Instabilities of a sand layer subjected to an ascending water flow by a 3D coupled Discrete Element - Lattice Boltzmann hydromechanical model

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ABSTRACT

This work deals with the numerical simulation of the instabilities occurring in a sand layer subjected to an ascending water flow. A coupled Discrete Elements - Lattice Boltzmann hydromechanical model is used for this end. After a bref presentation of the numerical model, simulations of ascending fluid flow through granular deposits are performed for two cases namely under a gradually increasing hydraulic gradient and under different constant volumetric flow rates. In the first case i.e. under the increasing hydraulic gradient, the simulations show that the quicksand condition is actually reached for a hydraulic gradient very close to the critical hydraulic gradient calculated from the global analysis of classical soil mechanics, i.e. when the resultant of the applied external pressure balances submerged weight of the deposit. The simulations point out moreover that the quicksand phenomenon could be produced locally under slightly lower gradients. In the second case, the simulations show that the constant flow rate condition allows to better visualize the phenomenon called "piping", which involves the formation and the evolution of a continuous tunnel between the upstream and the downstream side.

REFERENCES

[1] P. Cundall and O. Strack, " A discrete numerical model for granular assemblies ", Geotechnique 1979; 29(1) : 47-65.
[2] L. S. Luo, " Theory of the lattice Boltzmann method: Lattice Boltzmann models for nonideal gases ", Physical Review E 2000; 62(4) : 4982-4996.
[3] M. Mansouri, J. Y. Delenne, M. S. El Youssoufi and A. Seridi, "A 3D DEM-LBM Approach for the Assessment of the Quick Condition for Sands", C. R. Mecanique 337 (2009), pp. 675-681.
[4] M. Mansouri, M. S. El Youssoufi and F. Nicot, " Numerical simulation of the quicksand phenomenon by a 3D coupled Discrete Element - Lattice Boltzmann hydromechanical model ", Int. J. Numer. Anal. Meth. Geomech. (2016), DOI: 10.1002/nag. Volume 41, Issue 3, 25 February 2017, Pages: 338–358.