Geophysical Research Abstracts,
Vol. 10, EGU2008-A-08876, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-08876
EGU General Assembly 2008

Parametrisation and visualisation of the pore structure of gradated soils via 3D image processing.

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During groundwater flow, fines in the grain skeleton can be mobilized by seepage forces. The kind of erosion where the displacement of fines in the grain skeleton takes place is called suffosion. When suffosion occurs, the permeability and the porosity will increase while the bulk density decreases. The consequences are less resistance against external load and settlement of the soil, as well as a significant change in pore pressure. The probability for scour, landslides and hydraulic heave will increase.

The objective of the national research project supported by the German Science Foundation (DFG) „Conditions of suffosive erosion phenomena in soils" is to study the structural stability of gradated soils with a vulnerability to internal suffosion. In order to be able to describe suffosion processes in microscale, it is necessary to get additional information about the pore structure of suffosive soils. 3D imagery of vulnerable soils was chosen. On the basis of 3D image data sets, provided by Micro CT, specific parameters of the pore and soil structure will be determined. Those parameters will be used to calibrate the simulations of transport and clogging processes with pore networks and correlated percolation-models.

To analyse the pore and structure characteristics of suffosive sediments, model glass spheres, artificial soils and fluviatile sediments will be visualized. One focus is to produce the correct natural soil. Different procedures (e.g. resin embedding, compacting) will be tested in order to make suffosive material suitable specimens. The specimens will be cut into defined blocks and mapped with x-ray computer tomography (CT).

The CT working group at BAM has several available systems with different radiation sources and detectors, as well as integrated image reconstruction algorithms, for the visualisation. Local resolutions between 1,5 μm and 500 μm can be obtained. The computed tomography delivers 3D-datasets which are ready to be applied in image processing.

Pore structure and soil structure analysis based on CT image data will be accomplished. The goal of this research is to find characteristic values and correlations of parameters for the soil and pore structure. This includes the orientation of particles, minimum distances between the particle surfaces, potentially mobile particles within the soil structure pore, pore throat and pore constriction size distributions, as well as correlations within the pore and soil structure. Each pore is bounded by interfaces between the void space and soil matrix, and by planes erected where the radius of the pore space exhibits local minima defined as pore necks. From the partitioned data, various statistics are readily obtainable such as the pore-size and coordination distrubutions, as well as the distributions of pore surface area between interfaces with solid phase and those with neighboring pores. We also calculate two fractal dimensions related to the discrete pores, which we suggest may represent an important method of characterizing the pore space. With morphologic image processing operations (e.g. opening, closing, erosion and dilatation as well as filter or histogram manipulations) the data will be prepared in such a way that correlations in pore structure and soil structure can be derived.