Investigations on the gas permeability of geosynthetics

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Origination

In the scope of the constructional measure „land reclamation at Osthafen in Bremerhaven, international ports", an area of approx. 6 ha has been backfilled using harbor silt as building material.

To ensure the necessary bearing capacity of the silt, the installation of geosynthetic reinforcement between the placed silt and the final sandcapping has been planned. Due to literature studies gas permeability is generally at the minimum assumed with the same transmission coefficient as the one for water.

As geosynthetic reinforcement a sandpad confectionated of a woven geosynthetic as reinforcement layer and a nonwoven geosynthetic fleece as filter layer with loading of ferric silicat granulate was installed. To ensure the bidirectional reinforcement two layers were placed orthogonal to each other. During the setting of the sand layers considerable deformations of the silt surface occurred. On the following installation of vertical drains for reduction of the excess pore water pressure it became apparent that gas formation processes took place in the silt. In the course of field experiments it became obvious that gas could not pass freely through the geo synthetic.

Insufficient gas permeability is recognized as potential partial cause for the surface deformations, because the equilibrium of force is displaced by uplift forces of accumulations of gas under the sandpad resulting. Moreover, gas bubbles would influence the shear strength in the silt locally negatively.

Upon that the gas permeability of the used sandpads were examined in the laboratory of the construction site by PHW in simple experiments in a two-phase-system (water/gas). In the experiments there, a lasting gas layer under the geo synthetic has been documented.

Fieldwork

In the scope of laboratory experiments on the construction site the used pieces of the reinforcement sandpad was installed in a glass cylinder, was dammed up with water und was admitted with gas from the bottom by blowing in air. At this, a stable gas bubble was formed with a thickness of several centimeters underneath the geo synthetic. The thickness of the gas bubble could be reproduced with comparable results at any time and was formed independently from the orientation of the sandpad.

Even the testing of fresh sandpad without silt or sand contamination would show comparable results. So collimation of the pores was not the main reason for the low gas permeability of the sandpad.

In further experiments on both single geo synthetics processed in the sandpad were examined separately in the same test set-up. At this, the results of the single products were comparable with the result of the used combined product.

Thereupon an investigation program for gas permeability of different geo synthetic products was initiated in cooperation with the manufacturer of the used sandpad, NAUE GmbH & Co. KG.

Investigations on standard geo synthetics

On the basis of the experiments on the construction site a unified test set-up was developed, in which different customary geo synthetics were examined in the two phase system referring to their gas permeability.

The investigations yielded comparable results for nonwovens as well as for finely woven geosynthetics.

With all examined geo synthetics stable gas layers were formed under the geo synthetic.

Investigations on treated geo synthetics

On the basis of the results on standard geosynthetics NAUE delivered geosynthetics, which were treated in the manufacturing process with admixtures in order to change the adherence behavior of the synthetic surface.

For this purpose standard nonwovens were treated with different admixtures and tested in the above described test set-up.

For some admixtures it became apparent that significant improvements referring to the permeability of air had been achieved.

Further on different gaseous hydrocarbons which corresponded with the decomposition products of biological derivation in silt were investigated.

The positive results of our investigation resulted in the production of geosynthetics with a high permeability for gas in a two phase (water/gas) system, comparable to the typical use of geosyntheics as reinforcement above soft organic soils.