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Predicting the hydraulic properties of Zbraslav sand, as affected by compaction

Soheil Safari Anarkouli and Martin Lanzendörfer
Institute of Hydrogeology, Engineering Geology and Applied Geophysics, Faculty of Science, Charles University, Prague, Czech Republic

Zbraslav sand has been used as a testing material in many former soil mechanics studies. It is a poorly graded sand with almost no fines and with grains of subangular shape. We will be interested in predicting the variation of its pore structure, in particular the pore size distribution (PSD), as a result of the oedometric compaction of the sample. Apart from the derived unsaturated hydraulic properties, we will be particularly interested in predicting its saturated permeability with respect to non-Newtonian (shear-thinning) fluids.

Clarifying and quantifying the dynamics of the PSD due to compaction will be a difficult undertaking owing to the instability of soil structure and variation of PSD over time. In this study, we will follow the discrete approach during the sand compaction process introduced by Mahmoodlu et al. [1] and later studies. Discrete element method (DEM) can directly trace the motion of individual particles and explicitly consider the particle–particle interactions without the need of macroscopic constitutive correlations. We will use this method to generate a packing of idealized particles for a certain porosity and particle size distribution, and simulate the movement of grains during the compaction process. Subsequently, having the simulated configuration of grains at each observed state, the pore network will be extracted to obtain the pore connectivity and morphology [2]. In the next step, the flow of various shear-thinning fluids through the media (the pore network) will be simulated [3, 4]. In this way, we are preparing for a subsequent study focused on the experimental measurement of the effective PSD directly during the oedometric test. We are particularly interested in how the observed variations in pore structure will be represented by the effective PSD obtained by the method, introduced by Abou Najm et al. [5], i.e. computed from the observed permeabilities with respect to shear-thinning fluids.

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