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摘要集

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目　录

CFD-DEM modeling of filtration through conventional and conical geotextile filter systems

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Abstract: A significant contributor to retaining wall structural failure occurs due to inadequate drainage in the backfill. A numerical model based on a computational fluid dynamics and discrete element method (CFD-DEM) coupled approach was developed to simulate particle movement in the graded filter zone and piping through the geotextiles. The model was used for conventional as well conical geotextile filter systems that use a series of woven geotextiles filtering a coarse-grained backfill soil. The model results were compared with laboratory results to verify the accuracy. The results indicated that conical filter systems contribute to higher soil piping rates but provide higher permeability than conventional geotextile filtration system counterparts. The model predictions compared with the laboratory measurements indicated that the movement of particles (i.e. suffusion) influenced the soil-geotextile contact zone permeabilities and caused a decrease in system permeabilities. A retention ratio, α_{sl}, successfully predicted piping rates for different types of woven geotextiles with a percent error range of 13–29%. Overall, the model predictions matched the laboratory results within an order of magnitude or less, indicating the predictive capability of the model.
Keywords: Geosynthetics, Discrete element modeling, Soil retention

Mechanical behaviour and stress-strain recovery characteristics of expanded polypropylene

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Abstract: Expanded polypropylene (EPP) foam has been widely recognized as an energy absorbing material, and it is routinely used for variety of industrial applications. However, EPP foam has a relatively limited scope in the construction industry, especially for load-bearing applications. To address this aspect, the mechanical behaviour of EPP foam was examined under unconfined conditions in this study, and the effects of different preloading/precompression strain histories (5% to 60%) on the stress-strain response and strain energy characteristics of EPP were evaluated. Additionally, the stress-strain recovery behaviour of EPP foam having different preloading histories was also studied while considering the effects of recovery time after preloading (0 to 28 Days). The results suggest that EPP foam subjected to different preloading histories has identical patterns of stress-strain response to other conventional closed-cell polymeric foams, such as expanded polystyrene (EPS) foam, and EPP can adequately be used for load-bearing applications under the recommended design limits. Furthermore, noticeable recovery in the stress-strain response of EPP was also witnessed during the initial 14 days after preloading. Based on these findings, it is anticipated that the promising stress-strain recovery characteristics of EPP foam enable it to be reused, even after experiencing large in situ deformations.

Keywords: Geosynthetics, expanded polypropylene (EPP) foam, preloading histories, loading rate, strain energy, stress-strain recovery

Hydration behavior of geosynthetic clay liner with polymerized bentonite

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Abstract: The hydration behavior of a GCL with polymerized bentonite (PB-GCL) was investigated by laboratory column tests in terms of hydration gravimetric water content (w), apparent degree of saturation (S_r^*) and air permeability (k_{air}), and compared with those of a GCL with natural bentonite as the core (NB-GCL). In cases of deionized water (DI water) and 0.1 M NaCl solution as pore water of the subsoil, the PB-GCL had higher final w values than the NB-GCL, but the values of S_r^* are similar. The values of k_{air} of the PB-GCL are approximately four orders lower than that of the NB-GCL. In addition, k_{air} of the PB-GCL at S_r^*=40% is comparable with that of the NB-GCL at S_r^*=70%. In the case of the subsoil with 0.6 M NaCl solution, the final value of k_{air} of the PB-GCL is about half of the NB-GCL. These results indicate that cation concentration in a subsoil has a considerable influence on the hydration behavior of a GCL. It is suggested that the PB-GCL has a better hydration performance than the NB-GCL.

Keywords: Geosynthetics, hydration of GCL, polymerized bentonite, permeability

Effect of closed and open system freeze–thaw cycles on GMB–GCL interface transmissivity

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Abstract: An experimental study of the effect of closed system and a limited study of open system freeze–thaw cycles on the interface transmissivity at applied stresses between 10 and 150 kPa is described. The effect of closed system freeze–thaw is most apparent after 100 freeze–thaw cycles and permeation at a stress ≤25 kPa. The effect of permeating fluid chemistry is also evident but decreased with increasing stress. One notable effect of permeant is the potential for internal erosion along weaknesses in the bentonite created by freeze–thaw cycles when permeated by distilled or reverse osmosis water. This is not observed when permeated with simulated pore water containing cations. In terms of practical application, closed system freeze–thaw cycles appear to have little effect on interface transmissivity, and to the extent that there is an effect, it is beneficial. In contrast, cryogenic suction arising with open system freeze–thaw cycles is shown to result in the formation of ice lenses both within the geosynthetic clay liner (GCL) and at the GCL geomembrane interface. Although limited, the data suggest that the effect of ice lens formation on interface transmissivity after open system freeze–thaw cycles is largely eliminated at applied stress above 20–25 kPa, although more research is warranted.
Keywords: Geosynthetics, Interface transmissivity, Geosynthetic clay liner, Freeze–thaw cycles, Landfill covers

Upper-bound limit analysis of MSE walls subjected to strip footing load

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Abstract: The paper presents an upper-bound solution for the bearing capacity based on the assumption of a general two-part-wedge (TPW) slip plane in MSE walls subjected to strip footing load. The proposed method is validated against the results from different analytical methods and model tests. Parametric analyses are carried out to study the effects that backfill shear strength, strip footing width and location, and reinforcement design could have on the bearing capacity and failure geometry in MSE walls. Results show that bearing capacity increases with reinforcement length up to l/H=0.6–0.7, beyond which reinforcement length shows no significant influence on bearing capacity. Predicted elevation of the break point in the geometry of the TPW slip plane is generally lower than 0.5H, except for smaller strip footing widths (e.g. less than 1.0 m).

Keywords: Geosynthetics, MSE walls, upper-bound solutions, two-part-wedge slip planes, bearing capacity

Experimental analysis of bearing capacity failure of geosynthetic-reinforced soil walls

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Abstract: Small- and large-scale 1***g*** experiments were conducted to investigate the bearing capacity failure of geosynthetic-reinforced soil walls. The small-scale experiments (1/10) provided fundamental insights into the development of failure based on digital image correlation analysis. Since these tests suffered from scale effects, large-scale tests (1/1.67) were performed to quantify the ultimate load-bearing capacity of a 1.2 m high wall. A vertical load was applied on top of the structures and internal soil movements and stresses, wall deformations and reinforcement strains were measured. The experimental results revealed that the failure was initially triggered at the rear end of the bottom reinforcement. The wall rotated to the backfill and the ground surface in front of the wall was uplifted. The results confirmed the quasi-monolithic behaviour of the reinforced zone. A multi-body failure mechanism was observed below the base of the wall, consisting of an active and a passive wedge connected by a transition zone. Important scaling factors were discussed using the two different scales which has shown important conclusions that are relevant for experimental studies. The analytical calculations revealed that a reduced reinforcement length needs to be considered in the analytical approach to predict a rather conservative load-bearing capacity.

Keywords: Geosynthetics, Geogrids, Retaining walls, GRS walls, Bearing capacity, Model tests, Physical modelling, Digital image correlation (DIC)

Construction of geofoam block embankments atop existing transportation infrastructure

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Abstract: Expanded polystyrene (EPS) block (geofoam block) is a mature geotechnology for constructing highway embankments. In addition to preventing bearing capacity and settlement related stability problems for the embankments constructed on soft soil sites, geofoam blocks are also used to construct embankments atop existing infrastructure. Selecting geofoam technology for these applications not only prevents possible structural problems due to the lightweight nature of geofoam blocks but also eliminates costly remediation alternatives. The details of three well-documented and monitored different geofoam embankments constructed atop different existing infrastructures (buried pipeline, buried culvert and pile cap of drilled shafts for a deep excavation) are presented. The backgrounds of these projects, design considerations, construction and instrumentation details are discussed. The monitoring results were presented, and long-term performance predictions were evaluated. Numerical modeling effort was utilized to model the both short- and long-term behavior of geofoam embankments. Time-dependent behavior of the embankments under service loads was compared with numerical simulations. Constitutive modeling and related mechanical properties of geofoam blocks, which mimicked the long-term field behavior, as a function of geofoam density were proposed for future numerical modeling efforts.
Keywords: Geosynthetics, EPS-block geofoam, geofoam embankments, numerical modeling