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Repeated loading of soilbag-reinforced road subgrade

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Abstract: Soilbags are three-dimensional soil-confining units used in road foundations. This paperuses vertical repeated loading tests to investigate the performance of soilbags as reinforcement in road subgrades as well as the influence of such factors as the frequency and amplitude of loading, the number of reinforcement layers, and the buried depth of the soilbag reinforcement. The results show that soilbags as reinforcement are effective at reducing permanent and resilient deformations of the road subgrade as well as vibrations caused by traffic loads. The soilbags as reinforcement perform better when the number of soilbag-reinforced layers is increased. More than two layers of soilbags are needed to reinforce the road subgrade to make efficient use of the effect of interlayer insertion between soilbags. Furthermore, a thin surface soil cover is desirable to spread the applied pressure more effectively over the soilbags and level the subgrade.
Keywords: Geosynthetics, soilbags, subgrade reinforcement, repeated loading tests, deformation, acceleration

Performance and design of modified geotextile tubes during filling and consolidation

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Abstract: The performance of geotextile tubes is affected by many factors such as the pumping pressure, fill material and geotextile properties, and so on. Hence, obtaining hydraulic compatibility between geotextiles and fill materials containing a variety of coarse and fine particles – that is, silty sand – is complex. For this reason, the modified geotextile tube (MGT) was invented to optimize the filling and dewatering or consolidation performance of geotextile tubes. To assess the behavior of MGTs, experimentation and theoretical analysis were conducted. The MGT retention performance, filling time, and water pressure were evaluated through a geotextile bag experiment while the MGT geometry, tension force, strain, water content distribution, and consolidation performance, were investigated through a parametric study. The two-dimensional MGT solution presented in this study is based on a combination of various modeling concepts that were modified or extended to be able to sufficiently describe the MGT behavior. Results showed that the performance of geotextile tubes can be optimized in a variety of ways by interchanging the geotextile placement, by changing the circumferential lengths, and by using geotextiles with different properties. With the methods presented in this study, modified geotextile tube design is made possible.

Keywords: Geosynthetics, Modified geotextile tubes, Modeling, Consolidation, Dewatering, Retention performance

Water characteristic curves of geosynthetic clay liners hydrated by a saline solution

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Abstract: Geosynthetic clay liners (GCLs) are used in saline environments but little is known about their soil water characteristic curve (SWCC) when exposed to saline solutions. This paper presents an investigation of the SWCC of three different types of GCLs, which were hydrated with deionised (DI) water and a 0.325 mol/l sodium (Na^+) synthetic brine pond solution (NaCl, $NaHCO_3$ and Na_2CO_3). One of the GCLs was made of bentonite modified with polyacrylamide polymer. Higher air-entry values and steeper slopes of SWCCs between the two inflection points were observed in samples hydrated with synthetic brine. Polymer addition increased the water retention of the GCL under both DI and brine hydration. Brine hydration was found to reduce the total mass of liquid absorbed by the bentonite, compared to DI water. Total suction under brine was found to be different from the sum of total suction under DI and osmotic suctions of the brine solution, which may be due to the loss of osmotic swelling and crystallisation of salt in air-filled pores. Compared to the more frequently used Van-Genuchten and Fredlund-Xing models, the three-zone linear Pham-Fredlund model provided better SWCC fit for brine-hydrated GCLs.

Keywords: Geosynthetics, GCLs, Unsaturated, SWCC, Suctions, Brine, Filter paper

Effect of aperture ratio on the cyclic shear behaviour of aggregate-geogrid interfaces

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Abstract: In order to study the effect of aperture ratio (geogrid aperture size (AS)/average particle size (D_{50})) on the shear behaviour of aggregate–geogrid interfaces, a series of monotonic direct shear(MDS) tests, cyclic direct shear (CDS) tests and post-cyclic monotonic direct shear (PCDS) tests were carried out on two particle-shaped reinforced interfaces at five values of AS/D50. The cyclic shear behaviour of the two interfaces under three displacement amplitudes is discussed, and the interface shear characteristics before and after cyclic shear are analysed. The test results indicate that four possible cyclic shear behaviours can occur for two reinforced interfaces, including shear hardening (H), cyclic cumulative softening (SI), direct softening (SII) and wave softening (SIII). With increasing amplitude, the cyclic shear response of both interfaces changes from shear hardening to shear softening. The vertical displacements of both interfaces indicate an overall shear contraction trend in the CDS tests. The stiffness of two reinforced interfaces was significantly affected by the displacement amplitude and the ratio AS/D50. Compared with the maximum dilation of two reinforced interfaces in the MDS tests, the corresponding value has increased in the PCDS tests; the increase is more significant at rounded aggregate-geogrid interfaces.

Keywords: Geosynthetics, Aggregate-geogrid interface, Aperture ratio, Dynamic response

Modeling the WRC and volume change behavior of GCLs considering net stress and temperature

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Abstract: Geosynthetic clay liners (GCLs) are used in cover and bottom lining systems to mitigate contamination from landfills. During their service period, they are often subjected to varying net mean stress levels, temperature fluctuation, and water content, which could affect their water retention and volume change behavior severely. These changes under thermo-hydro-mechanical conditions can be evaluated through experimental methods or mathematical models. In the present study, the combined effect of net mean stress and temperature on water retention and volume change behavior of GCL in the unsaturated regime were studied. A theoretical thermo-hydro-mechanical framework for GCLs over a wide suction range is proposed based on experimental observations. The proposed framework was implemented in a simple water retention model and volumetric constitutive model to capture the thermo-hydro-mechanical behavior of GCL through several sets of experimental data available in the literature. The predicted results from the proposed method were in good agreement with the experimental results. Also, the proposed method required minimal input parameters to predict water retention and volume change behavior over a wide suction range. The proposed framework is therefore quite useful for engineering applications of GCLs under the combined effect of suction, net mean stress, and temperature.

Keywords: Geosynthetics, GCL, volume change, water retention, net mean stress, temperature, thermo-hydro-mechanical framework

Thermal conductivity of nonwoven needle-punched geotextiles: effect of stress and moisture

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Abstract: This paper explores the use of geotextiles as insulation material for energy geostructures made of compacted soil. This work is based on measurements of the thermal conductivity of four nonwoven needle-punched geotextiles of varying thicknesses made from virgin or recycled fibres. These values were measured using the hot-plate method. Then, to assess the use of these geotextiles under a covering soil layer, compression tests were performed. For each sample, the relation between thickness and vertical stress was thus established. The thermal conductivities varied from 0.04 to 0.06 W/m/K depending on the geotextile type and the compression stress applied. Subsequent measurements focused on the thermal conductivity of a bilayer compacted soil plus geotextile. Results revealed a water migration towards the geotextile and therefore a larger thermal conductivity. These results highlighted the main importance of compression load and moisture environment in the use of geotextiles as insulation products.
Keywords: Geosynthetics, Geotextiles, Insulation, Energy geostructures, Thermal conductivity

Effect of fiber reinforcement on the mechanical behavior of bio-cemented sand

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Abstract: To explore the possibility of providing additional reinforcement to bio-cemented san through fiber inclusions, a series of sand-fiber mixtures were prepared by mixing sand with three type of fibers (polypropylene fiber, basalt fiber and carbon fiber) at different fiber contents (0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6 and 0.8% by volume of sand). Each mixture was subjected to two cycles of controlled microbial-induced calcite precipitation (MICP) treatments. Unconfined compression tests and calcium carbonate content tests were performed to characterize their mechanical properties and calcite amounts, respectively. Stress-strain results indicate that fiber inclusions change the bio-cemented soil from brittle to ductile failure modes. Basalt fibers with the highest tensile strength were most effective to increase the unconfined compressive strength (UCS) of the mixture. Due to higher elongation at breakage, polypropylene fiber is superior to the other two fiber types for energy absorption during the softening phase, resulting in higher residual strength. Scanning electron microscopy (SEM) photographs reveal the spatial distribution of calcite precipitations at the inter-particle contacts, on sand grain surfaces, and on the fiber surfaces, which primarily contributes to the roughening of the surface texture of particles and fibers and increases the internal friction and inter-particle bonding.

Keywords: Geosynthetics, Fiber-reinforced soil, Microbial-induced calcite precipitation (MICP), Mechanical behavior, Fiber type, Microstructure, Soil improvement

Compatibility of tailings–nonwoven geotextile under stress and the effect of sand filter

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Abstract: Geotextiles have been widely used in engineering drainage. The clogging of geotextile filters used in fine tailings dams often occurs owing to complex environmental conditions. To better understand the influence of stress and the hydraulic gradient (i) on the hydraulic compatibility of fine tailings–nonwoven geotextile filter, a series of gradient ratio (GR) tests were performed in this study. To reduce the physical clogging and enhance the drainage capability of nonwoven geotextiles, a layer of sand filter was placed between the tailings and the nonwoven geotextiles. The effects of the sand filter were explored by GR tests and the following beneficial conclusions were drawn. Compaction induced by normal stress increased the interlocking between tailings particles; consequently, the internal stability of the tailings increased, which lowered the clogging potential and volume of drainage of the system. The value of i (1–20) had only a slight effect on the clogging potential and permeability coefficient of the tailings, especially in the case of high normal stress. The sand filter prevented the formation of filter cake at the soil–geotextile boundary, and increased the volume of drainage of the system. This reduced the clogging potential and enhanced the drainage capability of the system.

Keywords: Geosynthetics, Fine tailings, Nonwoven geotextiles, Hydraulic compatibility, Sand filter

Interaction between PFASs and geosynthetic liners: current status and the way forward

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Abstract: This paper gives an overview of the current state of the practice on the interaction between geosynthetic liners and per- and polyfluoroalkyl substances (PFASs). The importance of PFAS chemistry and the need to make a clear distinction between on-site repositories and landfill applications is highlighted, as the liners will be subjected to widely different concentration loadings and types of dominating PFASs. Consequently, the selection of geosynthetic liner components needs to account for these differences and distinguish between the expected exposure conditions. In particular, geomembranes need to be selected carefully as their resin type will dictate their performance. Preliminary hydraulic conductivity test results using unamended and activated carbon amended geosynthetic clay liners indicate they can play a role in minimising the migration of PFAS, although the tests are still ongoing.
Keywords: Geosynthetics, PFAS, Geomembrane, GCL, Per and polyfluoroalkyl substances