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摘要集

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目　录

Hydraulic compatibility of nonwoven conical filters with a backfill material

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Abstract: Alternative drainage designs are developed due to high failures in retaining walls with missing or inadequate drainage. This study investigates the usage of nonwoven conical filter systems and their hydraulic compatibility with common backfill material using both laboratory and computational modeling. Computational fluid dynamics numerically solved the fluid flow and the discrete element method allowed for the modeling of particle to particle, and those methods were coupled to simulate particle-to-fluid contact. Through a combination of these methods, piping and retention performances of various soil-geotextile systems were studied. Nonwoven geotextiles were numerically modelled, partly by using the Poisson line process to simulate the inherent randomness found in fabricated nonwoven filters. The model results were compared with laboratory tests to corroborate the accuracy of the models. The soil-nonwoven filter systems, either conventional or conical, provided 6–87% lower permeability values compared to soil-woven systems and had 10–48% higher piping rates than their counterparts. A support-vector-machine algorithm was utilized to classify zones for the performance curves for woven and nonwoven geotextiles, where a clear distinction in zones was shown.

Keywords: Geosynthetics, nonwoven geotextile, computational fluid dynamics, discrete element modeling, soil retention

Geocell-reinforced bed under static and cyclic loads: Soil density and grain size effects

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Abstract: This paper reports on a series of static and cyclic plate loading tests performed on a weak unreinforced sand bed in a test pit. The weak sand was covered by a 160 mm thick layer comprised of one of three compacted soil types which was either unreinforced or geocell-reinforced. The purpose was to investigate the effects of soil density and grain size as filler materials for the covering layer. The three covering soils were granular with average particle sizes of 2.2 (Soil 1), 6.14 (Soil 2), and 8.47 (Soil 3) mm. Under static loading, the bearing pressure increased on average 23% when the average grain size of the upper, unreinforced, soil layer changed from 2.20 mm to 8.47 mm. The improvement in bearing pressure was about 37% due to the use of a soil-filled geocell but, unlike the unreinforced situation, employing larger soil grains to fill the geocell pockets didn't show significant further improvement. For cyclic loading tests, the maximum settlement reduction by employing a geocell layer was about 50% for Soil 1. Whether loaded statically or cyclically, increasing soil density likely would be more efficient for improving geocell performance than employing a soil having larger particle sizes.

Keywords: Geosynthetics, Geocell reinforcement, Soil density, Soil grading, Replaced layer

Discrete element method investigation of shear behaviour of 3D geogrid–sand interface

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Abstract: Interface shear characteristics have an important impact on the stability of geosynthetically reinforced soil structures. The shear characteristics of three-dimensional (3D) geogrid–sand interfaces were investigated using large-scale direct shear tests and the discrete element method (DEM). Geogrids were manufactured by 3D printing. The effect of mesh pattern and transverse-rib thickness on the stress–displacement relationship, strength parameters, coordination number and porosity distribution were evaluated. The results showed that the mesh pattern and transverse-rib thickness have an impact on the interface shear characteristics. The peak and residual interface shear strength of the modified geogrid mesh pattern exceeded that of biaxial geogrids. The average coordination numbers of the modified geogrid mesh pattern were greater than those of biaxial geogrids. The variability of particle compactness, as characterised by the porosity distribution, shows how the modified mesh pattern increases the interface shear strength. The interface shear strength of the geogrid–sand interface was improved by thickening the transverse ribs of the modified geogrid mesh pattern.

Keywords: Geosynthetics, Shear strength, Three-dimensional geogrid, Transverse-rib thickness, Mesh pattern, Discrete-element modelling

Three-dimensional analysis of inclined anchors in reinforced sand

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Abstract: Inclined anchors are used in civil engineering structures where the foundations are expected to resist pullout forces during their operational period. This paper presents a three-dimensional numerical analysis of inclined anchors placed in unreinforced and reinforced sand. The influence of several parameters on the response of inclined anchor plates has been investigated in this study. Results indicate that geogrid reinforcement placed on top of the anchor plate significantly influences the anchor plate's performance. The ultimate pullout capacity is found to increase with the inclination angle (varied from 30° to 60°) of the anchor plate both in unreinforced and reinforced sand. The anchor capacity is also affected by other parameters such as friction angle of sand (varied from 35° to 45°), embedment depth of the anchor plate (varied from 2 to 10) and tensile stiffness of the geogrid. Besides, the comparison between piles and anchors has been presented with the help of an illustrative example of a transmission tower foundation. The design calculations indicate that inclined anchors placed in reinforced sand can lead to economical design at shallow depth as compared to piles.

Keywords: Geosynthetics, Numerical modelling, Inclined anchors, Pullout capacity, Transmission tower

Digital image-based performance evaluation of GCL-sand interfaces under repeated shearing

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Abstract: Inadequate shear strength mobilization at the interfaces results in translational failures in Geosynthetic Clay Liners (GCL). Periodic addition of solid waste into the landfill causes additional normal and shear stresses in GCLs. The mechanical response of GCLs and fibre strength are highly time-dependent. Hence the interface shear resistance reduces under the application of repeated shear cycles. To simulate these conditions, a repeated interface shearing test was conceptualized in this study. A natural river sand and a manufactured sand of identical gradation were used in experiments. Each GCL-sand interface was subjected to eight cycles of shearing in dry and hydrated conditions under three different static normal stresses. Results showed that the variation of the peak interface shear stress has different phases, governed by different mechanisms. Digital image analysis of tested GCL surfaces after each shearing cycle provided important clues for this response. Entrapment of sand particles into GCL surfaces is beneficial initially because of increased friction at the interface and this benefit is more pronounced in the case of manufactured sand, due to the irregular shape of particles. Quantification of sand particle entrapment and surface changes to GCL helped in understanding these micro-level interaction mechanisms.

Keywords: Geosynthetics, Interfaces, Geosynthetic clay liner, Repeated loading, Digital image analysis, UN SDG 12: responsible consumption and production

Geometric and strain behaviour of full-scale geotextile tubes for dewatering sludge

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Abstract: Geotextile tubes have been presented as a viable alternative for dewatering sludge generated in different industries, characterised by having fine grain and high moisture content. The material commonly used to develop this system is woven geotextile due to its high strength properties. However, nonwoven geotextile tubes are a possible underexplored alternative that have good cost benefits. This paper presents the geometric and strain behaviour of two full-scale nonwoven geotextile tubes used for dewatering water treatment plant (WTP) sludge. Four technologies were used to monitor the full-scale tests: ultrasonic sensor (US), perspective laser tracking (PLT), light detection and ranging (LIDAR) and draw wire sensor (DWS). The geometric parameters of a quarter of the cross-section and the strains in the geotextile were obtained during sequential fills. These data were compared with results obtained from an analytical method based on membrane theory that considers the non-linear-elastic behaviour of the geotextile. The DWS and LIDAR technologies were the most suitable for monitoring the strains and shapes of the tubes, respectively. Good agreement was found between analytical and experimental results, indicating the applicability of the adopted method to the design of the first filling cycle of the monitored nonwoven geotextile tubes.

Keywords: Geosynthetics, Nonwoven Geotextile Tubes, Dewatering, Full-Scale Test,
Strain Behaviour, Geometric Performance

Determining performance of two-tiered GRS walls subjected to traffic cyclic loading

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Abstract: This study evaluates the performance of two-tiered geogrid-reinforced soil (GRS) walls subjected to traffic cyclic loading considering several influencing factors. These factors herein include the offset distance (*D*) of walls, the number (*N*), amplitude (P_{max}), and frequency (*f*) of applied cyclic loading. Seven GRS walls with a reduced scale of 1:3 were prepared in the laboratory and employed to investigate their (i) vertical foundation pressures during construction, (ii) load-induced settlements, (iii) facing lateral displacements, (iv) vertical and horizontal earth pressures, and (v) geogrid strains under the action of cyclic loading. Experimental results demonstrate that GRS walls constructed in tiered configurations can effectively reduce vertical foundation pressures. The increasing *D*, as well as the decreasing *N* and P_{max}, introduces a reduction to the above five mechanical and deformation properties. However, increasing *f* results in the decrease of wall settlements and facing lateral displacements, and in the increase of others. Performance of several empirical equations for predicting the vertical foundation pressures, location of maximum geogrid strains, and failure surfaces inside walls was examined using the experimental data obtained in this study. Comparisons were also performed to describe the deformation and failure surface modes of the walls after loading.

Keywords: Geosynthetics, Two-tiered GRS walls, Cyclic loading, Earth pressure, Failure surface