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Hydro-Mechanical Characterization of PolyChlorinated Biphenyls Polluted Sediments in Interaction with Geomaterials for Landfilling

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Abstract : This paper focuses on the hydro-mechanical behavior of polychlorinated biphenyl (PCB) polluted sediments when stored in landfills and the interaction between PCBs and geosynthetic clay liners (GCL) with respect to hydraulic performance of the liner and the overall performance and stability of landfills. A European decree, adopted in the French regulation forbids the reintroducing of contaminated dredged sediments containing more than 0,64mg/kg Σ 7 PCBs to rivers. At these concentrations, sediments are considered hazardous and a remediation process must be adopted to prevent the release of PCBs into the environment. Dredging and landfilling polluted sediments is considered an eco-environmental remediation solution. French regulations authorize the storage of PCBs contaminated components with less than 50mg/kg in municipal solid waste facilities. Contaminant migration via leachate may be possible. The interactions between PCBs contaminated sediments and the GCL barrier present in the bottom of a landfill for security confinement are not known. Moreover, the hydro-mechanical behavior of stored sediments may affect the performance and the stability of the landfill. In this article, hydro-mechanical characterization of the polluted sediment is presented. This characterization led to predict the behavior of the sediment at the storage site. Chemical testing showed that the concentration of PCBs in sediment samples is between 1.7 and 2,0 mg/kg. Physical characterization showed that the sediment is organic silty sand soil (%Silt=65, %Sand=27, %OM=8) characterized by a high plasticity index (Ip=37%). Permeability tests using permeameter and filter press showed that sediment permeability is in the order of 10-9 m/s. Compressibility tests showed that the sediment is a very compressible soil with Cc=0,53 and Cα =0,0086. In addition, effects of PCB on the swelling behavior of bentonite were studied and the hydraulic performance of the GCL in interaction with PCBs was examined. Swelling tests showed that PCBs don't affect the swelling behavior of bentonite. Permeability tests were conducted on a 1.0 m pilot scale experiment, simulating a storage facility. PCBs contaminated sediments were directly placed over a passive barrier containing GCL to study the influence of the direct contact of polluted sediment leachate with the GCL. An automatic water system has been designed to simulate precipitation. Effluent quantity and quality have been examined. The sediment settlements and the water level in the sediment have been monitored. The results showed that desiccation affected the behavior of the sediment in the pilot test and that laboratory tests alone are not sufficient to predict the behavior of the sediment in landfill facility. Furthermore, the concentration of PCB in the sediment leachate was very low (< 0,013 µg/l) and that the permeability of the GCL was affected by other components present in the sediment leachate. Desiccation and cracks were the main parameters that affected the hydro-mechanical behavior of the sediment in the pilot test. In order to reduce these infects, the polluted sediment should be stored at a water content inferior to its shrinkage limit (w=39%). We also propose to conduct other pilot tests with the maximum concentration of PCBs allowed in municipal solid waste facility of 50 mg/kg.

Keywords : geosynthetic clay liners, landfill, polychlorinated biphenyl, polluted dredged materials
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