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摘要集

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目　录

Permittivity and filtration properties of grout socks for rock bolt installations

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Abstract: Rock bolts are commonly used to stabilise slopes and underground excavations but their installation can sometimes be difficult in challenging grounds due to excessive leakage or washout of the grout. To manage these problems, tubular geotextile socks have been adopted in the industry but there has been a lack of research on their properties. To advance the understanding of sock behaviour, the water permittivity and filtration properties of two types of grout sock have been investigated in their unstretched state. From the permittivity tests, it is shown that water flow through these socks will be laminar and that using more than one layer in a setup can effectively reduce the flow velocity. Moreover, it has been shown that the effect of the tester should be considered in the analysis or else the permittivity of the geotextile could be underestimated. From the filtration tests, it is shown that both types of grout sock tested are effective in minimising grout loss and that the permittivity of the filter cake will be many orders of magnitude lower than that of the socks. The results also show that the water-cement ratio of the grout will be reduced as a result of the dewatering process.

Keywords: Geosynthetics, Permittivity, Filtration, Rock bolts, Grout socks

Experiments and dimensional analysis of waste tire-based permeable pavements

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Abstract: This study investigates the stress-strain response of a novel high-porosity semi-bound soft-rigid permeable pavement blend prepared using rock-and tire-derived aggregates (RDA and TDA) bonded by a polyurethane (PUR) binder. A series of unconfined compression tests were performed on 36 mix designs (with different RDA and TDA proportions, PUR contents and curing durations) to identify the variables governing the stress-strain response. The greater the TDA content, the lower the mobilized strength (UCS) and stiffness (E_{50}), both following an exponentially-decreasing trend. Meanwhile, an increase in PUR content (i.e. increase in the number of inter-particle bonds) and/or curing duration enhanced the UCS and E_{50}. Unlike the UCS which often achieved a stabilized state at seven days of curing, the development of stiffness extended into higher curing durations. Applying the dimensional analysis concept, a practical modeling framework was proposed and validated (using an independent database) for the UCS and E_{50}, allowing these parameters to be simulated as a function of the blend's basic properties-that is, RDA (or TDA) content and its mean particle size, PUR content, curing duration, and dry density. The proposed models can be used with confidence for preliminary design assessments and/or semi-bound soft-rigid optimization studies.

Keywords: Geosynthetics, Permeable pavement, Tire-derived aggregate, Polyurethane, Curing duration, Strength and stiffness, Dimensional analysis

Bearing capacity improvement using soil-filled post-consumer PET bottles

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Abstract: This study proposes reusing post-consumer soil-filled PET (polyethylene terephthalate) bottles as a novel soil reinforcing element by conducting a laboratory-scale experimental investigation. The concept is that the polymer bottle walls act to confine the interior soil so that the bed behaves somewhat like a brick-built load spreading zone. The soil-filled bottles were horizontally laid within the soil bed in the desired depth and then the backfilling was performed. The effect of different parameters such as depth of placement, width and height of the soil-filled, bottle-reinforced mattress are studied under static plate load testing. T est results revealed that the bottle-reinforced bed is highly rigid, delivering very high bearing capacities at small soil displacements. Optimum depth of placement, width and height of the bottle-reinforced zone were respectively about 0.03B, 2.17B and 0.57B. A n improvement in bearing capacity ratio (BCR) by a factor of ~3, and up to 80% reduction in soil settlement, were observed. The proposed method of soil reinforcement can be an excellent and relatively economic alternative to conventional geosynthetic reinforcement, as well as delivering geotechnical and environmental advantages.
Keywords: Geosynthetics, bearing capacity, footing settlement, PET bottles, soil reinforcement

Evaluation of required stiffness and strength of cellular geosynthetics

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Abstract: Cellular geosynthetics have been widely used in engineering practices for their enhanced confining effects. However, limited research has been reported on methods of evaluating the required stiffness and strength of cellular geosynthetics based on the strength of geosynthetic-encased soil in engineering practices. In this study, an analytical approach was formulated to estimate the required stiffness and strength of cellular geosynthetics based on the equivalent strength of geosynthetic-soil composites considering soil nonlinearity , soil plasticity, soil dilatancy, and soil-geosynthetic interaction. Large-scale triaxial compression tests on geosynthetic-encased sand were performed to validate the effectiveness of the method. Parametric studies were conducted using the validated method to investigate the effects of nonlinear elastic parameters, the peak strength of the infill soil, and the aperture size of cellular geosynthetics on the required stiffness and strength.

Keywords: Geosynthetics, analytical method, stiffness, strength, parametric study, nonlinear elastic parameters

Undrained response of geocell-confined pond ash samples under static and cyclic loading

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Abstract: In this study, the effect of geocell confinement on strength, deformation, dynamic properties, and liquefaction characteristics of pond ash samples were investigated. Pond ash was collected from the Panki thermal power station, India. The geocells were handmade with high-density polyethylene sheets. Each geocell has three equal diameter circular cells. Consolidated undrained triaxial tests were conducted on both remolded and geocell-confined ash samples of size 100 × 200 mm under static and cyclic loading conditions. The confining pressures were chosen as 50, 75, and 100 kPa, cyclic strain rates were chosen as 0.2, 0.3, and 0.4% and the frequency of cyclic loading was 1 Hz. From this experimental study, it is observed that the increase in peak deviatoric stress of geocell-confined pond ash samples is about 21% to 32% higher than the unconfined samples. The liquefaction resistance of ash samples increases 51% to 87% due to geocell confinement. Result shows that ash samples exhibit better response in terms of cohesive strength, dynamic properties, and liquefaction resistance with geocell confinement, which proves the applicability of geocell-confined pond ash as a suitable material for construction of road embankments and slopes.

Keywords: Geosynthetics, Geocell, Pond ash, Static triaxial tests, Cyclic triaxial tests

Interface creep behavior of tensioned GFRP tendons embedded in cemented soils

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Abstract: This paper presents an experimental investigation and modeling of interface creep behavior of glass fiber-reinforced polymer (GRFP) tendons embedded in cemented soils. Rapid and creep pullout tests were carried out on GRFP tendons embedded in cemented soils using a specially developed pullout setup. Interface creep displacement responses for specimens with two different water-cement ratios were derived under various interface shear stress conditions. A modified Burgers model was developed to characterize the interface creep behavior by incorporating a time-dependent viscosity coefficient. This viscosity coefficient was calibrated using creep rate variation obtained experimentally. Regression fittings on a part of interface creep measurements were conducted to determine the value of the parameters of the interface creep model. Additional interface creep measurements were used to validate the applicability of the presented creep testing protocol and the effectiveness of the rheological modeling was validated.

Keywords: Geosynthetics, Glass fiber-reinforced polymer, Cemented soils, Interface creep behavior, Burgers model

Laboratory evaluation of different geosynthetics for water drainage

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Abstract: During road construction, soils are often compacted at the optimum water content to achieve maximum dry density and best performance. After construction is completed, the soil water content in the field will inevitably increase with time due to capillary rise, rainfall infiltration, and other factors. Conventional drainage systems rely on geomaterials or geosynthetics with large pores to drain gravity (or free) water but cannot drain out capillary water. The excess water in the road system causes pavement deterioration under repetitive traffic load. Recently, two new types of geosynthetics were used as drainage materials. However, most of the field tests were inconclusive due to complicated site conditions and soil nonuniformity. The relative performances of these drainage geosynthetics and their working mechanisms were largely unclear. In this study, laboratory tests were conducted to quantify the cumulative amount of water drained under different drainage situations. The volumetric water content of soils was monitored by moisture sensors and the water contents of soils under different drainage situations were evaluated and compared. Finally, the working mechanisms of different drainage materials were discussed.

Keywords: Geosynthetics, Drainage belt, Wicking geotextile, Capillary water, Water retention curve, Unsaturated soil

Consolidation of unsaturated soil by vertical drain considering smear and well resistance

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Abstract: This paper proposes an approximate analytical solution for equal-strain consolidation of unsaturated soils with vertical drains considering smear and well-resistance effects. According to the modified laws of both Fick and Darcy, the governing equations for the air and water phases are established in the matrix form and solved using the matrix analysis method. Comparisons with previous analytical solutions and finite difference solutions are conducted to assess the correctness of the proposed solution. Upon the successful calibration of the proposed approach, graphical interpretation is presented to elaborate the influence of combined smear and well-resistance parameters on the consolidation characteristics. It can be found that the proposed approximate analytical solution is accurate to meet engineering requirements. Moreover, the smear and well-resistance effects decrease the dissipation rate of excess pore-air and pore-water pressures considerably, while the average degree of consolidation at the end of the first consolidation stage does not change much for different combined smear and well-resistance parameters.

Keywords: Geosynthetics, Analytical solution, Equal-strain consolidation, Unsaturated soils, Smear effect, Well resistance

Air and hydraulic flow characteristics of polymer amended bentonite based unsaturated GCLs

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Abstract: Geosynthetic clay liners (GCLs) are used in landfill applications because of their high deformation resistance and excellent self-healing ability. In the present study, air and hydraulic flow characteristics of natural bentonite based GCL (GCL-N) and polymer amended bentonite based GCL (GCL-A) were assessed using air permeability and hydraulic conductivity measurements. The airflow characteristics of GCLs were studied at various apparent degrees of saturation (S_a) and corresponding suction using a custom-designed air permeability test setup. The effect of desiccation on the airflow characteristics of GCL-A was also examined. Further, hydraulic flow characteristics of virgin and desiccated-rehydrated GCLs were assessed using a flexible wall permeameter. The water absorption capacity of GCL-A is relatively higher than GCL-N, irrespective of the stress state. For any chosen S_a, air permeability of GCL-A is lower than GCL-N. Moreover, with the decrease in the suction from 2500 kPa to 1000 kPa, the air permeability of virgin GCL-A has reduced from $9\times10^{-12}m^2$ to $3.57\times10^{-16}m^2$ while the desiccated-rehydrated GCL-A has reduced from $8.86\times10^{-11}m^2$ to 1.9×10^{-13} m^2. The hydraulic conductivity of GCL-A is two orders of magnitude less than GCL-N, which shows the better performance of GCL made with amended bentonite.

Keywords: Geosynthetics, geosynthetic clay liner, amended bentonite, air permeability, hydraulic conductivity, desiccation, self-healing capacity

Dewatering of dredged slurry by horizontal drain assisted with vacuum and flocculation

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Abstract: This study proposes a new method using the combination of flocculation and prefabricated horizontal drain (PHD) assisted with vacuum pressure for rapid dewatering of high-water-content dredged slurry. First, to demonstrate the superiority of using PHD over the more commonly used prefabricated vertical drain (PVD), experiments were conducted to compare the dewatering performance between the PHD and the PVD. Then six model tests with the proposed dewatering method were performed with various contents of flocculant (anionic polyacrylamide (AP AM)) to investigate the effect of AP AM content on the dewatering process and soil properties (i.e. undrained shear strength, permeability and compressibility). Furthermore, particle size distributions of the slurry before and after model tests were measured to analyze the dewatering behavior and changes in material properties. Finally, particle loss during vacuum consolidation for various AP AM contents were compared to study the flocculation effect on clogging problem. Results indicate that the proposed method can prevent significant bending deformation of the drain board and mitigate clogging of the drain filter and, thus, can significantly accelerate the dewatering process of high-water-content dredged slurry.

Keywords: Geosynthetics, Prefabricated horizontal drain (PHD), Vacuum consolidation, Flocculation, Dredged clayey slurry, Polyacrylamide

Geosynthetic encased column-supported embankment: behavior with and without basal geogrid

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Abstract: Centrifuge model tests were performed to investigate the beneficial effect of the basal geogrid in improving the performance of geosynthetic encased column (GEC)-supported embankments. The digital image correlation (DIC) technique was adopted to understand the deformation behavior of GEC-supported embankment models. The mobilized tensile strain at various locations on the model basal geogrid was quantified using strain gauge-based instrumentation. The results from the centrifuge test indicate that vertical and lateral displacement of the GECs and surrounding soil has been significantly reduced with the inclusion of basal geogrid in the embankment. Moreover, the differential settlement between the GECs and surrounding soil due to embankment loading were significantly reduced with the inclusion of basal geogrid, thereby the distress in the embankment resting on soft foundation can be avoided. The basal geogrid in the embankment has enhanced the stability of the embankment and improved the load transfer between the GECs and surrounding soil. The maximum mobilized tensile strain in the basal geogrid occurred near the shoulder of the embankment, which indicates the resistance offered by the basal geogrid in preventing the differential settlement between the GECs and surrounding soil.

Keywords: Geosynthetics, encased columns, basal geogrid, embankment, soft clay, centrifuge model test

Effect of temperature on the mechanical properties of two polymeric geogrid materials

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Abstract: Understanding the tensile behavior of geosynthetic reinforcement materials at different temperatures is essential for the design of reinforced soil structures in seasonally cold regions. This study describes a series of tensile tests performed on two polypropylene geogrid materials, namely a biaxial geogrid and a geogrid composite. A total of 84 tests were performed in an environmental chamber with temperatures as low as −30°C and as high as +40°C. The response of each material is examined over the range of investigated temperatures to evaluate the effect of temperature changes on the tensile strength of the two geogrid materials. The response of the biaxial geogrid is found to be sensitive to temperature variations, with samples tested at low temperatures exhibiting brittle behavior characterized by high rupture strength and small ultimate strain while samples tested at elevated temperatures displayed ductile behavior with large elongation at failure and comparatively small rupture strength. A similar response was found for the geogrid composite, however, the rupture strength seemed to be less sensitive to temperature changes. The modes of failure observed at each temperature are examined based on photographic evidence taken during the experiments.

Keywords: Geosynthetics, geogrid, tensile loading, temperature effect, mechanical properties