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Dual permeability FEM models for distributed fiber optic sensors development

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Fiber optic cables are commonly known for being robust and reliable mediums for transferring information at the speed of light in glass. Billions of kilometers of cable have been installed around the world for internet connection and real time information sharing. Yet, fiber optic cable is not only a mean for information transfer but also a way to sense and measure physical properties of the medium in which is installed. For dike monitoring, it has been used in the past for detecting inner core and foundation temperature changes which allow to estimate water infiltration during high water events. The DOMINO research project, aims to develop a fiber optic based dike monitoring system which allows to directly sense and measure any pore pressure change inside the dike structure. For this purpose, questions like which location, how many sensors, which measuring frequency and which accuracy are required for the sensor development. All these questions may be initially answered with a finite element model which allows to estimate the effects of pore pressure change in different locations along the cross section while having a time dependent estimation of a stability factor. The sensor aims to monitor two main failure mechanisms at the same time; The piping erosion failure mechanism and the macro-stability failure mechanism. Both mechanisms are going to be modeled and assessed in detail with a finite element based dual permeability Darcy-Richards numerical solution. In that manner, it is possible to assess different sensing configurations with different loading scenarios (e.g. High water levels, rainfall events and initial soil moisture and permeability conditions). The results obtained for the different configurations are later evaluated based on an entropy based performance evaluation. The added value of this kind of modelling approach for the sensor development is that it allows to simultaneously model the piping erosion and macro-stability failure mechanisms in a time dependent manner. In that way, the estimated pore pressures may be related to the monitored one and to both failure mechanisms. Furthermore, the approach is intended to be used in a later stage for the real time monitoring of the failure.