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NUMERICAL MODELLING OF HYDROLOGICALLY-DRIVEN SLOPE INSTABILITY BY MEANS OF POROUS MEDIA MECHANICS

Evanthia Kakogiannou[1], Lorenzo Sanavia[1] and Bernard A. Schrefler[1]

[1] Department of Civil, Architectural and Environmental Engineering - University of Padua,
Via F. Marzolo 9, 35131 Padua, Italy
e-mail: evanthia.kakogiannou@unipd.it, lorenzo.sanavia@unipd.it, bernhard.schrefler@unipd.it
web page: http://www.dicea.unipd.it

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Heavy rainfall can trigger slope failure which generally involves shallow soil deposit of different grading and origin usually in a state of partial saturation [1]. In this case of slope instability, the behaviour of the soil slope is closely related not only to the distribution of pore-water pressure but also to the stress state during rainfall infiltration involving both mechanical and hydrological processes. Therefore, a multiphysics-based approach, which will be taking into account these physical processes by means of advanced hydro-mechanical couplings, is considered necessary for the numerical modelling of rainfall-induced landslides.

Furthermore, concerning the notion of failure in geomaterials, it is now well recognized that frictional materials can develop an unstable domain well before the Mohr-Coulomb plastic limit condition is met [2]. Additionally, such kind of materials may perform a failure of the diffuse type that a localization criterion is not able to detect [3], [4]. Hill’s sufficient condition of stability [5], based on the sign of second-order work, can be a pertinent criterion to detect these types of bifurcations as it constitutes a lower bound of the aforementioned criteria [3], [4].

In this paper three different cases of fully coupled thermo-hydro-mechanical finite element analysis are presented: firstly, the numerical simulation of a biaxial compression test where strain localisation occurs followed then by the analysis of a slope failure initiation in a small-scale laboratory test, due to toe erosion. Lastly, the simulation of the Sarno flowslide (occurred in Italy in May 1998) onset due to rainfall is discussed. All the analyses have been conducted by using the geometrically linear finite element code Comes-Geo for non-isothermal elasto-plastic multiphase solid porous materials, as developed by [6]. For the detection of the material instability, the second order work criterion is implemented, extended for the case of unsaturated soils [7] in order to additionally account for the hydraulic energy contribution. Finally, the detection of the effective instability of the domain is also discussed by applying the global second order work criterion [5] in all three cases.

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