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摘要集

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目　录

Effects of pressure on graphene oxide nanoparticle deposition and transport in GCLs

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Abstract: The leakage of graphene oxide nanoparticles (GONPs) in landfills poses a great threat to the environment. A series of column tests were conducted to investigate the effects of hydrostatic pressure, input concentration and bentonite modification on the transport of GONPs in the geosynthetic clay liner (GCL). The experimental results show that pressure affected the mobility of GONPs at high input concentrations, while this effect was smaller at low input concentrations. The retention of GONPs in a GCL containing thermally modified bentonite (TMB) and sodium-modified bentonite (SMB) was greater than that in a GCL containing unmodified bentonite. The type of TMB, SMB and unmodified bentonite was granular bentonite. The sorption and deposition of GONPs in GCLs were also investigated. Pressure affected the deposition of GONPs by decreasing the permeability of the GCL and delaying the transport of GONPs but had little effect on the sorption of GONPs. The dependence of GONP retention on pressure was greater at high input concentrations than that at low input concentrations. The sorption of GONPs in TMB and SMB was much greater than that in unmodified bentonite because of the greater specific surface area and lower negative zeta potentials of TMB and SMB.
Keywords: Geosynthetics, Graphene oxide, Deposition, Geosynthetic clay liner, Pressure, Landfill

Encased stone columns: coupled continuum – discrete modelling and observations

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Abstract: The present research focuses on the simulation of encased stone columns in a 2D state by utilising the coupled finite difference method (FDM) and discrete element method (DEM). The stone column material was modelled by DEM using irregularly shaped particles, and the geotextile used as the encasement of the stone column was simulated using parallel-bonded particles. The surrounding clayey soil was modelled by FDM. Two models were combined by employing a direct coupling method. After validating the coupled DEM-FDM model through comparisons with experimental results, the encased stone column was investigated at the micro and macro scale. The results indicated that the coupled model can imitate the behaviour of the encased stone column to a reasonable degree. Furthermore, the encased stone column exhibited different deformation behaviour than the ordinary stone column. The use of the encasement decreased the stress deviation at the top and bottom of the column. Also, the soil surrounding the encased stone column displayed different displacement behaviour than the soil surrounding the ordinary stone column. In addition, the effect of encasement length on stone column responses was examined.
Keywords: Geosynthetics, Stone column, Geotextile encased, Coupled numerical modelling, Discrete element method, Finite difference method

Thermal desiccation of geosynthetic clay liners under brine pond conditions

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Abstract: Desiccation of geosynthetic clay liners (GCLs) in composite lining systems is investigated experimentally. Field conditions similar to those encountered in brine ponds (high surface temperature and low overburden pressure of 20 kPa) are simulated in two soil columns. The GCL is first allowed to hydrate from a sandy subsoil under isothermal conditions (44 days), then subjected to a thermal gradient applied through a heat source (78°C) on top of the geomembrane (39 days). Changes in water content, temperature of subsoil and movement of the surface during hydration and heating stages are measured. A sharp rise in moisture content is observed in the upper region of the subsoil immediately after the start of heating, which shortly dissipates. After 39 days of heating, the bentonite in the tested GCLs is dehydrated to around 8% gravimetric water content, down from over 100% after hydration. In addition, more than 3 mm of shrinkage of bentonite in the vertical direction is recorded. X-ray imaging after the tests reveals extensive desiccation cracking of bentonite. The study has confirmed the existence of a significant risk of desiccation of GCLs under thermal gradients and has generated data that are useful for validating models used for the prediction of GCL behaviour.
Keywords: Geosynthetics, Desiccation, GCL, Column studies, Brine pond

Static liquefaction behavior of short discrete carbon fiber reinforced silty sand

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Abstract: Saturated silty sand is more likely to cause landslide due to static liquefaction behavior. In this study, easily dispersible short synthetic carbon fibers (CF), with larger aspect ratio and smaller diameter (7 μm) compared with conventional polypropylene fibers, were used to improve the liquefaction resistance behavior of silty sand. A series of triaxial tests under different confining pressures were carried out on reinforced samples with different fiber contents (0.2, 0.5, 1.0%) and lengths (3, 6, 10 mm). The properties of stress and strain relationships, development of pore water pressure, effective stress path, liquefaction brittleness index, critical state line and volumetric strain were examined. The results from undrained tests showed that both the peak and post-peak deviator stresses of CF reinforced samples did not show a regular increase with fiber length. The 6 mm CF fiber showed the best reinforcement effect at a confining pressure of 100 kPa while 3 mm CF fiber achieved the best results at a confining pressure of 200 kPa. CF-reinforced sand was confirmed to be an effective liquefaction mitigation method compared with the method using conventional polypropylene fibers. This study provides an effective improvement method in particular to prevent a geological hazard in backfilling engineering projects.

Keywords: Geosynthetics, Carbon fiber, Shear strength, Excess pore water pressure, Brittleness index

Evaluation of required connection load in GRS-IBS structures under service loads

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Abstract: This study presents an evaluation of the connection load (To) and stress-strain conditions right behind the facing of a Geosynthetic Reinforced Soil – Integrated Bridge Structure (GRS-IBS) based on field instrumentation data obtained from an abutment constructed in Virginia. The observations from this site are compared against other projects in Delaware and Louisiana. The lateral stress distribution obtained from the field was observed to be lower than the active lateral earth pressure distribution but higher than predicted using the bin pressure method. The results from all sites showed that the reinforcement strains measured in the field were below the maximum geosynthetic strains allowed in the design of GRS-IBS. The distributions of both lateral stresses and reinforcement strains with depth were found to be approximately uniform. The T_o values for the Virginia structure were obtained based both on reinforcement strain and lateral stress data, which agreed well with each other. All sites indicated the existence of lateral stresses behind the facing, which contributed to the development of T_o. The normalized T_o values for all GRS-IBS projects evaluated in this study showed that the theoretical tributary area approach outlined in MSE design can be conservatively adopted to predict T_o in the design of GRS-IBS.
Keywords: Geosynthetics, Geosynthetic reinforced soil (GRS), Integrated bridge system (IBS), Mechanically stabilized earth (MSE), Field monitoring program, Lateral stresses, Reinforcement strains, Connection load, Vertical and lateral deformations

X-ray computed tomography imaging of fibre-reinforced clay subjected to triaxial loading

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Abstract: The strength evolution of fibre-reinforced soils has often been examined experimentally using conventional soil testing techniques and numerically by modelling the physico-mechanical behaviour of the soil-fibre interface. Although fibre reinforcement provides a surplus strength to the soil, its real strength contribution is highly dependent on the re-orientation of fibres within the spatial domain of the compacted soil under loading. In this study, a series of unconsolidated undrained triaxial tests were carried out on miniature fibre-reinforced clay samples and the 3D architecture of the fibres before and during the loading was visualised using an intensive image processing technique. This research for the first time investigates the mechanism of fibre re-orientation, spatial distribution, displacement and tortuosity in a randomly fibre-reinforced clay at different stages of loading using an advanced X-ray computed tomography (CT) imaging facility. The results showed a high degree of anisotropic distribution of fibres (i.e. both in spatial location and angles in XZ/XY planes) that is further intensified upon loading.

Keywords: Geosynthetics, Fibre, Reinforced clay, Triaxial test, Shear strength, X-ray computed tomography, Image processing

Predicting strength of soilbags under cyclic compression

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Abstract: Soilbags have a wide range of applications in geotechnical engineering. To explore the compressive strength and deformation behaviour of soilbags, a formula for predicting the strength of soilbags is derived considering the relationship between the tensile force of the bag and the vertical strain. A soilbag under cyclic compression is numerically simulated using the discrete element method to verify the basic stress formula and the derived formula for the tensile force. The results indicate that the increase and distribution of the tensile force in the bag material have an important effect on the compressive strength of soilbags. The derived formula can predict the compressive strength of soilbags under vertical loading, providing a theoretical basis and design methods for structures built with soilbags.
Keywords: Geosynthetics, Soilbags, Strength formula, Discrete element method (DEM), Cyclic compression

Analyzing filtration flow rate change of woven geotextiles for fine grained slurries

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Abstract: Many studies have been performed in recent years to investigate the dewatering phenomena of slurry using geotextile tubes. The laboratory test methods primarily used the pressure filtration test (PFT) and falling head test (FHT) to evaluate the dewatering nature of geotextiles using slurries with different fines contents. The objective of this paper is to examine and analyze the published test data obtained from various testing conditions, and to develop a general equation that can predict the change of flow rate over time. For the PFT, a power law showed a good fit with test data at different fines content ranges. Furthermore, the change of filtration rate with time decreased with the fines content, indicating that slurry with high fines content resulted in a faster drop in filtration rate than slurry with low fines content. For the FHT, a two-term power law was found to fit all of the test data, indicating a two-stage filtration behavior.

Keywords: Geosynthetics, geotextile tube filtration, geosynthetic applications

Effect of infilled materials and arrangements on shear characteristics of stacked soilbags

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Abstract: The shear characteristics of stacked soilbags are related to their interlayer arrangements and the properties of the materials with which the bags (geosynthetics) are filled. To study the effects of those factors on the shear strength and failure mode of stacked soilbags, a series of shear tests were conducted. The results show that although the shear failure surface occurred at the horizontal interface between soilbags when they were stacked vertically, it was ladder-like when the soilbags were stacked in a staggered manner. The angle of insertion was found to govern the shape of the shear failure surface and, thus, the final shear strength of soilbags stacked in a staggered manner. Two shear failure modes of the stacked soilbags were observed with different infilled materials. When the frictional resistance of the contact interface was smaller than the shear strength of the materials with which the bags was filled, only interlayer sliding failure occurred. Otherwise, the simple shear failure of materials filling the bags occurred first, followed by interlayer sliding failure.

Keywords: Geosynthetics, Soilbag, Contact interface, Shear failure model, Shear strength

Pullout of geogrids from tire-derived aggregate having large particle size

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Abstract: Although tire-derived aggregate (TDA) has been used as an alternative backfill in geotechnical engineering applications, the interaction between TDA having large particle sizes (e.g. TDA with a maximum particle dimension of 300 mm) and reinforcing geosynthetics has not been studied. This paper presents results from pullout tests on uniaxial and biaxial geogrids embedded in Type B TDA using a new large-scale pullout device having internal areal dimensions that can accommodate TDA layers with a height up to 1470 mm. Normal stresses ranging from 10 to 60 kPa were applied to TDA layers using dead weights atop a rigid plate and the pullout force was applied via hydraulic actuators operated in displacement control to a bolted-epoxy sandwich-type grip mounted on slide bearings that permit pullout displacements of up to 810 mm. The maximum pullout force increased with normal stress, with a displacement at maximum pullout force ranging from 100 to 350 mm. Internal displacements measured using tell-tales indicate gradual mobilization with pullout force, and the TDA layers all contracted during geogrid pullout. Uniaxial and biaxial geogrids with square-shaped apertures showed higher pullout capacity than uniaxial geogrids with rectangular-shaped apertures, but they experienced combined tensile-pullout failure at higher normal stresses.
Keywords: Geosynthetics, Geogrids, Pullout, Tire-derived aggregate