Micromechanics of normal hydroerosion processes

Andrea F. Rotunno[*†], Francesco Froiio[†], Carlo Callari[‡], Andrea Guidobaldi[*]

[*] Department of of Civil Engineering and Computer Science Engineering (DICII)
University of Rome "Tor Vergata"
Via Politecnico 1, 00133 Roma, Italy
e-mail: a.rotunno@ing.uniroma2.it

[†] Laboratoire de Tribologie et Dynamique des Systèmes (LTDS)
Univ Lyon, École Centrale de Lyon
36 Avenue Guy de Collongue, 69134 Ecully,
e-mail: francesco.froiio@ec-lyon.fr

[‡] Department of Biosciences and Territory, Engineering Division (DiBT)
University of Molise
Via De Sanctis, 86100 Campobasso, Italy
e-mail: carlo.callari@unimol.it

ABSTRACT

A number of hydro-mechanical erosion processes of particular interest in geonvironmental engineering and petroleum engineering refer to situations in which a porous domain is eroded in the vicinity of a free-flow region, under the action of the outward seepage flow across the relevant interface. Such processes, which we refer to as *normal hydroerosion processes,* are being studied for example in relation to the backward erosion mechanism responsible for the upstream-oriented propagation of piping erosion in embankment dams and dykes [1,2]. Sand production in petroleum engineering is a further such phenomenon, which significantly affects the productivity of oil wells and can result into damage to equipment, plugging of wells, etc. [3,4]. In a recent work we proposed a preliminary discrete numerical model of the aforementioned backward erosion mechanism [2]. The two-dimensional model was based on the coupling of DEM with the Lattice Boltzmann Method (LBM), for the description of the granular- and the fluid phase, respectively. On this background, we recently developed more advanced two-dimensional numerical models of a variety of normal hydroerosion configurations, in reference to both, the backward erosion and sand production phenomena. We present herein a micromechanical analysis of the results provided by these models: we focus on the validation of previously conjectured resistance and degradation mechanisms (e.g. force chain arching, crack coalescence) and seek for the main non-dimensional parameters controlling the erosion kinetics. The general architecture of the in-house DEM-LBM code is also discussed, along with the technical solutions enabling an effective implementation of the hydro-mechanical coupling and a convenient description of the boundary conditions.

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