

Abstract

Intention of the present study was to examine the effects of solutions of humates, fertilizers and tensides on capillary barrier systems in surface seals of waste deposits, within the scope of the Bay FORREST research projects F 54 („Influence of ingredients of seepage waters on capillary barrier systems“) and F 54 F („Utilization of recycling materials in capillary barrier systems for waste deposit seals“), supported by the Bavarian State Ministry of Land Development and Environment. A further scope was to demonstrate the application possibilities of residual substances and recycling materials in systems of capillary barrier systems and to deduct parameters for the selection and dimension of suitable material combinations therefrom.

The determination of water tensions and capillary heads of quartz sand with the granular size 0/1 under the influence of solutions of humates, fertilizers and tensides of different concentrations was carried out in column experiments. The column experiments with different solution ingredients showed a lower capillary head in case of highly concentrated solutions of tensides and humates, due to the lower surface tension. In case of natural concentrations – this is particularly true for humates – no influence on the capillary behaviour of the capillary layer materials is to be expected.

Serial tests with different kinds of sand of different Bavarian producers served to find an optimal combination of capillary layer (c.l. - in the German text referred to as KS) and capillary block material (c.b. - in the German text referred to as KBS) by comparing the respective soil mechanical properties. The results of the column experiments with customary granular sizes of different Bavarian sand and gravel plants showed that materials of the granular size 0/4 are suitable for the utilization as capillary layer in case of a capillary head of 15 to 20 cm (saturated capillary fringe). A value of app. 0.4 to 0.5 can be assumed as a rule of thumb for the rating of the minimum thickness of the c.l. High-grade fractured sands – compared to natural sands – show a too heterogeneous distribution of pore sizes. Therefore, if possible, only sands with well rounded grains ought to be employed in capillary barrier systems. The suitability of recycling materials, apart from soil mechanical and hydraulic properties, depends on environmentally relevant aspects (for instance eluability of aggressive substances). Moreover, geotextiles may contribute to a considerable increase in efficiency of capillary barrier systems, particularly in case of high infiltration rates.

Due to the results from the column and tank experiments, a selection procedure in three parts and furthermore quality criteria for capillary barrier system materials are proposed. The pre-selection of the capillary barrier system materials is carried out by means of the local spreading in the vicinity of the planned measure, as well as by means of the quickly and easily ascertainable parameters grain distribution, rough grain density, mineralogical composition, and, if need be, examination of the solubility behaviour pursuant to DEV S-4 (German Standard Procedure). In case of recycling materials for the c.b. it is necessary to additionally determine the proportion of glassy and foamy grains, due to a possible negative influence on the porosity stability.

The improvement of the material combinations rated as potentially suitable comprises the determination of the limits of the compactness pursuant to DIN 18 126 (German industry standard), as well as, particularly with c.b. materials, the impact stability DIN 52 115 T 3 („crushing stability against hammer-blow“). The proof of the environmental compatibility is provided by especially controlled elution experiments (DEV S 4, column tests). In addition, porous materials are also examined with regard to their water absorptivity pursuant to DIN 52 103. The improvement phase also includes the examinations for the selection of the geo-textile which is to be used. The final test with the proof of equivalence is carried out by means of tank experiments and large-scale channel tests.

The overall result of the examinations demonstrated that capillary barrier systems, also under partially extreme testing conditions, represent an efficient element in surface seals of waste deposits, that they are equivalent to the standard system pursuant to TA-Si (German Technical Instructions for Waste Deposits) with regard to their system permeability and that they may represent a cost-effective alternative to it.