Advancements on the simulation of internal erosion processes with the Material Point Method

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ABSTRACT

Internal erosion mechanisms are a main cause of failure of hydraulic and water retaining structures such as dikes and dams. Internal Erosion encompasses many different processes such as piping, contact erosion, and suffusion. The study of suffusion, the migration of fine particles due to fluid flow through a coarse grained soil skeleton, is an important research area in geotechnical and hydraulic engineering fields. Estimate for risk analysis requires i) understanding the initiation and progression of internal erosion that leads to breach and ii) estimating post-failure behavior. Predicting the formation of a breach and its consequences involve large deformations of the material.

In the literature, several formulations have been presented to model the fluid-solid interaction leading to migration of fine grains. Most formulations are integrated in classical finite element, finite difference or finite volume codes. These numerical approaches are powerful tools to simulate the initiation of internal erosion but have serious limitations in their ability to model large deformation processes, such as those occurring during the formation of a breach and the collapse of a water retaining structure. Recently, the Material Point Method (MPM) has been proposed as a good alternative for large deformation modeling. The first coupled hydro-mechanical MPM approach to model suffusion type internal erosion was presented by Yerro et al. [1].

This work presents an alternative MPM formulation in which the migration of fines from the solid skeleton to the porous fluid. The migration of fines is represented by the mass transfer between two different sets of material points representing both liquid and solid constitutive behaviors (i.e. two-point formulation). One of the advantages of this novel formulation is that intrinsically preserves the mass of all components. Finally, numerical results are discussed and validated against experimental data.

REFERENCES

[1] A. Yerro, A. Rohe, K. Soga, "Modelling internal erosion with the Material Point Method", *Procedia Engineering*, **175**, 365-372 (2017).