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Experimental and numerical study of fly-ash migration in sands of various particle size distributions

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Fly-ash migration in three sands of various particle size distributions and consequently various porosities, was studied in the laboratory. The following technical sands were used: ST8 (particle sizes 0.10-0.63 mm), ST03/08 (particle sizes 0.315-0.80 mm) and ST 06/12 (particle sizes 0.63-1.25 mm). First, sands were packed in glass cylinders with diameters of 5.52 cm and heights of 18 cm. Two grams of fly-ash were applied on the top of the sand columns followed by pulls applications of 100, 200 and 300 cm3 of distilled water. The fly-ash migration was assessed visually. Then the soil columns were divided into the 2 cm thick layers and the amount of fly-ash in each sand layer was determined gravimetrically. Secondly, sands were packed in plastic cylinders with diameters of 30 cm and heights of 40 cm. The fly-ash was applied on the top of all cylinders followed by pulse infiltrations. The sensors SM200 (Delta-T Devices Ltd.) for soil-water content measurements and micro-tensiometers Tensior 5 (UMS GmbH) for pressure head measurements were placed 10, 20 and 30 cm below the sand surface to monitor water regime within the sand columns. The plastic tube for inserting the Kappameter SM400 (Petrovský at al., 2004) was positioned in the column center. The SM400 device that measures vertical distribution of magnetic susceptibility was used to monitor migration of ferrimagnetic particles-tracers presented in the fly-ash. Visually observed and gravimetrically evaluated fly-ash migration on small cylinders corresponded to fly-ash mobility in large columns detected magnetically using the

SM400 Kappameter. While the fly-ash migrated freely thought the course sand material, in the other two sand materials the fly-ash moved to the depths of 10-14 and 4-6 cm (depending on the applied pulls infiltrations) in the medium and fine sand, respectively, due to the pore-space blocking and water flow decrease. However, minor fractions of fly-ash migrated through the both sands columns when high pulls infiltrations of distilled water were applied. The experiments proved fly-ash mobility in sandy material. The HYDRUS-1D was used for numerical simulation of water flow and fly-ash transport. Soil hydraulic properties were determined using the numerical inversion of multi-step outflow experimental data (100-cm3 columns) and data obtained from the large column experiment. Fly-ash transport parameters were also optimized.

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