weight aggregates (LWA) made from sewage sludge incineration ash (SSIA) by Zerowaste Asia. As NIW and SSIA possess different physical properties and contaminants compared to IBA, the RVs for IBA could not be directly applied. Therefore, the second part of Phase 2 project will study the properties and contaminants of SSIA and develop preliminary RVs for the LWA derived from SSIA (SSIA-LWA). Additional types of NIW may be included into the study using earlier established conceptual site model (CSM), if needs arise and there are sufficient resources. Risk assessments, both regarding Environment (ERA) and Health (HRA), will be used to evaluate the impacts from IBA and SSIA-LWA. Studies like Material Flow Analysis (MFA), Techno-Economic Analysis (TEA), and Life Cycle Assessment (LCA) will estimate future availability, cost, demand, and reuse limits, informing local waste management policies and strategies.

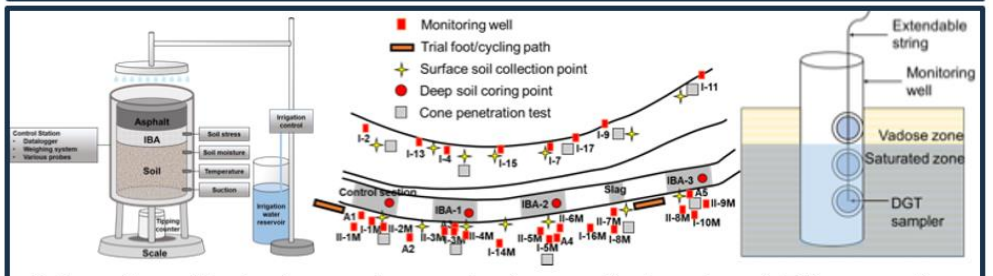


Current road-based and non-structural concrete construction model using treated IBA

Sampling & characterization

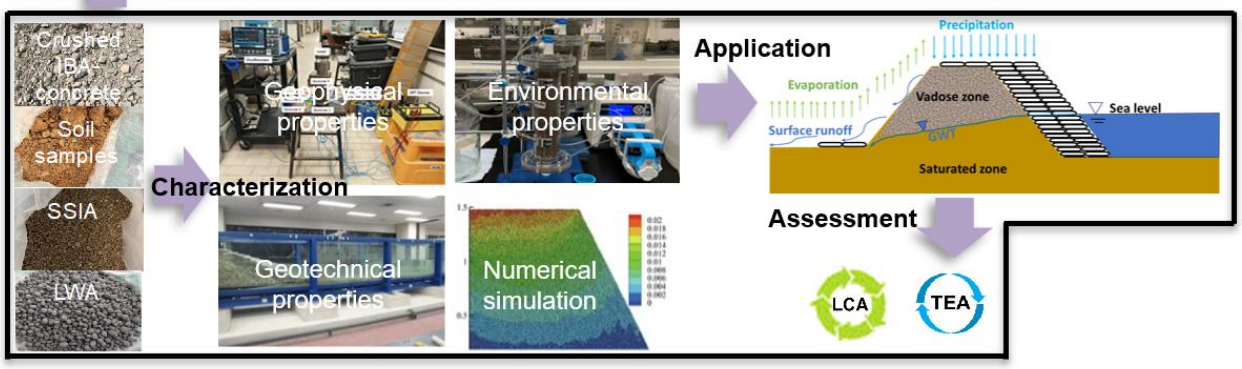


Interaction tests between contaminants and liquid and solid media



Schematics of lysimeters and groundwater monitoring plan at IBA reuse sites

Update CSM and refine the RVs for IBA



Resource recovery and sustainability:

- Derive Reference Values for reusing IBA in loose and concrete forms.
- Derive preliminary Reference Values for reusing SSIA in aggregate and concrete forms.

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