A simple model of the hydro-mechanical behaviour of earthfill dams to support decision making regarding tailings dams' safety.

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ABSTRACT

The high rate of tailings dams' failure over the past decades, and the gravity of their environmental consequences and high related costs, has drawn attention to the issue of the maintenance and monitoring of these structures.

State-of-the-art techniques developed to improve the monitoring of tailings dams and similar infrastructure, are based on sensor networks that are installed on the structure. The devices collect and report measurements of pore water pressure and/or other parameters, and report them to a monitoring center, often in real time. To optimize the exploitation of this kind of data for educated decision making, the need to combine the data with a numerical model arose. Tailings dams are usually earthfill dams, often made of tailings material itself. Therefore, the model should be able to simulate the water flow through the porous material of the body of the embankment. It should account for the coupling between the hydraulic and the mechanical part of the problem and possibly also simulate the transfer of pollutant substances.

In this work we present an initial "toy" model that has been developed in order to simulate the hydromechanical behavior of earthfill embankments using Finite Element Method. The model was developed in FEniCS computing platform, an open-source platform that automates the solution of Partial Differential Equations with FEM [1]. This is a conceptually similar model to the well-known Barcelona Basic Model [2-3] that describes the behavior of unsaturated soils. The model accounts for the two-way, time-dependent coupling between the deformation of the soil structure and the groundwater flow. The dependence of soil permeability on the stress state introduces non-linearities to the problem.

The essential objectives of this project are the development of a numerical tool that will be able to simulate the physical procedures that are related to tailings dam's safety in a realistic way, and the implementation of model order reduction methods on the tool, in order to enhance its efficiency to the point that it can be used to perform sensor data assimilation. The ultimate goal is the optimization of the entire monitoring system, by determining the critical spots in the body of a dam where the sensor devices should be installed, in order to obtain maximum information on the system.

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