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摘要集

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Coupled numerical and experimental analyses of load transfer mechanisms in granular-reinforced platform overlying cavities

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Abstract: A numerical model based on Finite Element Method (FEM) - Discrete Element Method (DEM) coupling is used to reproduce well controlled laboratory experiments that simulate circular cavity openings under granular embankments reinforced by a geotextile. The numerical deflection of the geotextile, the surface settlement and the soil expansion factor were investigated for various embankment heights, diameter ratios, cavity-opening modes, soil properties, and geotextile stiffnesses, and then compared to the results of laboratory tests. The load transfer mechanisms were also investigated. Good agreement between numerical and experimental results is shown, thus demonstrating the relevance of the numerical model. Complementary to the experiments, a numerical sensitivity analysis, that allows highlighting the influence of the main parameters and improving experimental observation, was also performed.

Keywords: Geosynthetics; Reinforcement; Cavity; FEM-DEM; Experiment

Improvements in small-scale standardized testing of geotextiles used in silt fence applications

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Abstract: Silt fence have been used as a means for intercepting and treating construction site stormwater runoff prior to offsite discharge for well over 30 years. Standard small-scale testing methodologies for evaluating the filtering component of silt fence installations have failed to mimic realistic flows and sediment loadings commonly seen in field applications. To address these issues, this study evaluated the performance capabilities of two nonwoven and three woven silt fence geotextiles using an innovative testing methodology and a newly developed small-scale testing apparatus. The overall intent for conducting the evaluations was to develop a deeper understanding of effluent flow rates, sediment retention capabilities, and water quality impacts associated with geotextile fabrics. Results suggest that effluent flow rates of nonwoven geotextiles are on average 43% lower than woven materials, which results in extensive upstream retention times of impounded stormwater for nonwoven mate-rials. Sediment retention results indicate that nonwoven geotextiles have an average sediment retention rate of 97% while woven geotextiles average 91 %. Finally, water quality analyses suggest that the primary means for turbidity reductions rely on the process of sedimentation during the 30-min test period (i.e., 46% reduction) and filtration during the 90-min dewatering period (i.e., 19% reduction).

Keywords: Geosynthetics; Silt fence; Sediment barrier; Geotextile filtering; Sediment control; Small-scale testing

Experimental and upper-bound study of the influence of soilbag tail length on the reinforcement effect in soil slopes

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Abstract: Soilbags have good reinforcement effect on soil slopes. In this paper, traditional soilbag is modified by adding a tail to it. Model tests have been used to study the influence of soilbag tail length on the reinforcement effect in soilbags reinforced slopes. Moreover, a permissive failure pattern and a corresponding velocity field have been established based on the experimental results. Then, the ultimate failure heights of the reinforced slopes are obtained by using the upper-bound solution theory and compared with the experimental results. Both the experimental and analytical results show that within a certain limit, the reinforcement effect improves with the increase of tail length. However, when the tail length is over a certain value, the increase of the tail length does not improve the reinforcement effect any more. This provides theoretical basis to the optimized design of soilbags reinforced slopes.

Keywords: Geosynthetics; Model test; Reinforcement of soil slope; Soilbags; Tail length; Upper-bound analysis

Performance of a test embankment on very soft clayey soil improved with drain-to-drain vacuum preloading technology

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Abstract: Vacuum consolidation of soils is a technology that, to date, has not been implemented in the Valley of Mexico, where clays are highly compressible and have very low shear resistance and low permeability. This paper describes the experience of a test embankment, in which the drain-to-drain vacuum preloading was assessed. The evaluation includes the description of the subsoil conditions, characteristics of the embankment, construction process and instrumentation that was installed. The test lasted approximately one year with a vacuum applied for six months. The monitoring results showed that the vacuum distributed along the vertical drains and on the surface soil layers accelerated the consolidation, reduced the lateral displacements toward the outside of the platform and increased the effective stress of the soil to a depth similar to the length of the drains. However, there were vacuum pressure losses of approximately 30% between the pumps and end of the horizontal flexible pipes that distribute the vacuum. These losses of vacuum pressure affected the soil consolidation process.

Keywords: Geosynthetics; Test embankment; Soft soil; Prefabricated vertical drains; Vacuum preloading; Drain-to-drain technology (membraneless)

Large-scale load capacity tests on a geosynthetic encased column

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Abstract: Stone columns have been used to minimize the settlement of embankments on soft soils but their use in very soft soils can become challenging, partly because of the low confinement provided by the surrounding soil. Geosynthetic encased columns (GECs) have been successfully used to enhance to reduce settlements of embankments on soft soils. This paper describes an investigation on the performance of encased columns constructed on a very soft soil using different types of encasement (three woven geotextiles with different values of tensile stiffness) and different column fill materials (sand, gravel and recycled construction and demolition waste, RCDW). The results of load capacity tests conducted on large-scale models constructed to simulate the different types of GECs indicate that the displacement method adopted during column installation can lead to an enhanced shear strength in the smear zone that develops within the very soft soil. In addition, breakage of the column fill material was found to affect the load-settlement response of gravel and RCDW columns. Furthermore, the excess pore water pressure generated in the surrounding soil during installation, was found to remain limited to radial distances smaller than three times the GEC diameter.

Keywords: Geosynthetics; Embankment; Soft soil; Geotextile; Large-scale test; Encased column

Investigations on fracture characteristics of geosynthetic reinforced asphalt concrete beams using single edge notch beam tests

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Abstract: Reflective cracking is a major cause for premature deterioration of asphalt pavements. Different varieties of geosynthetics are used at the interfaces of surface layers to control the reflective cracks. The significant factors influencing their efficiency are the flexural strength and interfacial bonding. Fracture energy that leads to development of cracks and their propagation can be investigated by single- edge notched beam (SENB) tests with sufficient accuracy. Double layered asphalt samples were extracted from pavement sections purposely built as part of this investigation for conducting quasi-static SENB tests. The goal of this paper is two-fold (a) to present a methodology for conducting SENB tests to measure the fracture properties of geosynthetic reinforced samples at temperatures of 10。C, 20°C and 30°C and (b) evaluation of the flexural and the fracture characteristics of unreinforced and geosynthetic reinforced samples. The geosynthetic reinforcement did not show much improvement of the Asphalt Concrete (AC) in the pre-cracking phase but slowed down the crack propagation. The failure pattern of reinforced specimens has changed from quasi-brittle to ductile. An equation is proposed to predict the crack initiation force of SENB sample knowing the bond strength of the corresponding reinforced AC layers at their respective temperature.

Keywords: Geosynthetics; Natural geotextiles; Single edge notched beam test; Fracture energy; Reflective cracking

Influence of toe restraint conditions on performance of geosynthetic-reinforced soil retaining walls using centrifuge model tests

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Abstract: Current design regulations most often require use of limit equilibrium methods for the internal stability analyses. of geosynthetic-reinforced soil (GRS) walls. However, the limit-equilibrium based approaches generally over-predict reinforcement loads for GRS walls when comparing with measured data from full-scale instrumented walls under working stress conditions. Wall toe resistance has an important influence on the performance of GRS walls but is ignored in limit equilibrium-based methods of design. This paper reports centrifuge modelling of GRS walls which have different toe restraint conditions but are otherwise identical. The GRS wall models prepared in this study isolate the influence of wall toe resistance on the performance of walls. Based on measured data from four centrifuge wall model tests, a reduction in wall toe resistance (by reducing the interface shear resistance at the base of the wall facing or removing the soil passive resistance in front of the wall toe or both) induces larger maximum facing deformation and reinforcement strain and load. The results also demonstrate that the wall models with typical toe restraint conditions are most likely operated under working stress conditions while those with poor toe restraint conditions may experience (or be close to reach) a state of limit equilibrium.

Keywords: Geosynthetics; Segmental retaining walls; Centrifugal modelling; Toe restraint; Facing deformations; Reinforcement loads; AASHTO simplified method; Simplified stiffness method

Evaluation of geocomposite compressible layers as induced trench method applied to shallow buried pipelines

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Abstract: This paper suggests as a rather simple and innovative alternative of the induced trench method with the use of geocomposite replacing EPS geofoam for protection of shallow buried pipes. Laboratory model tests and the numerical studies have been conducted on induced trenches constructed with relatively thin drainage geocomposite, as compressible layers, placed into sand. A parametric study using numerical modelling was conducted considering different arrangements of compressible layers in order to optimize the use of these geosynthetics in rehabilitation and maintenance of shallow buried pipes. It was concluded that geocomposites have compressibility enough to replace EPS using diminished area, which favor the applicability for shallow pipelines protection. Reduction on vertical soil pressures over the crown of the pipe reached values of 90%. The stress reduction at the crown was found to be significant affected by the width of the geocomposite and its distance from the crown of the pipe. The use of a more compressible condition of sand backfill provide more efficiency as far the geocomposite is from the crown of the pipe. Results from numerical modelling also indicate that using more than two geocomposite layers led to negligible stress reductions compared to one layer solution.

Keywords: Geosynthetics; Induced trench method; Geocomposite; Buried pipes

Centrifuge and numerical model studies on the behaviour of geogrid reinforced soil walls with marginal backfills with and without geocomposite layers

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Abstract: The aim of this paper is to study the effect of geocomposite layers as internal drainage system on the behaviour of geogrid reinforced soil walls with marginal backfills using centrifuge and numerical modelling. A series of centrifuge model tests were carried out using a 4.5 m radius beam centrifuge facility available at IIT Bombay. A seepage condition was imposed to all models to simulate rising ground water condition. Displacement and pore water pressure transducers were used to monitor the performance of all centrifuge models. A geogrid reinforced soil wall without any geocomposite layer experienced catastrophic failure soon after applying seepage due to the development of excess pore water pressure within the reinforced soil zone of the wall. In comparison, reinforced soil wall with two geocomposite layers at the bottom portion of the wall was found to have a good performance at the onset of seepage and by embedding four geocomposite layers up to the mid-height of the wall from bottom as a result of lowering phreatic surface much more effectively. For analysing further the observed behaviour of centrifuge model tests, stability and seepage analysis were conducted using SLOPE/W and SEEP/W software packages. A good agreement was found between the results of numerical analysis and observation made in centrifuge tests. The effect of number of geocomposite layers as well as its transmissivity was further analysed using parametric study. The results of parametric study revealed that the number of geocomposite layers plays a main role on the good performance of the geogrid reinforced soil walls with marginal backfill.

Keywords: Geosynthetics; Geogrid reinforced soil walls; Marginal fills; Centrifuge modelling; Geocomposite; Seepage

Evaluation of the combined effect of facing inclination and uniform surcharge on GRS walls

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Abstract: In the current paper, using experimental studies and numerical analyses, the combined effect of facing inclination and uniform surcharge on the behaviour of geosynthetic-reinforced soil (GRS) walls under working stress conditions is evaluated. Data from four well- instrumented GRS walls at the end of construction and under surcharge applications were used considering different facing types, inclinations, and toe conditions. The numerical analyses were carried out considering different wall heights, facing inclinations, and surcharges. Moreover, data from the physical and numerical model studies were utilised to verify the predictability of the AASHTO simplified (2017) and Ehrlich and Mirmoradi (2016) design methods and some limitations of each method are discussed. The results clearly indicate that for better representation of the actual conditions, the uniform surcharge and facing inclination should not be independently taken into account in the design procedures.

Keywords: Geosynthetics; Facing inclination; Uniform surcharge; Experimental study; Numerical analyses; Working stress conditions

Controlling leakage through installed geomembranes using electrical leak Location

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Abstract: Installed geomembranes typically contain holes, which can be located for repair in most cases using electrical leak location (ELL) technologies. It is of special interest to quantify the likelihood that a geomembrane has holes, the impact of such holes with respect to a facility's expected performance, and subsequent remedial actions. In addition to providing a summary of research to date on these topics, the aim of this paper is to answer these questions with modern case studies, contextual hole frequency statistics and a recapitulation and reexamination of leakage data from double-lined landills. Finally, the physics of electrical leak location technology is explained in order to illustrate the capabilities and limitations of the methods as well as to provide guidelines for maximizing the effectiveness of the technologies.
Keywords: Geosynthetics; Electrical leak location; Geomembranes; Landfill leakage; Hole frequency; Action leakage rate