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摘要集

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目　录

Effect of unequal biaxial tensile strains on the filtration behaviour of continuous filament needle-punched nonwoven geotextiles

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Abstract: The effect of unequal biaxial tensile strains on the filtration behaviour of continuous filament needle-punched nonwoven geotextiles was investigated via gradient ratio tests. The filtration behaviour of four groups of unequal biaxial tensile strains were examined, including the gradient ratio (GR), permeability of the soil-geotextile system, mass of soil loss, and permittivity of pure geotextiles. The strains in the machine direction of a geotextile in the four groups were the same, ranging from 10% to 30%, with the ratios of the strain in the machine direction to that in the cross-machine direction set to 1, 2, 3, and 4, respectively. It is shown that for the same strain ratio, the GR value at the time of test termination (GR_t) increases with increasing strain, and the permeability of the soil-geotextile system, permittivity of pure geotextiles, and the soil loss decrease with increasing strain. For the same strain in the machine direction, there are general decreasing trends for the GR_t value and soil loss with increasing strain ratio, and the permeability of the soil-geotextile system and permittivity of pure geotextiles under equal biaxial tensile strains are higher than those under unequal biaxial tensile strains.

Keywords: Geosynthetics; Gradient ratio test; Unequal biaxial tensile strain; Strain ratio; Clogging; Permeability

Shaking table performance of reinforced soil retaining walls with different facing configurations

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Abstract: In this paper, a new type of MSE wall facing, termed as hybrid facing, is introduced and studied, which is built using a combination of concrete modular blocks and cast-in-place concrete. Two shaking table tests were carried out to compare seismic performances of model reinforced soil retaining walls with full-height vs. hybrid facing configurations. Results of this study show that the stability and performance of the hybrid facing model were similar to those of the full-height panel wall for peak input acceleration magnitudes less than 0.40 g. The amplification factors along the height of the facing were more uniform and smaller in the hybrid facing model as compared to the full-height panel wall, especially at higher peak acceleration amplitudes. Dynamic increment of lateral earth loads acting on the facing in both cases were found to be only 20% of the values calculated using pseudo-static methods. Connection loads in the hybrid facing model were smaller than those in the full-height panel wall, which was attributed to its smaller facing displacements.

Keywords: Geosynthetics; Reinforced soil retaining walls; Shaking table; Full-height panel facing; Hybrid facing; Seismic response

Comparison and evaluation of analytical models for the design of geosynthetic-reinforced and pile-supported embankments

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Abstract: Geosynthetic-reinforced and pile-supported (GRPS) embankments are becoming more and more popular as this technique showed good performances in practice. Various design methods were introduced to analyze GRPS embankments. However, the applicability of these design methods was not always fully validated. This paper focuses on the review of projects containing field observations of GRPS embankments. The comparison results showed that the assumptions related to the subsoil support, geosynthetic, arching shape, and its evolution are not consistent in the analytical methods. Comparison results with twenty-five full-scale cases and six series of experiments emphasize that these available design methods produce significantly different results in predicting loads transfer mechanism. The analytical models predict arching for cohesionless fill better that for cohesive fill soils. Besides, the analytical methods which consider subsoil support such as the CUR226 and EBGEO methods give results that are in a better agreement with experimental data as compared to other methods which do not consider the subsoil support. The CUR226 (2016) analytical model seems to be able to give the best performance with measured data when compared to other design methods. Finally, the results pointed out that the limit equilibrium model is adequate and has good performance.

Keywords: Pile-supported embankment; Geosynthetic; Arching; Design methods; Load transfer mechanisms; Field measurement

Centrifuge model tests on the deformation behavior of geosynthetic-encased stone column supported embankment under undrained condition

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Abstract: A series of centrifuge model tests were carried out to investigate the performance of geosynthetic-encased stone columns (GESCs) supported embankment under undrained condition. The influence of stiffness of encasement, basal reinforcement and embankment loading on the deformation behavior of GESCs were also assessed. The centrifuge test results reveal that under undrained condition, compared to ordinary stone column (OSC) supported embankment, the settlement of column has reduced by 50% and 34% when columns were encased with high and low stiffness geogrids respectively. Moreover, under identical embankment loading condition, the stress concentration ratio has increased significantly upon inclusion of basal reinforcement in the GESCs supported embankment. In case of OSCs supported embankment, columns experiences bulging in the top portion, inward bending in the central portion and a noticeable shear at the bottom portion. However, when columns were encased with geogrid layer, bulging in the top portion was significantly reduced but the inward bending of columns were noticed. With the inclusion of basal reinforcement, bending curvature of columns increases thereby inducing higher settlement in columns and relatively lesser settlement in surrounding soil. The differential settlement between the encased column and the surrounding soil under embankment loading has been considerably reduced with the inclusion of basal reinforcement.

Keywords: Geosynthetics; Geosynthetic-encased stone column; Embankment; Centrifuge model test; Undrained condition; Column deformation

Numerical investigation of reinforcement pullout resistance effects on behavior of geosynthetic-reinforced soil (GRS) piers

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Abstract: In this study, three-dimensional numerical analyses were carried out to investigate the effects of reinforcement pullout resistance including facing connection strength on the behavior of geosynthetic-reinforced soil (GRS) piers under a service load condition. Three different piers were investigated in this study, which simulated different levels of reinforcement pullout resistance. Each pier had two cases with different reinforcement stiffness J and reinforcement spacing S_v but the same ratio of J/S_v. Numerical results showed that reinforcement pullout resistance had a significant effect on the behavior of GRS piers. When the pullout mode prevailed, the case with small S_v and low J had smaller lateral facing displacements and vertical strain of the pier under the same applied pressure as compared to the case with large S_v and high J when the ratio of J/S_v was kept constant. When the pullout mode did not prevail, two cases with the same ratio of J/S_v showed similar performance despite different combinations of S_v and J were used. To more effectively mobilize reinforcement strength and improve GRS pier performance, small reinforcement spacing or high-strength facing connection should be considered when sufficient reinforcement pullout resistance cannot be guaranteed otherwise.

Keywords: Geosynthetics; Geosynthetic reinforced soil; Numerical; Pier; Pullout; Reinforcement spacing

Geosynthetic-reinforced soils above voids: Observation and prediction of soil arching

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Abstract: The assumption with the biggest impact on the design of geosynthetic-reinforced soils above voids is the presence and degree of soil arching, which affects the predicted applied stress on the geosynthetic. A series of centrifuge tests were conducted to investigate the soil arching in geosynthetic-reinforced soils with measurements of the soil stresses and observation of soil and geosynthetic deformation used to infer the arching behaviour. Detailed analysis of the results showed that arching significantly reduces the stress at the base of the soil when a void forms; this mechanism is due to stress redistributions and not the formation of a physical arch as suggested in some models. A new method to reliably predict this reduction is proposed by calculating the coefficient of lateral stress on vertical failure planes based on the observations of a continuous convex arc of major principal strains above the void, and the assumption that this is indicative of the stress behaviour.

Keywords: Geosynthetics; Void spanning; Centrifuge; PIV; Soil arching

Cyclic shear behavior of GMB/GCL composite liner

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Abstract: The composite liner system consisting of geomembrane (GMB) and geosynthetic clay liner (GCL) has been widely used in landfills. Although there have been a lot of studies on the monotonic shear behavior of GMB/GCL composite liner, the dynamic test data are still very limited and consequently, the dynamic shear mechanism is not clear. A series of displacement-controlled cyclic shear tests were conducted to study the shear behavior of GMB/GCL composite liner, including the shear stress versus horizontal displacement relationships, backbone curves, and shear strengths. Hysteretic loops in the shape of parallelogram were obtained and equivalent linear analyses revealed that the secant shear stiffness decreased and the damping ratio increased with the rise in loading cycles. According to the test results, it is generally acceptable to predict the dynamic peak strength of a GMB/GCL composite liner with its static strength envelope. Furthermore, the dynamic softening mechanism and rate-dependent shear stiffnesses were well described by the proposed equations, which also facilitate the accurate modeling of the cyclic shear behavior.
Keywords: Geosynthetics; Geomembrane; Geosynthetic clay liner; Cyclic shear test; Dynamic shear strength

Physical model studies on damage and stability analysis of breakwaters armoured with geotextile sand containers

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Abstract: Harnessing the advantages of geotextile sand containers (GSCs), numerous submerged breakwaters and shoreline protection structures have been constructed worldwide. But an emerged breakwater structure with geotextile armour units, capable of replacing the conventional structures, is rarely discussed. A 1:30 scaled physical experimentation is chosen as a preliminary investigation to test the feasibility of using GSCs as breakwater armour units. Structural design is evolved based on a comprehensive literature survey. The paper focuses on the stability parameters and damage characteristics of the proposed structure. Four different configurations are subjected to waves, confining to Mangaluru's wave parameters. Effect of armour unit size and sand fill ratio on the stability of the structure is analysed and it is concluded that changing sand fill ratio from 80% to 100% shot up the structural stability to a maximum of 14%. Increasing bag size also resulted in the increased stability up to 8%. Experiments revealed that the best performing configuration could withstand wave heights up to 2.7 m. Stability curves for all tested configurations are discussed and can serve as an effective guideline for designing GSC breakwaters.

Keywords: Geosynthetics; Geobags; Geotubes; Breakwater; Wave flume tests; Damage classification; Stability curves

Numerical evaluation of the effect of foundation on the behaviour of reinforced soil walls

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Abstract: This study numerically investigates the influence of foundation conditions, in combination with other factors such as wall height and reinforcement and facing stiffness, on the behaviour of reinforced soil walls (RSWs) under working stress conditions. The foundation was simulated using different stiffnesses and geometries (with and without slope). The results highlight the importance of the combined effect of foundation conditions and the abovementioned factors on the performance of RSWs. The results of these analyses indicate that the shape of the distribution of the maximum reinforcement loads (T_{max}) with respect to wall height depends on the combined effect of the foundation condition, facing and reinforcement stiffness, and wall height, and varies from trapezoidal to triangular. Additionally, the results indicate that the effect of variations in foundation stiffness on reinforcement tension mobilisation decreases with wall height. Furthermore, the T_{max} prediction accuracy of three design methods were evaluated and some limitations of each method are presented and discussed.

Keywords: Geosynthetics; Foundation condition; Numerical analysis; Reinforced soil wall; Working stress condition

Three-dimensional finite element analysis of geosynthetic-reinforced soil walls with turning corners

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Abstract: The paper presents in-depth three-dimensional finite element analyses investigating geosynthetic-reinforced soil walls with turning corners. Validation of the 3D numerical procedure was first performed via comparisons between the simulated and reported results of a benchmark physical modeling built at the Royal Military College of Canada. GRS walls with corners of 90◦, 105◦, 120◦, 135◦, 150◦, and 180◦ were simulated adopting the National Concrete Masonry Association guidelines. The behaviors of the GRS walls with corners, including the lateral facing displacement, maximum reinforcement load, factor of safety, potential failure surface, vertical separation of facing blocks, and types of corners were carefully evaluated. Our comprehensive results show (i) minimum lateral displacement occurs at the corner; (ii) lower strength of reinforcements are required at the corner; (iii) higher corner angles lead to lower stability; (iv) potential failure surface forms earlier at the end walls; (v) deeper potential failure surfaces are found at the corners; (vi) larger numbers of vertical separations are found at walls with smaller corner angles. The paper highlighted the salient influence of the corners on the behaviors of GRS walls and indicated that a 3D analysis could reflect the required reinforcement length and the irregular formation of the potential failure surfaces.

Keywords: Geosynthetics; Geosynthetic-reinforced soil wall; Reinforcement load; Three-dimensional effect; Turning corner; Finite element procedure

Pullout behavior of geosynthetic reinforcement in biocemented soils

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Abstract: The pullout resistance of a geosynthetic reinforcement is crucial for the design of reinforced soil structures. In this paper, an innovative concept, biocementation-geosynthetic (BG) system is presented, in which biocementation is used in combination with geosynthetic to increase the pullout resistance of the geosynthetic reinforcement. A series of pullout tests were conducted in laboratory to obtain the pullout behavior of the biocementation-geosynthetic system. From the pullout test results, it was found that the BG system was more efficient in enhancing the pullout resistant as compared with the ordinary geosynthetic (OG) system. For both geosynthetic strips and biaxial geogrid, the BG system had a higher pullout resistance at various levels of relative density. The BG system with only about 0.65% calcite produced by the biocementation process has a 13% – 38% improvement in the pullout resistance compared to the OG system. In addition, the interface shear strength parameters (the adhesion ca and average interface friction angle ϕ) of the BG system are also higher than that of the corresponding OG system in most cases, indicating the better interface performance of the BG system.
Keywords: Pullout tests; Pullout resistance; Biocementation; BG system; OG system

Dynamic shear behavior of GMB/CCL interface under cyclic loading

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Abstract: The dynamic shear behavior of composite liner interface is of great importance for landfill seismic analysis. In this study, an experimental investigation of the shear behavior of the interface between smooth high density polyethylene (HDPE) geomembrane (GMB) and compacted clay liner (CCL) is presented. A series of displacement-controlled cyclic shear tests were conducted to investigate the effects of displacement amplitudes, normal stress levels and number of cycles on the GMB/CCL interface shear behavior. Cyclic loading with higher displacement amplitude will produce greater vertical contraction and lower interface initial shear stiffness. Also, significant shear strength degradation was observed within the first 5 shearing cycles, then followed by slight interface reinforcement in subsequent cycles. The dynamic shear modulus of GMB/CCL interface is dependent on both normal stress levels and displacement amplitudes, while the damping ratio is only affected by displacement amplitudes. Finally, a method considering the GMB/CCL composite liner as an equivalent soil layer was proposed, which is useful for landfill seismic analysis.
Keywords: Geomembrane; Compacted clay liner; Dynamic shear behavior

Model tests of freeze-thaw behavior of geocell-reinforced soils

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Abstract: Freeze-thaw cycles are a major cause for destabilizing pavements in cold regions. Among countermeasures for freeze-thaw damages, use of geocells to reinforce pavement bases is an effective solution in practice. However, as opposed to widespread applications, research concerning freeze-thaw behavior of geocell-reinforced bases is limited, probably due to a lack of proper devices for conducting experimental tests. This paper presents a new model-test device capable of performing both freeze-thaw tests and plate loading tests on geocell-reinforced soils. A thermodynamic numerical model was developed to assist with the design of freeze-thaw component of the device, while the design of plate loading component was developed by referring to features of existing devices. Eleven tests were run on geocell-reinforced and unreinforced sands to confirm the effectiveness of the proposed device. The test results showed the device successfully provided vertical heat transfer in sands during freeze and thaw. After five freeze-thaw cycles, geocells reduced peak frost heave and thaw settlement of sands by 18% and 34%, respectively, and increased the stiffness and bearing capacity by 40% and 253%, respectively. It was found a temperature drop occurred at the interface between cooling plate and sands, which was due to the existence of thermal contact resistance.

Keywords: Geosynthetics; Model test device; Freeze-thaw test; Plate loading test; Geocell reinforcement; Bearing capacity

A shakedown limit calculation method for geogrid reinforced soils under moving loads

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Abstract: A method to calculate the elastic shakedown limit of transportation systems (e.g. pavements and railways) supported by geogrid reinforced soils is presented. For the first time, lower-bound shakedown theory is combined with a strength-based geogrid simulation approach, resulting in a rapid method to quantify the benefit of geogrids on the elastic shakedown limit. It allows decoupling of elastic stress generation and shakedown calculations, meaning it is straightforward to implement, and requires minimal computational effort. Therefore it presents a useful tool to optimise geogrid design for transportation structures such as highway pavements and railways. To show the capability of the method, shakedown limits are calculated for a variety of geogrid configurations using elastic stresses induced by a moving Hertz load. The effect of geogrid depth, soil cohesion, soil friction angle and loading type (normal versus tangential) are investigated for reinforced and non-reinforced soils. It is found that the optimum depth is sensitive to the soil strength properties. Regarding loading, it is shown that for highly tangential loads, shallower geogrids are effective, while for loads with a minimal tangential component, deeper geogrids are effective.

Keywords: Highway pavement design; Geogrid reinforced soil; Shakedown limit theory; Moving cyclic loading; Railway track subgrade

A simple unified stress-strain model for geotextile-wrapped soils

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Abstract: The stress-strain behaviour of geotextile-wrapped soils is a matter of great concern in geotechnical engineering practices. In this study, a unified stress-strain model for geotextile-wrapped soils is proposed and is applied to understand the strength and deformation characteristics of soilbags (woven bag-wrapped soils) in 2D biaxial loading. It is demonstrated that the strength of wrapped soils is greatly improved due to the wrapping effect, and the shearing contraction of the wrapped soils is more pronounced than that of the pure soils. The validity of the results is verified through numerical simulation using the discrete element method (DEM). The effect of the geometric size and material properties of the woven bag on the strength and deformation characteristics of the soilbags is also analyzed using the proposed model. The proposed model differs from existing phenomenological models in that it is able to predict the mechanical response of soilbags when the constitutive behaviours of the wrapped soils and the woven bag are given.

Keywords: Geosynthetics; Stress-strain model; Geotextile-wrapped soils; Soilbag; Deformation; Strength; DEM

Influence of bio-clogging on permeability characteristics of soil

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Abstract: It is necessary to enhance the barrier performance of cutoff walls in order to improve the contamination control level, especially for reconstruction or expansion of existing landfill sites. This paper presents a comprehensive laboratory investigation on the synergistic effects of microorganisms and fibers on the hydraulic conductivity of silty sand to evaluate the applicability to the field condition as an alterative barrier material. Inside the soil, the added carbon fibers not only provided good biocompatibility, but also formed spatial three-dimensional network between soil particles to improve the bacterial adhesion that eventually caused 2 – 3 orders of magnitude decrease in soil permeability. The resistance of the biofilm to extreme conditions was tested by permeation with solutions of different salinity and pH values, and by subjecting specimens to various hydraulic gradients and soil conditions. Despite the microbial growth inhibition occurred at these conditions, however, biofilm can largely remain intact and continue to reduce k, which due to the gradual adaptation of microorganisms to the extreme environment and the gradual recovery of their activity. Results of these tests demonstrate that biofilm treatment may be a feasible technology for creating waste containment barriers in soil.

Keywords: Geosynthetics; Bio-clogging; Fiber; Landfill; Cutoff wall; Hydraulic conductivity

Geosynthetics reinforced interposed layer to protect structures on deep foundations against strike-slip fault rupture

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Abstract: In the present study, the interaction mechanism of a 10-story moment-resisting building frame sitting on the conventional piled raft foundation with a strike-slip fault rupture with a dip angle of 90° is studied via three dimensional finite element numerical simulation using ABAQUS. In addition, an alternative composite foundation system with geosynthetics reinforced interposed layer between piles and raft is proposed to improve the safety and performance of foundation under strike-slip fault ruptures. The interposed layer is reinforced with two high tensile strength of the geotextile layer. The inelastic behaviour of piles under large ground deformations is simulated using moment-curvature relationships of the real reinforced concrete section of piles and ductility concepts. The performance of both composite and conventional piled raft foundations is evaluated in terms of the geotechnical and structural responses of foundations including rotational and translational displacements and shear forces of the raft, as well as shear forces and ductility capacity of piles. The obtained results show the superior performance of composite foundation with geotextile reinforced interposed layer in terms of a significant reduction in shear forces in the raft and piles, as well as ductility demand in the piles.
Keywords: Geosynthetics; Fault rupture; Strike-slip fault; Piled raft foundation; ABAQUS

Shaking table tests on polymeric-strip reinforced-soil walls adjacent to a rock slope

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Abstract: This research adopts the approach to constructing reinforced-soil walls on rock slope, where the extent of reinforced zone has to be constrained since excavation of the relatively rigid zone may not be economical and may disrupt the traffic. To examine the seismic behavior of these structures, a series of 1-g shaking table tests using variable-amplitude harmonic excitations was conducted on 0.8m-high polymeric-strip reinforced-soil walls (PSWs) on rock slope under a scenario of waves with different intensities. Rock slope appeared to have a satisfactory dynamic response compared to the soil base as the rock behind the reinforced zone controls the development of active wedge failure and prevents higher amplification and progressive deformation. The results illustrated that the confining pressure and reinforcement length considerably affect the shear modulus and damping ratio. Also, it was found that in PSWs on rock with L/H ratio of 0.3 for bottom strips, the lowest facing panel, having the maximum horizontal displacements after failure, and lower maximum shear modulus (G_{max}), and damping ratio (D), is the most crucial one despite having the highest confining pressure representing the profound effect of L/H ratio when it equals 0.3.

Keywords: Polymeric-strip reinforced-soil walls; Shaking table tests; Limit equilibrium methods; Rock slope; Reinforcement length; Harmonic waves with different intensities

Large scale soft ground consolidation using electrokinetic geosynthetics

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Abstract: Field test of electro-osmotic consolidation with area of 800 square meters was carried out using electrokinetic geosynthetics (EKG). By introducing this field test, new concepts and solutions of difficulties in large scale application of electro-osmosis is introduced. Strategies of building smart DC power source to meet the large current intensity requirement of electro-osmosis are introduced. Roll polling program is a key program for the control system of smart DC power source. It reduces the requirement of current intensity to 1/3; it also decreases the energy consumption to less than 1 $kW \cdot h/m^3$. Design method for electro-osmotic consolidation is demonstrated while designing a field test. It is based on the energy level gradient theory. Design includes power estimation, wires and cables configuration, treatment time estimation and settlement estimation. The field test show that large scale application of electro-osmotic consolidation is feasible with acceptable power requirement and energy consumption. Electro-osmosis can accelerate consolidation and achieve better consolidation effect.

Keywords: Electro-osmosis; EKG; Consolidation; Roll polling program; Energy level gradient

Filtration performance of geotextile encasement to minimize the clogging of stone column during soil liquefaction

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Abstract: Stone columns, which are frequently employed to stabilize the liquefiable soil, are susceptible to accumulation of soil particles. The progressive accumulation of the soil particles causes clogging of the stone column which decreases its drainage capacity. The stone column can be encased with geotextile to sustain its long term drainage function. The encasement prevents the movement of the soil particles into the stone pores. In the present paper, a mathematical model is presented to assess the filtration performance of the geotextile encasement to prevent the clogging. The filtration capacity of the geotextile is related to its maximum pore size, porosity and soil characteristics. It is observed that the encased stone column dissipates the excess pore pressure at a faster rate compared to the stone column without encasement. The peak maximum excess pore water pressure (U_{max}) is not significantly affected due to selection of the opening size of the geotextiles for single earthquake. However, the opening size can significantly affect the peak U_{max} value for multiple earthquakes. Depending on the capture coefficient of the stone column, the clogging can be fully prevented for higher hydraulic gradient if geotextile with maximum opening size in between D10 to D5 is used as encasement.
Keywords: Liquefaction; Stone column; Geotextile encasement; Clogging

Failure mechanisms of geosynthetic clay liner and textured geomembrane composite systems

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Abstract: The objective of this study was to evaluate shear behavior and failure mechanisms of composite systems comprised of a geosynthetic clay liner (GCL) and textured geomembrane (GMX). Internal and interface direct shear tests were performed at normal stresses ranging from 100 kPa to 2000 kPa on eight different GCL/GMX composite systems. These composite systems were selected to assess the effects of (i) GCL peel strength, (ii) geotextile type, (iii) geotextile mass per area, and (iv) GMX spike density. Three failure modes were observed for the composite systems: complete interface failure, partial interface/internal failure, and complete internal failure. Increasing normal stress transitioned the failure mode from complete interface to partial interface/internal to complete internal failure. The peak critical shear strength of GCL/GMX composite systems increased with an increase in GMX spike density. However, the effect of geotextile type and mass per area more profoundly influenced peak critical shear strength at normal stress > 500 kPa, whereby an increase in geotextile mass per area enhanced interlocking between a non-woven geotextile and GMX. Peel strength of a GCL only influenced the GCL/GMX critical shear strength when the failure mode was complete internal failure.

Keywords: Direct shear; Geomembrane; Geosynthetic clay liner; Shear strength

Field study and numerical modelling for a road embankment built on soft soil improved with concrete injected columns and geosynthetics reinforced platform

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Abstract: Generally numerical modelling can provide an accurate and cost-effective approach to understand the behaviour of geosynthetic-reinforced column-supported embankment. When the problem geometry cannot be simplified to the two-dimensional plane-strain or axisymmetric, a full three-dimensional solution is required to obtain sensible results. This study presents a modelling of the geosynthetic-reinforced composite ground supporting a road embankment. Response of soft soil is captured by adopting Modified Cam-Clay model. In addition, Hoek-Brown constitutive model is considered to simulate non-linear stress-dependent yield criterion for Concrete Injected Columns (CIC) that describes shear failure and tensile failure by a continuous function. To assess whether the proposed numerical model can capture real behaviour of composite ground, field monitoring data of deep soft clay deposit improved by CIC from Gerringong Upgrade is used to validate the model. The settlement and lateral displacements of ground, stress transferred to column, and pore water pressure results for the embankment during and after the construction, measured using the field instrumentations including settlement plates, inclinometers, earth pressure cells on CIC, and pore pressure transducers, are compared with numerical predictions. In addition, the numerical results provide insights to investigate load transfer mechanism in the composite ground, capturing response of soil - column - embankment system.

Keywords: Ground improvement; Concrete injected columns (CICs); Soft soil; Load transfer platform (LTP); 3D-simulation

Modified stress and temperature-controlled direct shear apparatus on soil-geosynthetics interfaces

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Abstract: In this paper, a bespoke stress and temperature controlled direct shear apparatus to test soil-geosynthetics interfaces is introduced. By adopting the apparatus, a series of 'rapid loading' shear tests and creep tests were conducted on the Clay - Geosynthetic Drainage layer (GDL) interfaces to assess the functionality of the apparatus. The experimental results indicate that, the modified apparatus can allow the shear deformation behaviour of soil-geosynthetics interfaces under environmental stress during thermal and drying-wetting cycles to be investigated, with a reliable performance. The resistance of Clay-GDL interfaces to shear deformation under the rapid loading of shear stress decreases after drying-wetting cycle and at elevated temperature. In the creep tests, the interfaces subjected to drying-wetting cycles and thermal cycles fail under a lower shear stress level than that of the interfaces without experiencing drying-wetting cycles and thermal cycles, respectively. The impacts of drying cycles on the horizontal displacement is significantly larger than that of wetting cycles. The first drying cycle has the largest impacts on the horizontal displacement than those of the following drying cycles. The impacts of drying alone on the horizontal displacement of Clay-GDL interfaces during drying cycles are small, and the main influence factor is the elevated temperature.

Keywords: Geosynthetic interfaces; Creep test; Geocomposite drainage layers; Drying-wetting cycle; Modified direct shear apparatus; Rapid loading shear test

Static stability analysis of geocell-reinforced slopes

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Abstract: This paper presents an analytical approach to investigate the stability of geocell-reinforced slopes using the limit equilibrium method (LEM). The so-called Horizontal Slice Method (HSM) is employed to simulate horizontal geocell layers. Each geocell layer acts as a beam providing bending and shear resistance in addition to axial strength. A formula is devised by picking relevant governing equilibrium equations, fitted to the new concept employed exclusively for analysis of geocell-reinforced slopes. Parametric studies are conducted to evaluate the effects of increasing the geocell height and replacing geogrids by geocells with various heights for slopes with different characteristics. The results showed that such actions would reasonably reduce the required tension and length of the reinforcement layers, meaning that the stability condition is improved and the less lengthy reinforcement system is formed. Output values also showed dependency on the slope angle and its material properties.

Keywords: Geocell-reinforced slopes; Analytical slope stability analysis; Limit equilibrium; Horizontal slice method (HSM); Parametric studies

The effects of porosity, asphalt content and fiberglass incorporation on the tensile strength and resilient modulus of asphalt concrete blends

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Abstract: Asphalt concrete is the prevailing material used for road surface construction. Its adequate characteristics in providing stability, durability and driving safety are controlled by complex interactions between its components. Thus, it is important to estimate the sensitivity of asphalt concrete mechanical properties as a function of its volumetrics. For this study, different combinations between asphalt content (3.5, 5 and 7.5%) and porosity values (above 4%) were used in order to disassociate these properties. The influence of mixing in fiberglass (0.5%) was also analyzed. It was found that porosity is significantly more relevant than the asphalt content in the prediction of tensile strength and resilient modulus of fiber-free asphalt concretes. In fiber-reinforced mixtures, the mechanical properties are improved by increasing the asphalt content, which suggests a better bonding between fibers and aggregates. For both cases, decreasing porosity is beneficial. By grouping both sets of results, it was possible to create a unique theoretical curve for both the tensile strength (qt) and the resilient modulus (RM). The RM/qt ratio was 5800 for the fiber-free group, and 3900 for the fiber-reinforced group - suggesting a better fatigue life indicator for asphalt concretes when fibers are added.

Keywords: Asphalt concrete; Fiberglass; Porosity; Asphalt content; Split tensile strength; Resilient modulus; Road and pavement design